WillItMap Field Use Guide

Complete one field procedure at a time, from the first observation to a checked, saved record.



Photo P16. A roadcut in Otero County, Colorado. An overview locates rock exposure, soil cover, and adjacent terrain before detail logging. The photograph is a real example, not the location of the fictional training outcrop. Jeffrey Beall. Source; CC BY 4.0.

OUTCROP / STRUCTURE / RMR / BARTON-BANDIS / GSI AND HOEK-BROWN / SLOPE HAZARD

v47 | 6 November 2026 | Companion to WillItMap v1.35.4

Photographs, detailed methods, worked examples and references are placed beside the protocol steps that use them. Slope hazard assessment remains a separate workflow.

Real photographs illustrate different sites. Training records and numerical examples are fictional. Use the project field procedure and qualified supervision.

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How to follow the protocols

Follow Protocols 1 and 2 to establish the exposure and its structure. Complete the selected characterization protocols as whole work packages: Protocol 3 for RMR; Protocol 4 for a particular discontinuity and its Barton-Bandis evidence; Protocol 5 for visual GSI and, when required, Hoek-Brown parameters. Protocol 6 records inputs for an engineering screening. Finish every visit with Protocol 7. Begin Protocol 8 separately for a slope hazard rating.

Stay with one assessment domain. Finish the inputs for the chosen outcrop, joint wall or slope assessment before changing context. Reuse an observation only after checking that its domain, feature, date, direction and scale still apply. A reused observation is not a newly measured value.

Shared methods are repeated where needed. RMR and Barton-Bandis both need discontinuity observations. Their procedural steps are kept together here so you do not need to assemble a workflow from scattered chapters. The shared method does not make their rating systems or input records interchangeable.

Required for a calculation is different from obtainable in the field. Complete the observations and provenance as a group; branch to tests or engineering interpretation when needed. Save a partial record and an evidence request if JCS, friction, intact UCS, stress or another justified value is unavailable.

Three kinds of entry

Measured: an instrument or defined procedure produced the value. Estimated: you selected a supported range or representative value and recorded its basis. Interpreted: you decided what a feature means, or selected a model assumption. Keep these distinct in notes and method dropdowns. A precise-looking number does not make an estimate precise.

Unknown is a valid field result

Leave an unknown numeric value blank, or choose Not assessed / Not recorded. Do not enter 0 to make a calculation appear. Zero is a real observation for some fields, including exposed-rock depth. N/A in the slope rating is an explicit zero-point option only where the worksheet offers it; it does not mean unknown.

Units on the actual screen

Lengths, elevation, aperture and rainfall are in feet; volumes are in cubic feet. Bearings and dips are degrees; coordinates are decimal degrees. Observed hardness is an R0-R6 grade; reference strength ranges and Hoek-Brown UCS use MPa; Barton-Bandis stress and JCS use psi. Road speeds in Slope rating use mph. Convert the instrument reading into the displayed unit before entering it.

Use this guide with the matching app and theory manual

Release review basis: WillItMap v1.35.4; paired Theory Manual v49 and Field Use Guide v47. Check the app version in the application. This is a field procedure guide; use the theory manual for formulas, exact category endpoints, calculation examples and engineering model limits.

Find and keep these guides: In Data > Help & manuals, expand Manuals & field guidance and choose Field Use Guide v47 or Theory Manual v49. Both PDFs open in a new tab and need internet. Before leaving coverage, save them to Files or Downloads and test opening them offline. On iPhone, use Share then Save to Files. Installing the app does not automatically save either manual; the links display the current file sizes.

Protocols 1-2: theory F covers records, location and orientation; K covers stereonets, statistics and kinematics. **Protocol 3:** F covers the five RMR categories, exact boundaries and adjustments. **Protocol 4:** F covers joint evidence and the Barton shear calculation. **Protocol 5:** F/S cover GSI and Hoek-Brown.

Protocols 6-7: K covers geometric screening; S/E cover separate engineering models; D covers exports, local records, recovery and account backup. **Protocol 8:** theory D1-D5 covers the independent slope-hazard worksheet. Its records and scores remain separate from outcrop RMR, even when both are backed up in one package.

Units follow the actual input: field lengths/elevation and slope geometry are feet; coordinates are decimal degrees and angles are degrees. Product designation and custom steel-area controls explicitly use inches/in², alongside converted feet/ft². Hoek-Brown UCS is MPa; Barton-Bandis JCS/effective stress are psi; engineering loads are lbf and unit weight pcf. Hazard speed remains mph and annual rainfall is feet. Never interchange pressure and length or psi and MPa.

What changed in this edition: Protocol 2.4J-2.4J.1 explains the equal-angle Wulff default, 10-degree grid and optional equal-area display; K2/K8/K27-K27A supplies reproducible construction, query and density equations. Existing pole-query and independent slope workflows remain. Protocol 2.4H-2.4I explains pole query/deletion,6.1C full-population kinematics and6.2N-6.2O manual overhanging toppling. Protocol 2.4G retains the observed-set color default whenever Stereonet analysis opens; Protocol 7.2/7.2G explains exact-file acknowledgement, cloud/deletion status and Desktop file scopes; Protocol 2.0 clarifies optional mapping groups. Protocol 6.2M retains step-specific Live Geometry, its optional surrounding-slope context and camera controls. Earlier ordered field measurements, source/interpretation distinctions, backup and independent slope-hazard procedures remain unchanged. S17A-S17C extends the supported rectangular-column geometry past vertical; its force recurrence is unchanged. The display changes do not establish rock-mass continuity or an engineering result. Photos teach observation; synthetic numerical checks cannot calibrate a phone.

Retained limit: flexural-toppling kinematics indicates geometric possibility. The whole-slope block-flexure equilibrium model does not provide an accepted FS. Do not treat a diagnostic threshold or an unresolved result as a design FS.

Later releases: the app and both manuals must be reviewed together. Use matching editions; retain earlier versions with historical project records.

Use the definition beside an unfamiliar input

1. Open the nearby guidance before choosing a number. Expand the definition/reference below an unfamiliar control. It explains the quantity and unit, how to observe or select it, and a source where appropriate. Existing charts remain beside their related inputs. Opening help does not enter a value or change a saved observation.

2. Keep observation separate from interpretation. A typical range is supporting context, not a measured value. Record the instrument, test, reference or assumption actually used. If the quantity is unknown, preserve that uncertainty rather than copying an example just to complete the form.

3. Work through each complete protocol. Use Protocol 3 for RMR, Protocol 4 for one Barton-Bandis joint, Protocol 5 for GSI/Hoek-Brown and the separate Protocol 8 for slope hazard. Adjacent definitions help with one field; they do not replace the sequence or applicability check.

4. Prepare for offline work. Help prose and bundled charts/diagrams are available with the installed app. Links to external references require internet. Save necessary publications and both manual PDFs to Files or Downloads before leaving coverage, and verify that each opens offline.

5. Check the actual unit. Feet describe lengths; degrees describe orientations; psi, MPa, pcf and lbf describe different quantities. In the independent hazard workflow, road speed is mph and annual rainfall is feet. The nearby label governs; do not convert a pressure into a length.

6. Preserve raw test data. In Barton-Bandis, supplied rebound readings are retained and arithmetically averaged. The app does not automatically discard low readings or turn rebound into JCS. Apply and document an appropriate external test/correlation procedure if used, and retain the original readings.

Before leaving for the field

Prepare the device while online

Open https://willitmap.com in the browser or installed home-screen app you will actually use. Review the terms. Open Collect, Readings, Collect > Joints > Strength test, and Slope rating. Load the reference charts you expect to need. Test reopening the app in airplane mode before the trip. A saved geology lookup or image is separate from the field database; save any needed reference files too.

Pack a measurement kit

Carry a calibrated geological compass/clinometer, tape in feet or a conversion card, hand lens, scale card, notebook, camera, battery pack and project maps. Add a crack comparator/feeler gauges, roughness profile gauge or straightedge, and authorized sampling supplies as needed. A rebound hammer is optional and requires the appropriate test procedure and calibration. Use eye protection and other site-required equipment; do not hammer protected, unsupported or unstable rock.

Set the rules before collecting

Agree on unique outcrop/sample/photo IDs, the location accuracy needed, the north reference, approved declination, scanline/window sampling method, and evidence needed for ratings. Define which observations are required for this project and who will select design parameters. A bridge foundation reconnaissance may need fewer joint measurements than a slope investigation, but neither should replace missing observations with assumed values.

Make the first backup routine now

Create a harmless training record, save it, export a full device backup and locate that file in Files/Downloads. If online backup is used, sign in and enable it before departure, then use Check cloud data. Draft recovery is useful but does not replace saving. Do not use private browsing or clear website data to troubleshoot a device containing field records.

Protocol 1: Establish and describe the outcrop

Build one identifiable, located geological record before attaching readings or classifications.

Where in the app: Field; Geology only for map context.

Do in this order	What you should have when finished
1.1 Define the exposure	Safe extent, access limits and rock domains
1.2 Identify the record	Project and unique outcrop ID
1.3 Locate and photograph	Coordinate meaning, accuracy and photo trail
1.4 Describe the rock	Lithology, formation evidence, color and texture
1.5 Measure cover and dimensions	Exposure dimensions and observed or unknown rock depth
1.6 Describe weathering	Whole-rock condition; separate wall-specific observations

1.1 Arrive, look and define the exposure



Photo P10. An outcrop-scale field discussion in Acadia. Begin with the setting and a representative exposure before taking close-up measurements; this is an illustrative photograph, not a WillItMap training dataset. NPS / Carmedy West. Source; Public domain (NPS credit).

Start at a safe overview position. Identify the rock exposure, cover, drainage, access limits and potential falling material. Do not stand beneath unsupported blocks or enter a traffic lane to improve a photograph. Record inaccessible or concealed areas rather than implying you inspected them.

Decide what belongs in this outcrop

Use one outcrop record for an exposure or observation area that can be described coherently. If lithology, weathering or structure changes materially, split the observation into additional outcrops or clearly named domains and explain their relationship. Avoid averaging strong sandstone, weak seams and weathered zones into a fictitious uniform rock.

Training visit

The walkthrough uses project Training traverse and outcrop OC-014. Its example is an exposed sandstone face with bedding and a joint set. All numerical values shown are invented for teaching. The photographs throughout this guide come from multiple credited sites and are not photographs of OC-014.

Take an overview first

Take a georeferenced photograph with the outcrop ID visible in a safe foreground or recorded in the photo log. Then collect context views showing the exposure limits and contacts. Make the photo log usable independently of the app: date/time, photographer, outcrop ID, viewing direction and filenames. Keep original images for GIS.

1.2. Create the locality before collecting its measurements

In the app: *Project name *; Date; County; Route; Nearest MP; Default Slope ID; Personnel; Project notes; Outcrop ID *; Slope ID; Station reference (optional)*

An outcrop is the locality that holds your observations, sets, orientation readings and discontinuity records. A station reference is optional; it is not a substitute for an outcrop ID.

Equipment / evidence: Project naming convention, route/site plan, notebook or photo slate.

1. In Collect, create or select the project. Enter its name, date, county, route, nearest milepost, personnel and any default Slope ID. Save project.

2. Select New in the Active outcrop card and enter a unique Outcrop ID, such as OC-014. Check the Project and Outcrop selectors at the top before every group of readings.

3. Use Slope ID if this locality belongs to an identified slope. Use Station reference only when a surveyed or project station actually exists; record its alignment/basis in notes.

4. Put the same project/outcrop ID on the first photograph or slate and on sample bags. The phone GPS alone is rarely enough to identify the exact bed or joint later.

5. Use Project notes for project-wide conventions. Put the actual exposure observations in that outcrop's notes. Save outcrop before opening Readings from the Collect hub.

Worked entry: Training example: project Demonstration Traverse; outcrop OC-014; slope S-03; station blank because this reconnaissance has no station alignment.

If unknown: Leave optional location descriptors blank if unavailable. Do not invent a milepost or station from a rough GPS position.

Watch for: A saved project is not a saved outcrop. The active context remains selected when changing tabs, so a forgotten selector can put otherwise correct measurements under the wrong outcrop.

Read further: R1, R3. See the source guide for links and relevant pages.

Identify the record on screen

Check the project and outcrop selectors before creating each group of readings. The ID in the photograph and notebook must match this record.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

1.2A Define a geological domain only when useful

Actual app controls; synthetic training data. Scroll to reach fields outside the image.

1. Keep the outcrop ID. A domain groups related observations; it does not replace the locality. Split or qualify a domain when lithology, structure, weathering or the engineering question makes that necessary.

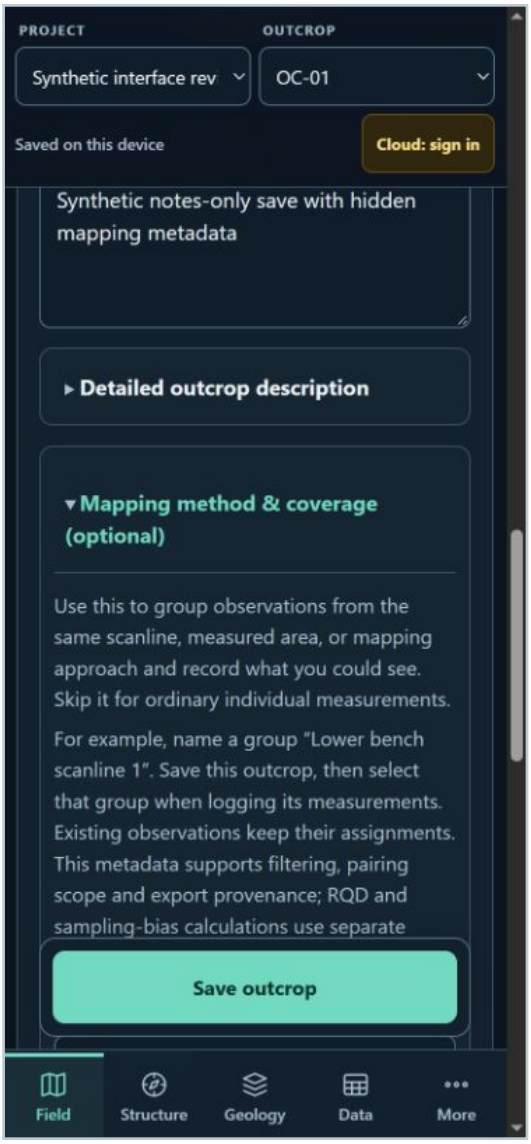
2. In Project setup, expand Geological domains (optional). Choose Add geological domain. Enter Domain name and Geological basis / boundaries. Explain what belongs together and what does not; a common joint-set label alone is insufficient.

3. Save the project. Only saved domains become available for assignment. A domain is identified within this project; an identical name in another project does not establish the same interpretation.

4. Open Mapping method & coverage (optional) in the outcrop. Choose Default geological domain and, if useful, Default slope reach / segment. A reach is a named cut, bench or segment, not a coordinate. Use the same spelling for the same reach.

5. Save outcrop. These are starting values for new observations. Existing measurements/discontinuities keep their recorded assignments. Review an older record explicitly before assigning new context.

Used domains cannot be removed while saved records refer to them. Retain their identity and explain revised interpretations in the description. Save a dated export when the historical interpretation matters.



1.3A. Locate the exposure and record what the coordinate represents

In the app: *Latitude; Longitude; Elevation (ft); Accuracy (ft); Capture GPS*

A coordinate locates the logging point. It does not describe every part of a large exposure or establish a survey control point.

Equipment / evidence: Phone location permission; sky view where practical; survey/GNSS equipment when project accuracy requires it.

1. Stand at a safe, identifiable point adjacent to the exposure. Tap Capture GPS in Field and allow location access. Wait for the status to finish, then inspect latitude, longitude, elevation and accuracy.

2. Check the coordinate is plausible for the site. Negative longitude is normally expected in the continental United States. Decimal coordinates are degrees; elevation and displayed accuracy are feet.

3. Record whether the point is at the toe, center of the logged window, or an offset. If you cannot safely stand at the exposure, log the safe point and write the offset direction/distance and method in notes.

4. If the location is poor, improve sky view where safe and repeat. Do not reduce the accuracy number manually to make the fix appear better.

5. Save outcrop. Current Structure measurements copy the saved outcrop location at capture; they do not independently acquire a fresh GPS fix for every strike/dip. Update and save the locality first when the measurement location changes materially.

Worked entry: Example note: GPS at accessible toe beside painted mark OC-014; joint profile photographed 8 ft east along face; accuracy shown 24 ft.

If unknown: If altitude is unavailable, leave it blank. A horizontal accuracy value does not supply vertical accuracy. A missing coordinate is better than a fabricated one.

Watch for: The browser API defines altitude relative to the WGS 84 ellipsoid, and the app does not apply a geoid/vertical-datum conversion. Do not call this a surveyed NAVD88 elevation. Manual edits clear captured GPS provenance.

Read further: R9. See the source guide for links and relevant pages.

1.3B. Take a photo sequence that someone else can navigate

In the app: *Photo references; Sample IDs; Optional photos / sketches; Observations / field notes; Interpretation; Hazards / site conditions; Discontinuity notes; Photo #; Comments*

Photographs preserve the setting and evidence; the entered interpretation should remain traceable to a specific feature.

Equipment / evidence: Camera/phone with geotagging enabled, visible scale, photo slate or notebook, pencil; permission before sampling.

1. From a safe viewpoint, take an overview showing the whole exposure and its surroundings. Add an ID/scale image and a closer view of each representative lithology or structural domain.

2. Photograph bedding, each critical joint set, infill, roughness profiles and any water or unstable blocks. Put a scale in the same plane as the feature when possible; note the camera viewing direction.

3. Enter original filenames or photo numbers in Photo references. Use the same identifiers in individual discontinuity Photo # and comments.

4. Keep georeferenced originals in the separate camera/GIS backup workflow. Optional photos / sketches creates a compressed app working copy and is not the only archive.

5. In Observations / field notes write what was seen or measured. In Interpretation write what you think it means. Use Sample IDs for bag/test identifiers and note exact collection position. Put access limitations and active hazards in Hazards / site conditions.

Worked entry: Observation: J1 trace continues behind vegetation; visible length exceeds 12 ft. Interpretation: possible release surface; continuation unconfirmed. Photos: OC014_001-008; sample: OC014-S1.

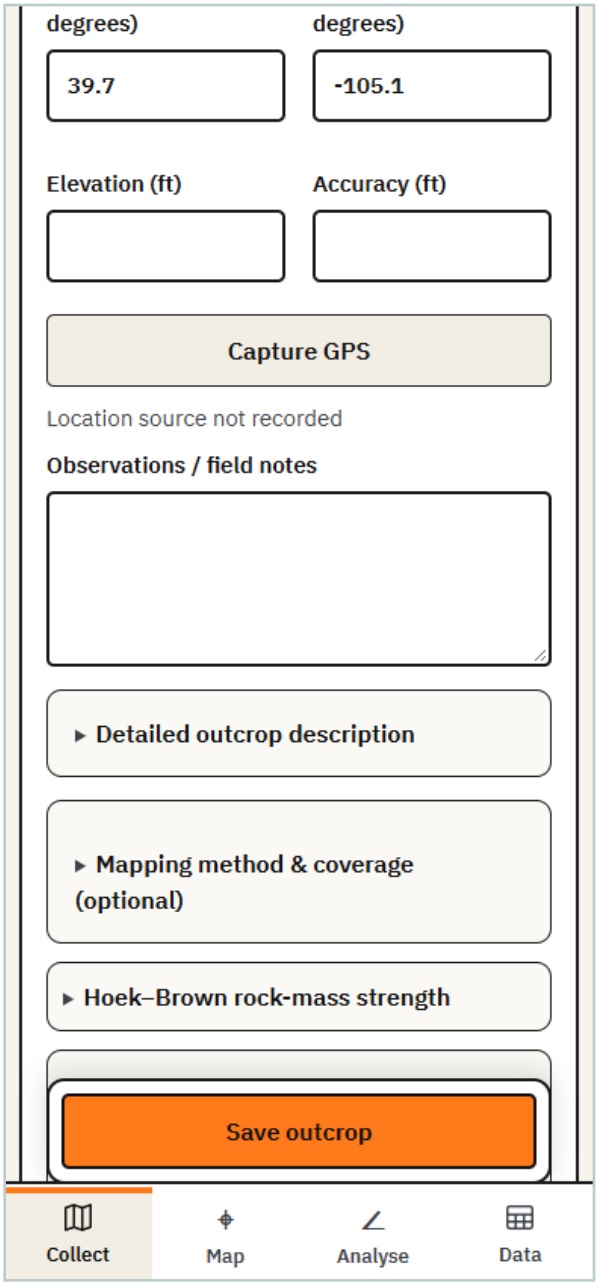
If unknown: State “not exposed,” “not accessible,” “not tested” or “uncertain identification” in notes. An empty field alone does not explain why evidence is missing.

Watch for: A photograph without scale, direction and record identity may be impossible to measure later. Do not sample, hammer or approach loose blocks solely to complete a form.

Read further: R1, R2, R3. See the source guide for links and relevant pages.

Location and the independent photo trail

Keep original georeferenced photos for GIS. Enter their identifiers in Photo references even when the files remain outside the app.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

1.4. Identify rock type, formation, color and texture

In the app: *Lithology / Rock Type; Formation / Unit; Color; Texture / Grain; Joint-wall rock type*

Describe the actual rock first. A mapped formation is supporting context, not proof that the exposed material matches its published description.

Equipment / evidence: Hand lens, grain-size comparator, geological map and legend; fresh surface only where safely and legally obtainable.

1. Examine more than the stained outside skin. Compare fresh and weathered surfaces and note whether the sample is in place or loose float.

2. Choose the best-supported Lithology / Rock Type. Use a broad name plus a question mark in notes if a hand specimen cannot support a more specific identification.

3. Enter Formation / Unit only when correlated to a map, stratigraphic marker or project interpretation. Note the source and confidence. Do not copy a nearby map unit as an observation without checking.

4. Record fresh and weathered color, and whether the surface was dry or wet. Use the project's color chart if one is required.

5. Describe grain size, grain shape, cement/matrix and texture, and any bedding, lamination, foliation or mixed lithology. Divide materially different rock domains into separate records or clearly identified zones.

6. Joint-wall rock type initially follows the outcrop. Override it if the wall is a weak interbed, altered seam or different lithology.

Worked entry: Sandstone; formation uncertain; fresh light gray, weathered orange-brown; fine sand-sized grains, quartz-rich, well cemented; thin siltstone beds 0.1-0.2 ft thick.

If unknown: Use a defensible general description and take a representative sample for later identification; do not force a dropdown name.

Watch for: Mineral hardness, intact rock strength and rock-mass quality are different observations. A granite label does not establish UCS, GSI or friction.

Read further: R1. See the source guide for links and relevant pages.

Read the exposure at two scales



Photo P02. Bands of different appearance in an exposed hillside below Devils Tower. Use an overview photograph to show the extent of each material; confirm lithology on an accessible representative exposure. NPS. Source; Public domain (NPS credit).

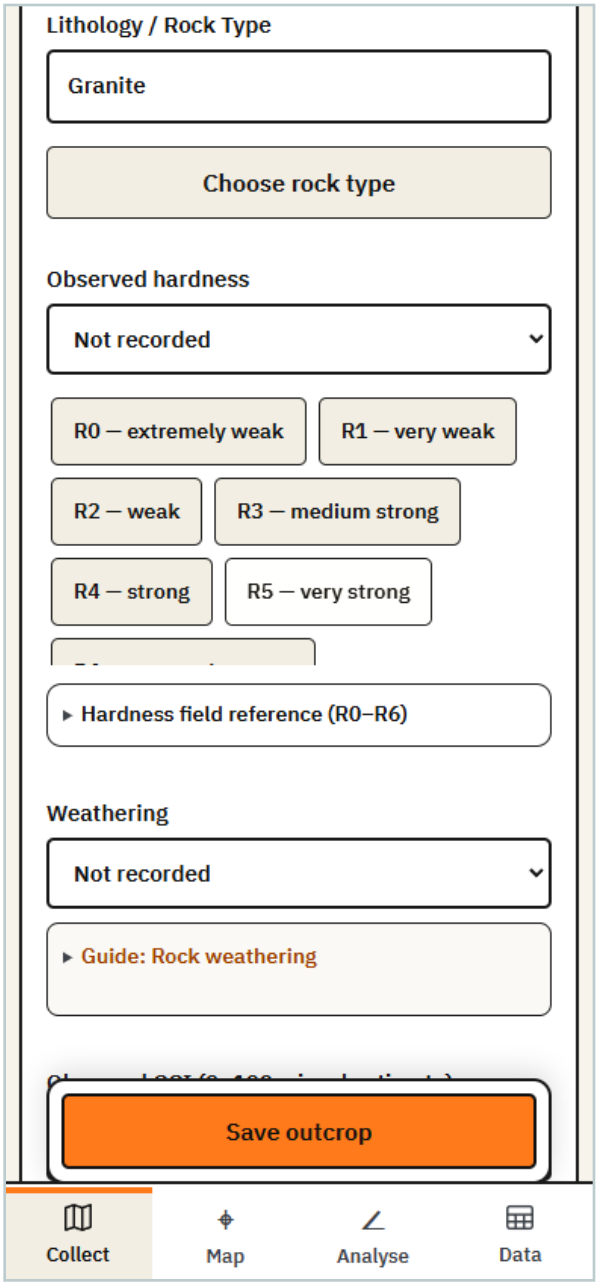


Photo P03. Weathered sandstone at Devils Tower. Compare surface shape and texture with a fresh representative sample where sampling is permitted. Appearance alone does not determine intact strength or JRC. NPS / Chris Racay. Source; Public domain (NPS credit).

The overview shows material domains; the closer view shows a weathered surface. Describe what you can observe and identify a representative fresh sample only where collection is permitted. These different photographs do not establish the same formation or any numerical rock strength.

Describe the exposure on screen

Describe before selecting a classification. Protocol 3 contains the complete hardness method and RMR sequence; Protocol 5 contains the independent visual GSI sequence.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

1.5. Measure exposure dimensions and depth to rock

In the app: *Depth to rock / regolith thickness (ft); Exposure length (ft); Exposure height (ft)*

Exposure dimensions explain how much rock was observable; regolith thickness describes cover at a specified location.

Equipment / evidence: Tape or calibrated laser rangefinder; clinometer where needed; measuring rod for an exposed soil-rock contact.

1. Define the logged window. Measure its length along the exposure and its vertical height. State the endpoints and method in notes; a sloping face length is not the vertical height.

2. Depth to rock defaults to 0 ft because a new outcrop is presumed to expose rock. Confirm that assumption at the recorded point.

3. Where cover is exposed, measure from the local ground surface to the interpreted bedrock contact along the documented depth direction, ordinarily vertical. Record whether the contact is sharp or gradational.

4. If rock lies below ground but the contact is not exposed or investigated, clear the zero and write “depth unknown.” A probing refusal is not automatically bedrock; document method and uncertainty.

5. If dimensions are estimated, say so. Do not enter a numerical maximum height from an oblique photograph without an appropriate scale/geometric method.

Worked entry: Exposure length 35 ft; vertical height 12 ft; depth to rock 0 ft at toe. At upper edge, weathered mantle ~1.5 ft, contact partly obscured.

If unknown: Blank means unknown/not measured; zero means observed zero. Distinguish inaccessible from absent.

Watch for: Do not confuse regolith thickness with the thickness of a weathered rind, joint infill or the full slope height. Large rock masses may be poorly represented by one small exposed patch.

Read further: R1, R3. See the source guide for links and relevant pages.

Visual method: exposed rock, cover and weathering

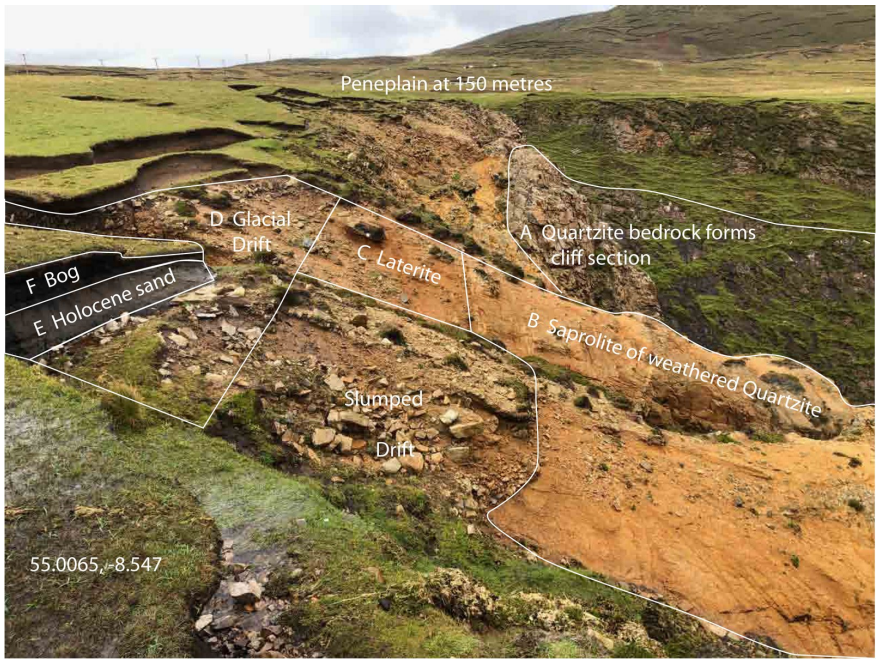
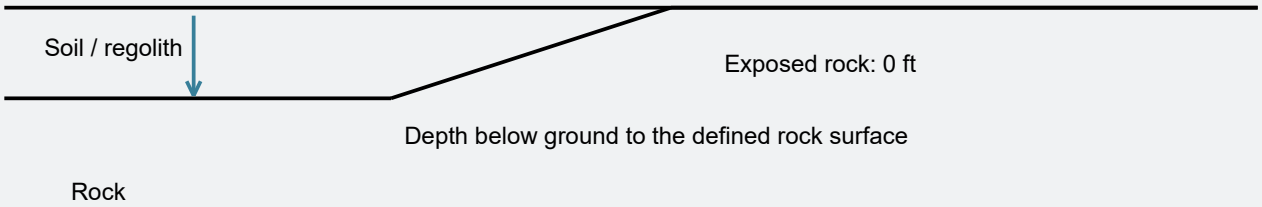


Photo P14. An annotated weathering profile in quartzite at Aranmore, Ireland. Soil and weathered rock can grade into one another; state the project definition of rock and the evidence used for depth to rock. Original annotations belong to the source. Geologician. Source; CC BY-SA 4.0.



At a covered point with no observed base, clear the default: unknown ≠ 0.

The photograph retains its original labels/units. App depths must be entered in feet. A gradational weathering profile requires a stated project definition of the soil/rock boundary.

1.6. Separate whole-rock weathering from joint-wall weathering

In the app: *Weathering*

Weathering describes alteration/disintegration. Its expression in the bulk rock may differ substantially from the surfaces of a joint.

Equipment / evidence: Hand lens, representative surface/sample, photo scale; project-approved weathering descriptors.

1. Compare a surface with the interior where a safe fresh break or existing exposure is available. Look for discoloration, mineral alteration, loosening of grains and strength loss.

2. Fresh has no evident weathering of the material; slightly weathered commonly shows discoloration with little strength loss. Moderate and high weathering involve increasing decomposition/disintegration. Completely weathered material has largely become soil while original rock fabric may remain.

3. Select the dominant condition for the defined rock domain in Field, then record the range and any weathering thickness or weak zones in notes.

4. On each discontinuity, assess the actual wall separately. A fresh block can have strongly altered joint walls, and a thin stained surface is not necessarily deeply decomposed.

5. If soil-like material has lost its rock structure, describe it accordingly and do not force a rock-mass strength model onto it.

Worked entry: Outcrop Slightly Weathered; J1 wall Moderately; iron staining penetrates ~0.01 ft; local clay seam. Record both observations rather than one compromise category.

If unknown: Leave unassessed where the surface cannot be inspected. Use notes to distinguish hidden walls from genuinely fresh walls.

Watch for: Weathering grades are broad descriptions, not automatic strength multipliers. Do not lower GSI only because of water pressure; pressure must be evaluated separately.

Read further: R1, R2, R6. See the source guide for links and relevant pages.

Protocol 1 completion check

Before moving on:

1. The ID, coordinate meaning/accuracy, photo references and exposure limits identify the same locality.

2. Lithology, color, texture, formation interpretation and weathering are distinguished from one another.

3. Depth 0 ft means observed exposed rock; clear it if the soil/rock boundary is not established.

4. Record hardness in Protocol 3 step 3.1 even if only a field strength description is required; the remaining RMR steps are needed for a complete rating.

Save and check: Save outcrop, reopen it and check the location and description. Continue to the structure population before interpreting orientation effects.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

Protocol 2: Measure bedding and joint populations

Collect and check a coherent population before using its orientation in a rating or model. Repeat the measurement sequence for bedding and each applicable joint set.

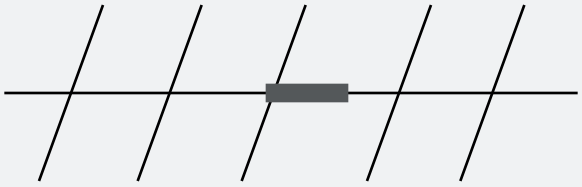
Where in the app: Collect > Readings; maintain the active outcrop.

Do in this order	What you should have when finished
2.1 Establish north	North convention and declination basis
2.2 Measure one plane	True dip, correct RHR strike and feature identity
2.3 Check phone use if selected	Comparison with a control instrument
2.4 Repeat and inspect	Representative population and live stereonet check

2.0 Record how this structural survey was collected

SCANLINE: measured traverse

Oblique crossings are not true set spacing.



Record length, trend/plunge and omitted intervals.

WINDOW: defined exposed area



Width (ft), height (ft)

Record face dip/direction and hidden areas.

Optional grouping: use Mapping method & coverage only to group observations from the same scanline, exposed area or approach and record visibility. Skip it for ordinary individual measurements. Name the effort, for example Lower bench scanline 1. Relevant units and Complete requirements appear beside the selected method; unrelated saved geometry and observation assignments remain retained. RQD and sampling-bias calculations use separate Engineering datasets.

1. Define the collection task before counting. Use Reconnaissance / spot mapping for an overview; Selected critical joints for deliberately chosen release candidates; Systematic scanline for a measured traverse; Systematic window for a defined exposed area. Selective critical-joint records must not be described as a representative random sample.

2. In Collect, open Mapping method & coverage (optional) > Add mapping group. Name the survey with a stable visit/line/window identifier. Enter Collection method, Survey north reference and the applicable geometry. Keep endpoint sketches and photo IDs in Visibility, access and survey limits.

3. Establish geometry and visibility. Scanline: measured tape length plus trend and plunge. Window: width and height plus exposed-face dip/dip direction. Record Smallest trace reliably visible (ft) when assessed. Blank means unknown; zero is an explicit value, not a safe placeholder.

4. Describe coverage. Choose Partial / interrupted or Not assessed while the evidence is incomplete. Complete within stated limits requires a known north reference plus the complete scanline or window geometry. It describes the declared survey, not every discontinuity in the slope.

5. Save the outcrop before collecting under this survey. A saved session becomes selectable in Readings and Joints. Do not rotate orientation readings merely because a different survey north reference was selected.

Example: a 20-ft line at 090 degrees trend / 0 degrees plunge, true north; smallest visible trace 0.5 ft; interval 8-11 ft under soil. Mark Partial if that covered interval lies inside the intended survey. Keep the actual observations and explain the gap.

2.0A Check the saved survey geometry

Actual app controls; synthetic training data. Scroll to reach fields outside the image.

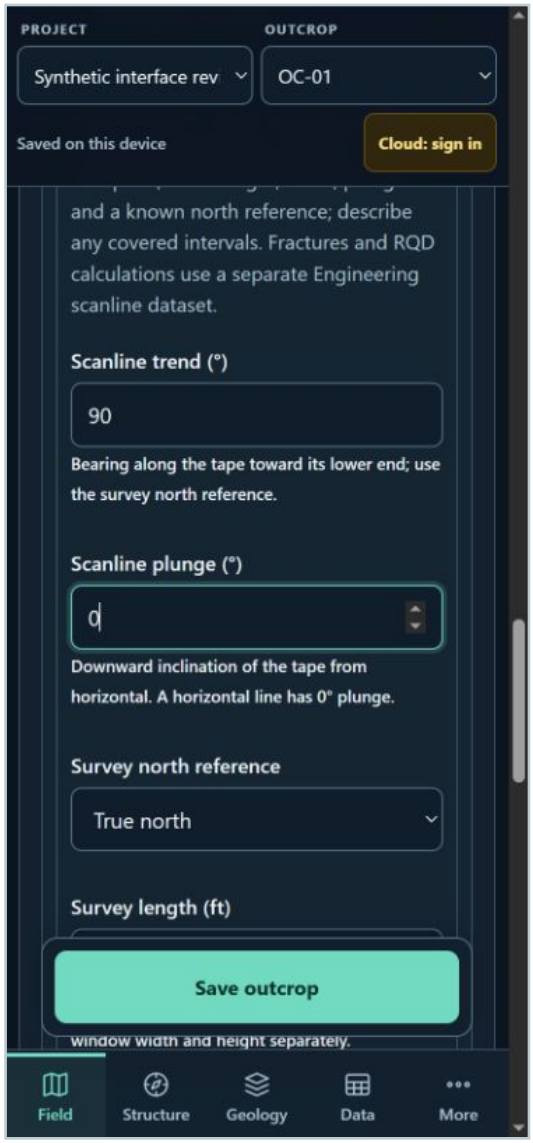
Scanline orientation: trend points along the tape toward its lower end; plunge is its downward inclination from horizontal. For a horizontal line, use a documented chosen direction and 0 degrees plunge. State true or magnetic north consistently with the instrument and field notes.

Survey length: enter the measured tape length in feet, not a guessed horizontal span. Window width and height are separate measurements; describe the measurement directions and exposure limits in the notes.

Window orientation: exposed-face dip is from horizontal; dip direction is its downhill bearing. Supply both or leave both unknown. A window survey marked complete also requires positive width and height.

Known values versus omissions: partial surveys can retain supported geometry while other fields remain blank. If the app rejects Complete within stated limits, follow the highlighted field and supply evidence or retain Partial / interrupted. Do not invent a dimension to close the form.

Save and reopen: check the values and coverage before using the survey in Structure or Discontinuities. This current synthetic example uses a 20-ft line at 090 degrees trend and 0 degrees plunge with true north. Complete describes this visible teaching interval only; it does not prove rock-mass completeness.



2.0B Attach each observation to its recorded context

Actual app controls; synthetic training data. Scroll to reach fields outside the image.

1. Check the active project and outcrop. Open Survey, domain & slope reach before saving the group of readings.

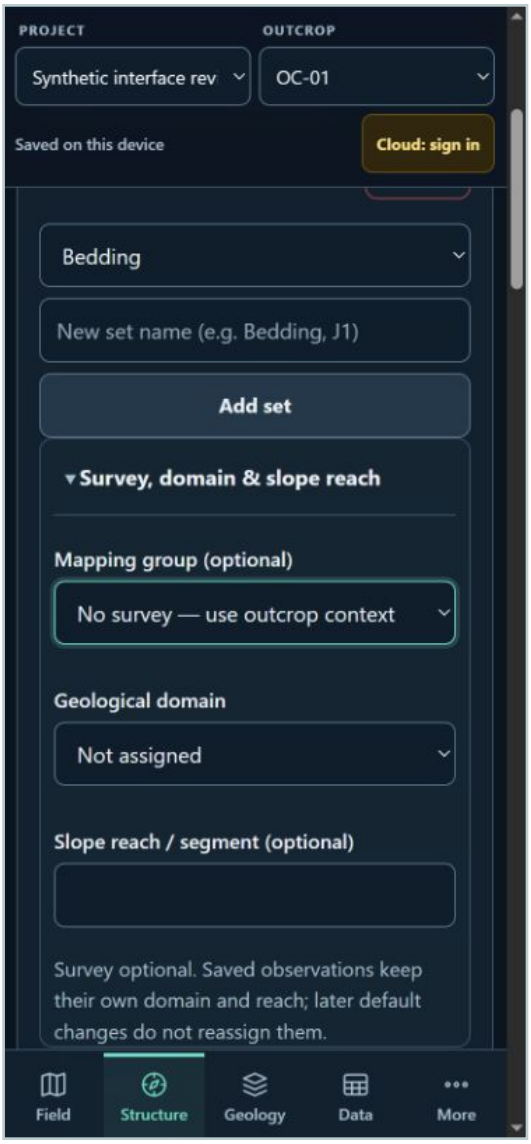
2. Select Mapping group (optional). Its saved domain and reach fill the observation controls. Override either only when the individual reading belongs elsewhere. Without a survey, a new record can use the outcrop defaults.

3. Save the observation. It stores its own survey/domain/reach assignments. Later default changes do not retroactively reclassify it. A legacy record without assignments remains unassigned when opened.

4. Repeat deliberately. Bedding, joint sets and unusual planes should retain the appropriate collection context. Start another session when exposure, purpose or coverage changes materially. Keep incomplete and selective data identifiable.

5. Review and reopen. Confirm the recorded context with the saved measurement or discontinuity. The survey metadata does not apply automatic weights, correct orientation bias or reconstruct joints that were never visible.

No minimum number of readings proves an adequate survey. Use the project investigation plan and USBR Chapter 7 for fuller field procedures.



2.0C Assign reviewed context to existing records

1. Review the original evidence first. An old measurement may have no survey or domain assignment. A current default is not proof of its historical context. Identify only the records supported by notes, photographs or the original survey.

2. In Desktop, choose Outcrops, Strike / dip or Discontinuities. Select the saved rows to update, all within one project. Click Assign survey / domain. This action does not apply to the independent slope-rating table.

3. Choose each assignment explicitly. Geological domain and Survey / exposure each offer Keep existing assignments and a clear option. A named survey is available only when all selected observation rows belong to one outcrop. Across outcrops, survey assignments can be kept or cleared, while a project domain can still be assigned.

4. Decide whether to change the reach. Tick Change slope reach and enter Slope reach / segment to replace it; a checked blank clears it. Leaving the checkbox off retains each existing reach. Unlike selecting a survey on a new field form, this batch action does not infer domain or reach from the chosen survey.

5. Stage context assignments, then Review & save edits. Inspect changed values before saving. Draft changes are not committed by the first button. Discard draft edits abandons them; Undo last edit uses the existing version checks to reverse a saved batch when eligible.

6. Reopen and rerun screening. Check the saved rows and pair counts. If you selected Outcrops, domain/reach changes affect defaults for future observations only; the existing measurements remain unchanged. Assign the measurement/discontinuity rows separately when evidence supports that change.

Changing labels does not prove physical intersection. Keep a dated export when the reassignment forms part of an engineering interpretation. The normal local-save and online-backup checks still apply.

2.1. Establish true or magnetic north before logging orientations

In the app: *Declination override (°); Override date; North reference*

An orientation is incomplete without its north reference. Mixing magnetic and true bearings can create false joint sets and wrong kinematic conclusions.

Equipment / evidence: Calibrated geological compass; current location/date magnetic-declination source; instrument instructions.

1. Check whether the geological compass is adjusted for declination. A corrected compass may already read true north; record that status before copying its number.

2. For phone capture, leave Declination override blank to use offline WMM2025 at the current device date and phone GPS or saved outcrop position. A project-prescribed value, including zero, overrides Auto; record its date and source.

3. For manual entry, select the reference of the actual entered bearing. Manual strike is not automatically corrected by the project declination field.

4. Enable sensors and allow location. Review True north, the applied angle and WMM2025/location source. Without a usable correction, the display stays Magnetic north and requires explicit acknowledgement before capture. Check against a calibrated instrument.

5. Check away from vehicles, steel fences, hammers, magnets and other magnetic interference. Repeat the reading after moving the instrument if a bearing seems inconsistent.

Worked entry: Illustrative arithmetic only: magnetic RHR strike 010° with verified declination +8° becomes true RHR strike 018°. Enter 018° / True north once; do not add +8° a second time.

If unknown: Select Unknown / not recorded if genuinely unresolved and document it. Resolve the reference before combining measurements in analysis.

Watch for: The project declination is not a universal correction for every imported or manual record. Double-correction is as wrong as no correction.

Read further: R3, R10. See the source guide for links and relevant pages.

2.2. Measure bedding and joint orientation with a compass-clinometer

In the app: *Active structural set; New structural set name; RHR Strike (°); Dip (°); North reference; Note; Feature type; Orientation entry; Strike (° / quadrant); Dip Direction (°); Measurement tool; Copy saved Structure measurement*

Strike is the horizontal line on a plane. Dip is the steepest downward angle from horizontal. Right-hand-rule strike is the strike direction for which the plane falls to your right.

Equipment / evidence: Geological compass/clinometer; flat nonmagnetic plate for a rough but representative planar surface; photo scale.

1. Identify the actual planar feature: bedding, joint, foliation, cleavage or fault. Do not measure a random chip face or the cut slope and label it bedding.

2. Create/select Bedding, J1, J2 or another descriptive set, then choose Feature type. Keep a new uncertain population separate until reviewed.

3. Seat the compass edge or a small plate on the representative plane. Find the level line and measure its bearing. Measure the maximum dip in the direction perpendicular to that level line, checking the clinometer orientation.

4. Choose the RHR strike so the downslope direction is 90° clockwise from strike. Check visually: a strike of 270° means a dip direction of 000°, not south. Dip remains between 0° and 90°.

5. In Structure enter RHR Strike, Dip, North reference and a short note. Inspect the orientation sketch, then tap Save & measure another. Confirm the count increased.

6. For a detailed joint record, open Discontinuities / Barton-Bandis and either copy that saved Structure measurement or enter dip direction/dip directly. Copying creates an independent snapshot; later edits do not update both automatically.

Worked entry: Plane dips northeast at 35°: dip direction 045°, RHR strike 315°. Structure entry is 315 / 35 with its actual north reference; the Discontinuity dip-direction entry is 045 / 35.

If unknown: If only apparent dip can be seen, record the apparent angle, viewing/section direction and limitation in notes rather than saving it as true dip.

Watch for: Strike has two opposite bearings; selecting the wrong RHR branch reverses dip direction. At exactly vertical the two dip-direction choices describe the same plane; near vertical, still check the measured strike. A horizontal plane has no unique strike.

Read further: R2, R3. See the source guide for links and relevant pages.

See the two instrument positions



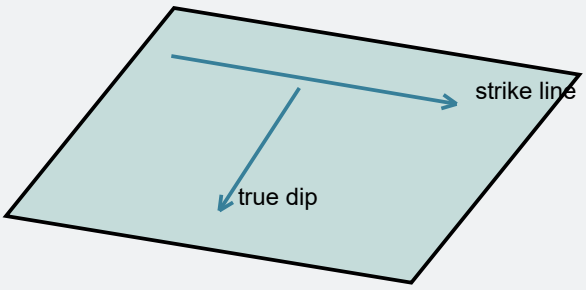
Photo P11. A clinometer is held vertically against a fault surface to measure inclination. Seek the maximum downward inclination for true dip; measure the bearing separately with the compass horizontal. Meanos. Source; Public domain (photographer dedication).



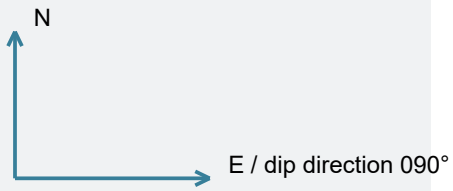
Photo P12. The compass is held horizontally to measure a geographic bearing associated with the inclined surface. Write down whether your bearing is strike or dip direction and which north reference you used. Meanos. Source; Public domain (photographer dedication).

Top: inclination measurement. Bottom: a horizontal compass bearing. The photographs show instrument positioning, not the RHR branch for your plane. Independently identify the strike line and downslope direction, then record the correct north reference.

Visual method: strike, dip and dip direction



Plane schematic; dip is the steepest downward inclination.



RHR strike 000°

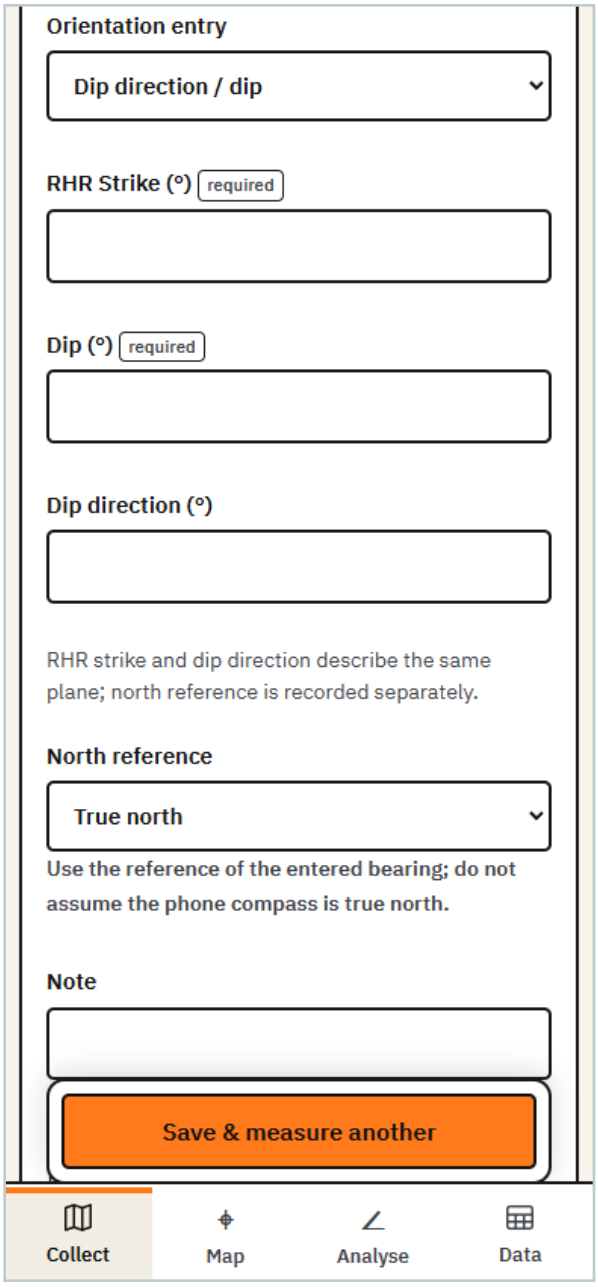
Dip 35° toward east

The strike and dip direction differ by 90°.

Visual method: strike, dip and dip direction

(continued)

From Collect, open Readings for a plane measurement or Joints for a discontinuity. Choose the entry convention explicitly. For example, RHR strike 000 / dip 35, true north, dips east: its dip direction is 090. The illustration shows the Readings controls before entry; do not enter 090 as RHR strike for this example.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

2.3. Use phone contact orientation only after a field check

In the app: *Enable phone sensors; Capture averaged reading; Live RHR Strike; Live Dip; Live Dip Direction; Sensor quality status; Sensor north reference; Compass accuracy*

Phone contact mode can accelerate data capture, but the app explicitly labels browser sensor mode experimental and not physically field-validated.

Equipment / evidence: Supported phone/browser, sensor permission, calibrated compass-clinometer and a known reference plane.

1. Before relying on readings, compare several low, moderate and steep planes with the geological compass. Check bearing and dip, repeatability, north reference and the phone case/contact surface.

2. Select the correct outcrop and set. Tap Enable phone sensors and grant the requested permission. If heading is unavailable or the app shows Dip only, use manual compass entry.

3. Hold the back of the phone flush to the representative plane, keeping hands stable and magnetic accessories away. Do not let a camera bump or thick case tilt the phone off the plane.

4. For a 70-90° face, turn the phone sideways within that same plane so its top points across the face instead of straight upward. The phone still lies flush; you are not tilting it away from the rock.

5. Wait for a stable reading and inspect quality, reference and compass accuracy. Capture averaged reading saves one observation. Averaging does not correct a systematic calibration error.

6. Check the saved point on the live stereonet and compare at least one repeat on the same feature. Record limitations in the field notes; use manual measurements when sensor performance is doubtful.

Worked entry: Training check: repeat a known steep plane with the phone portrait and sideways; compare both with a compass. Keep the authoritative compass result if phone bearing changes materially.

If unknown: Permission denial, absent magnetometer, missing accuracy metadata and no heading are not solved by entering zero. Use manual entry.

Watch for: Readings saved before v1.11.6 may require corroboration or recollection because older dip directions can be incorrect. Do not rotate all historical values automatically. The quality badge is not proof of survey accuracy.

Read further: R3, R9. See the source guide for links and relevant pages.

Read and capture together. The Contact orientation panel groups RHR strike, dip and dip direction above Capture averaged reading. Check the visible north reference and quality message before capturing. Enable phone sensors starts collection. Expand Phone position & earlier readings for steep-face instructions and the historical-reading warning; View stereonet opens saved observations. Capture confirms saving inline below its button, without a success popup. If quality is poor, review the visible warning and acknowledge it inline before deliberately capturing; the acknowledgement resets after saving or changing project, outcrop, set or north-reference context. A failed save stays visible inline. Live north reference and quality remain visible. At 200% text the readings stack to preserve readability.

Copying a live reading. Use live reading preserves its exact angles. If quality is poor, review and acknowledge it inline in the current context before copying. A previous context acknowledgement does not carry forward.

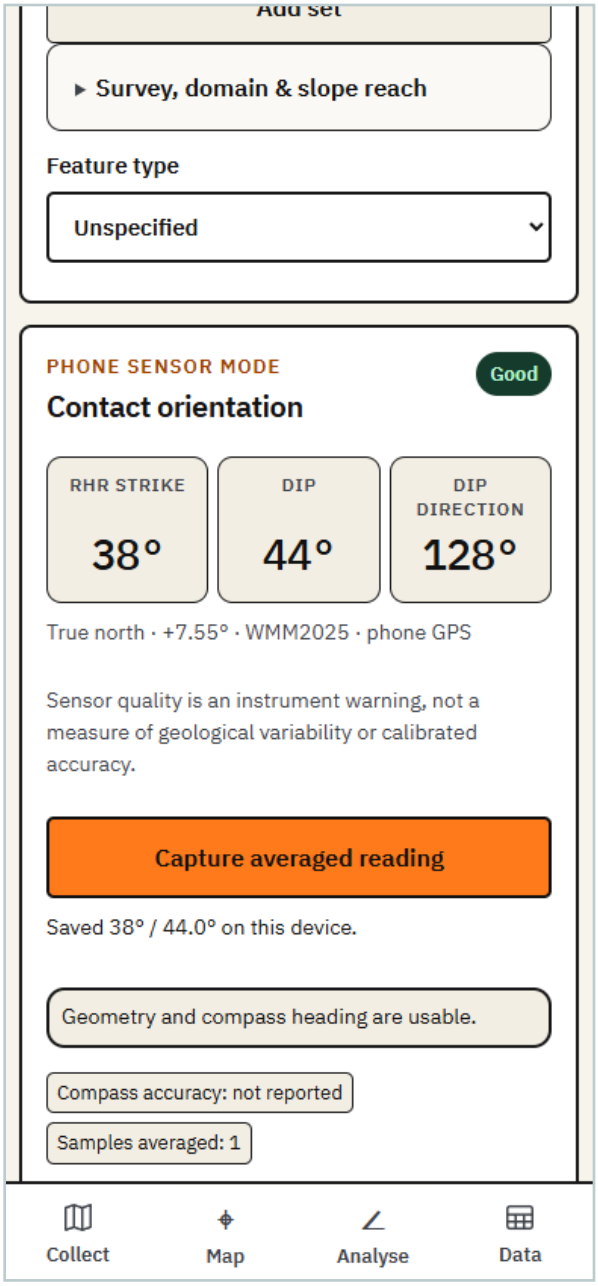
2.3A Phone contact check at steep dips

First compare the exact phone/browser with a trusted compass and inclinometer on horizontal, inclined and vertical reference planes. Record repeatability and the project's acceptance limits. Browser sensor mode is explicitly experimental in this release; synthetic software tests do not calibrate physical hardware.

Open Collect > Readings > Enable phone sensors and grant the requested permissions. Remove magnetic interference where practical. Place the back of the phone flush to the intended rock plane. A protruding camera or case must not rock the contact; use a suitable flat reference surface without bridging unrelated asperities.

For steep planes (70-90 degrees), rotate the phone sideways within the plane so its top edge points across the face instead of nearly straight upward. Watch the quality/compass warnings, allow readings to settle, and use Capture averaged reading only when the orientation agrees with the control instrument.

Check the north reference and declination. At nearly horizontal planes, strike is unstable; at exactly vertical planes either opposing dip direction can describe the same plane. Re-check the strike line and geometry. Corroborate or recollect phone records from before v1.11.6: a known old orientation-convention issue can affect dip direction; never rotate all old data automatically.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

2.4. Collect a representative population, then use the stereonet to question it

In the app: *New structural set name; Active structural set; Feature type; Note; Measurements shown; Inspect a measurement; Show selected plane*

One easy-to-reach face can hide entire sets. The live plot is a consistency aid, not a target that all data should be forced to match.

Equipment / evidence: Tape/scanline, map or sketch, compass-clinometer, record of accessible and obscured portions.

1. Define the area or scanline and logging objective. For a slope, include uncommon planes that could release a block; for a broad rock-mass description, do not only collect the most striking joints.

2. Sample bedding and observable joint sets at multiple positions. Use additional safe viewing directions or traverses so a set nearly parallel to one line is not omitted.

3. Assign provisional set labels based on orientation and geological character. Keep bedding, shears and different domains traceable. The number of sets is an observation, not a requirement of the app.

4. Use All sets in this outcrop, inspect a saved measurement, and optionally show its plane. A pole is the normal to the measured plane; steep planes plot toward the rim and shallow planes toward the center.

5. Investigate outliers: wrong set, reversed strike, poor contact, real fold/curvature or a critical rare joint. Correct documented errors; retain real geological variation.

6. Note sample size and visibility limitations. Repeated measurements on one joint test repeatability but are not additional independent joints.

Worked entry: Bedding, J1 and J2 are common; one persistent clay-coated plane differs by 30°. Keep it as a separate critical observation rather than deleting it to tighten the J1 cluster.

If unknown: Write which orientations or parts of the exposure could not be inspected. A blank sector on a plot can mean sampling bias.

Watch for: A set mean hides within-set scatter and does not prove a mechanically connected plane. Do not pool materially different outcrops just to obtain a larger n.

Read further: R3. See the source guide for links and relevant pages.

Bedding and joint networks are different features



Photo P17. Tilted sandstone beds on the Fossil Discovery Trail at Dinosaur National Monument. Establish which surfaces represent bedding before measuring. An image shows apparent inclination; true dip must be measured in the steepest downward direction on the actual plane. NPS / Dan Johnson. Source; Public domain (NPS credit).



Photo P06. A top view of basalt columns at Devils Postpile shows a joint network on a glacially modified surface. The network is useful for identifying trace intersections; this surface is not an exposed matched joint pair for JRC assessment. NPS. Source; Public domain (NPS credit).

Upper photo: follow the sedimentary layers, then measure an actual plane at an accessible representative point. Lower photo: a basalt joint network; polygon edges are not bedding. Neither photograph supplies a true dip or a calibrated spacing without additional field evidence.

2.4A Review the live stereonet

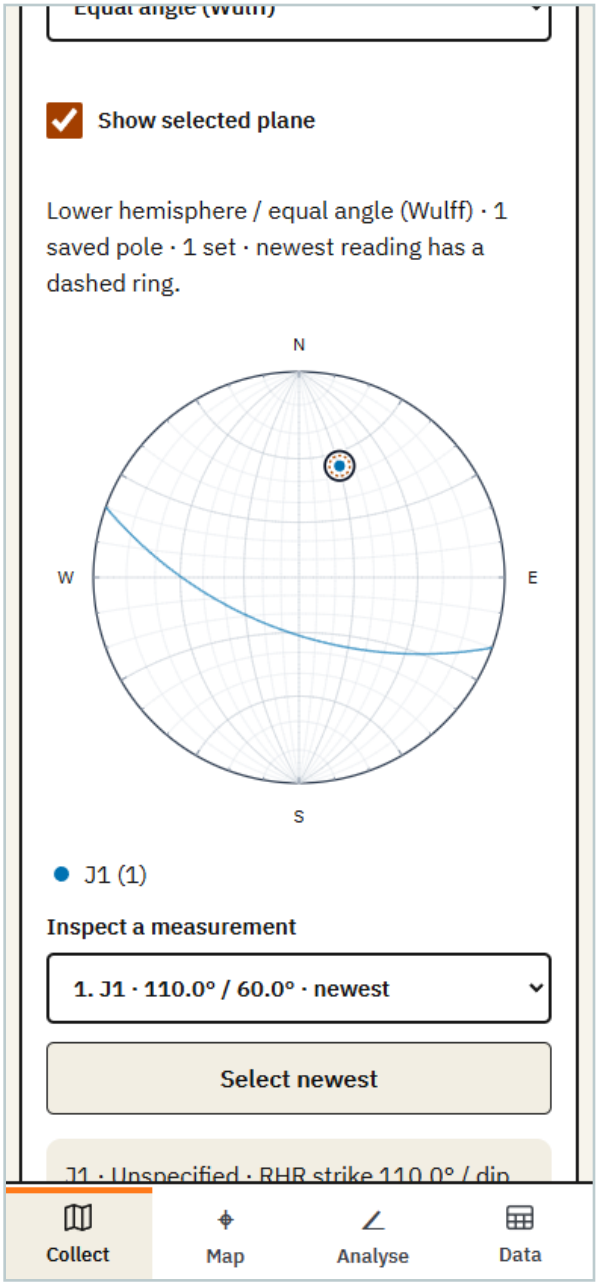
Select View stereonet or open Live stereonet. Use All sets in this outcrop to compare populations, or Active set only to inspect one. Expand plot for a larger view. The plot updates after records are saved.

Projection opens at Equal angle (Wulff). Its 10-degree reference grid and selected plane use the same transform. Equal area (Schmidt) is available in the Projection selector; recorded orientations are unchanged.

Each point is a pole perpendicular to a plane, not the dip-direction arrow. Shallow planes plot near the center; steep planes plot near the rim. Pole bearings are opposite plane dip directions. Set colors and shapes help distinguish populations.

Tap an unexpected point or choose it in Inspect a measurement. Compare its feature type, north reference, strike and dip with the notebook and rock. Check for an RHR reversal, transposed strike/dip, wrong set or accidental input. Re-measure if feasible; a separated point may represent real geology.

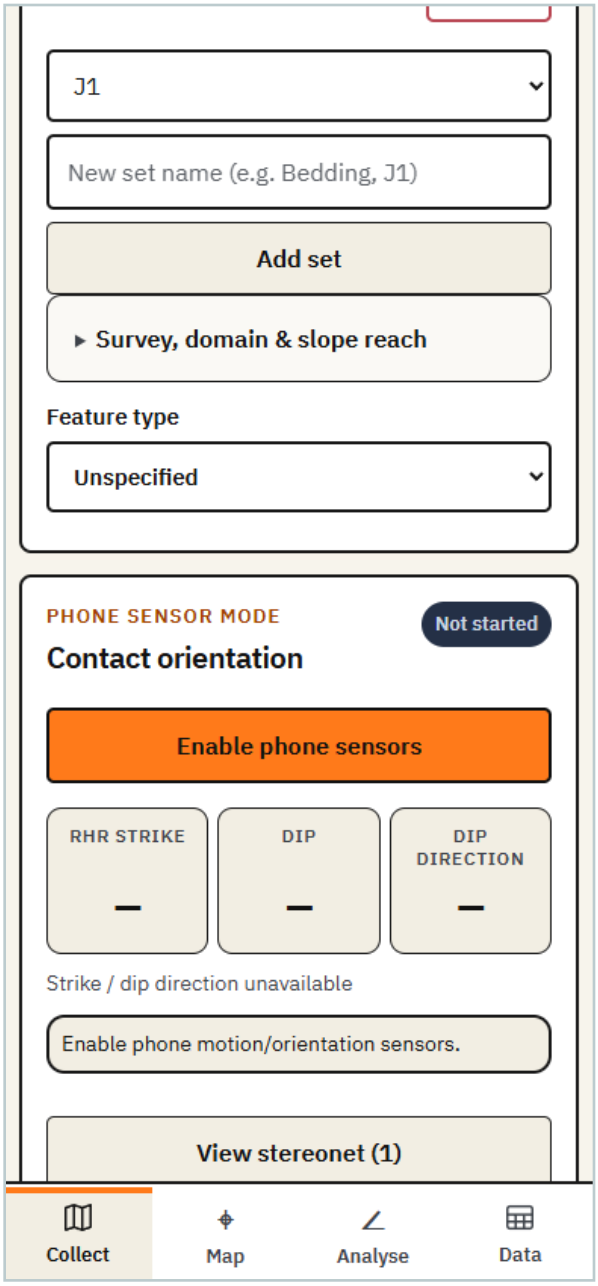
Retain legitimate variation. Do not delete points merely to make a tight cluster or a preferred mean. A cluster does not prove connected blocks or failure. Kinematic screening and slope stability are separate later interpretations.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

Assign readings to the right set

Use a bedding set and separately identified joint sets as appropriate. Do not substitute one attractive plane for a representative joint population. Preserve unusual readings until their geological or measurement explanation is known.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

2.4B Import a spreadsheet with joint-set labels

When to use this branch: observations already exist in a spreadsheet or CSV. Open the structural analysis workspace and choose Import CSV / paste rows. This is an analysis handoff; ordinary Structure measurements still use their field Save procedure.

Dip	Dip direction	Outcrop	Joint set
45	120	OC1	J1
47	125	OC1	J1
70	220	OC1	J2
50	130	OC2	

1. Prepare the rows. Use one measurement per row, with angles in degrees and a consistent stated north reference. These are teaching values, not observations. Copy the header and cells from a spreadsheet, or use comma-separated text beginning Dip,Dip direction,Outcrop,Joint set. Keep local joint IDs such as J1 and J2 consistent with the notebook. Surrounding spaces are trimmed; case is preserved, so J1 and j1 stay different. Leave a genuinely unassigned set blank.

2. Read and map the columns. Choose the file or paste the rows. Confirm First row contains column names, Orientation convention and North reference; choose Read columns. Check the Dip, Dip direction, Outcrop and Joint set (optional) mappings. Expand How joint sets are imported for the label/storage explanation. With RHR strike data, map strike instead of dip direction. Without headers, explicitly map Outcrop and Joint set after Read columns. The optional joint-set column can be omitted; do not substitute a guessed set just to complete a row.

3. Preview the classifications. Choose Preview import. Check angles, outcrops, supplied Joint set and initial Interpreted set, along with errors and duplicate warnings. The example has two J1 rows, one J2 row and one unassigned row. Correct errors, including labels longer than 120 characters, before Add reviewed dataset. Preview again after a correction.

4. Add and inspect. Choose Add reviewed dataset. Inspect the table and poles. The supplied Joint set remains the original Observed set; the initial interpreted assignment can be edited separately. Preserve the source sheet and its north/sampling notes with the analysis export.

2.4C Keep local joint labels and interpretations distinct

Check the outcrop population before combining it. The same interpreted label combines rows in the selected population, including across outcrops. J1 at OC1 and J1 at OC2 may describe different local populations. Filter to the relevant outcrop, or rename the interpreted groups to distinct labels before combining them. A repeated label never proves physical continuity or engineering applicability.

Original versus edited groups. The imported Joint set is preserved as Observed set (fieldSet in a machine-readable export). New imports seed the assignment once; existing saved analyses are not automatically regrouped. Changing or clearing the interpreted assignment does not rewrite the supplied label. Review an interpreted group against the poles and geological evidence; do not adjust the original observation merely to make a tight cluster.

If reimporting an analysis export: the separate Interpreted set (optional) mapping recognizes the exported interpreted classification, including analysisSet. When this column is mapped, its cells control the initial interpreted assignment, even when a cell is blank. For example, Joint set J1 with an empty Interpreted set stays observed J1 and interpreted Unassigned. If the interpreted column is absent, J1 initially seeds the interpreted group J1.

Keep the storage boundary clear. Add reviewed dataset creates an analysis dataset. An imported Outcrop label does not automatically attach records to an existing field outcrop, create a field measurement, or upload it through field-record sync. Save/export the analysis with its own controls and reopen or inspect the exported rows to confirm their labels. Retain the original CSV as a separate source record.

If you deliberately attach an import later: use the separate adoption review and APPLY confirmation. Automatic matching uses a supplied outcrop ID exclusively and respects a supplied project ID; without an outcrop ID, its code must match uniquely. Stale or ambiguous identity requires an explicit target; choosing one deliberately overrides imported metadata. A blank interpreted label remains unassigned; attachment uses the neutral Imported observations container, not the original J1 label. Existing field observations cannot be reassigned to a blank interpretation. Verify the chosen destination before confirming.

Before using a mean or slope analysis: check the selected outcrop/domain, feature type and north reference. Set labels do not provide strength, persistence, joint connectivity or a safety conclusion. See Theory K1-K1A for import conventions and K for statistical and kinematic limits.

2.4G Read the live stereonet by observed joint set

Open Stereonet analysis. Color by starts at Observed set on every opening, including an older cached analysis. A new analysis also starts at All features; existing scope and filters are retained. The legend separates recorded J1, J2 and other set labels; bedding without a set label appears as Bedding. An unlabeled joint appears as Unassigned joint.

Check the population. Confirm the project/outcrop scope and plotted count before comparing colored clusters. A common label across different outcrops does not establish a connected joint surface or a common domain. Check north references and the source measurements before calculating a mean.

Interpret separately. Use Color by Interpreted set to inspect reviewed analysis assignments. Clustering suggestions and imported labels do not silently replace field observations. Explicit Load view restores that view's color and filter settings. Closing and reopening analysis starts at Observed set again without deleting imported rows, accepted assignments or views. Review the legend before exporting a figure.

Protocol 2 completion check

Before moving on:

1. Bedding and joint readings have correct outcrop/set IDs and known north references.

2. Strike and dip conventions agree with the actual plane; steep phone readings were independently checked.

3. Sampling limits, doubtful readings and any corrections are explained.

Save and check: Confirm the saved measurements and set counts. Recheck questionable poles while the rock face is still available.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

2.4D Review imports and preserve observation identity

1. Choose the orientation convention and read the source columns. Map dip, the authoritative bearing, outcrop, joint set and optional metadata. You can change convention later without losing explicit mappings, but always Preview again. Check corrected versus original bearing columns carefully. Not imported remains an intentional opt-out.

2. Preview the exact selected file or pasted table. Replacing either invalidates the old preview. Wait for the new file to finish, resolve row errors, and only then Add reviewed dataset. Original cells and source filenames remain with the observations. Importing is a local analysis action; it does not automatically upload new field records.

3. Check source identity before applying a mean. Two OC-01 labels in different projects are two outcrops. Within-outcrop means remain separate; choose an across-outcrop interpretation only when geologically justified. Imported labels without IDs are scoped to their dataset. On field adoption, review any incompatible survey/domain assignment before choosing to retain it as provenance only.

4. Keep location and orientation quality separate. Complete the missing coordinate when justified, or retain the reading as unlocated. A latitude alone is not a map position, but a valid dip/bearing can still be analysed. True-north bedding means receive oriented map symbols; magnetic/unknown means are qualified until an applicable correction is established.

5. Export an analysis file including saved views before transferring devices. Project-specific views retain their source populations; 100 imported datasets can coexist with the designated field snapshot. Large notes retain their original cells. A file exceeding a supported limit is rejected with an explanation rather than downloaded as an unusable backup.

2.4E Protect unfinished field work

1. Save each completed observation and verify its saved record. Unfinished drafts are separate. Repeated Load latest saved records (retain form drafts) preserves your unfinished text; Restore brings it back for review. A save that finishes after you start newer input must not erase that new input.

2. Cancel edit or Clear on a discontinuity intentionally discards that draft. A recovered existing edit includes Cancel edit. Use cancellation only when you mean to discard the unfinished change.

3. When correcting coordinates manually, the pending GPS capture is invalidated. Start a fresh capture if you want the device location instead. Wait for selected photos to finish before replacing a new-outcrop form; late conversions from an old form are not attached to the new outcrop.

4. Keep deliberately blank optional fields blank. Existing project dates and slope IDs do not inherit new-record defaults during notes-only saves. A new outcrop may still inherit the project default. Check the identity shown before saving.

5. On cloud conflicts, review the chosen record and related updates together. Accepting cloud checks revisions and relationships and preserves a recovery snapshot. Older complete backup merges keep coherent recovered copies. Do not clear browser storage or replace the only good copy as a routine conflict workaround.

2.4F. Check the recorded location, time and attachments

1. Record both latitude and longitude. If an observation has only one coordinate, the app retains it for review but never combines it with the other axis from the outcrop. A map may show the complete parent-outcrop location instead; check location provenance before treating it as the observation position. Zero is a valid coordinate.

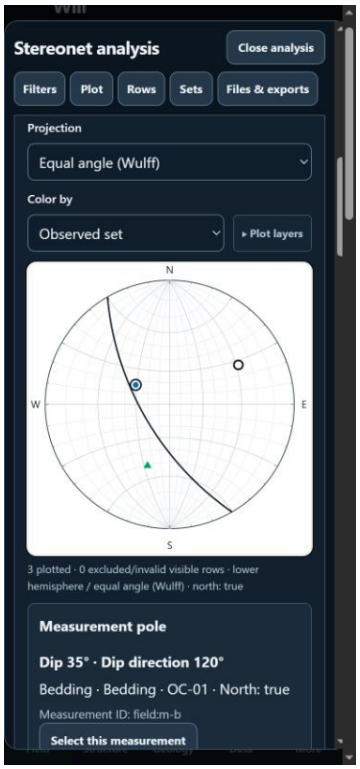
2. Check the inspection Date for every new independent slope rating. Its default is the current local calendar date, including after an overnight session. Editing an existing rating preserves its recorded date or deliberate blank. Observation timestamps remain full instants, so newest/Undo works across timezone offsets and daylight-saving changes.

3. Review uploaded sketches as well as photographs. Transparent drawings receive a white background during JPEG conversion so black linework stays legible. Keep external originals where image fidelity matters. A pending attachment still belongs to the form in which it was selected.

4. Open the needed reference chart once while installing the app, then verify it can open separately with connectivity unavailable. Installed reference-image tabs use the app cache. Save the two PDF manuals separately; installing the app does not automatically save them.

5. When using a keyboard in the field layout, Tab or Shift+Tab moves through controls and scrolls a covered control above the bottom navigation. At enlarged text or a short window, confirm the focused Save button is visible before activating it. This does not save or change a field by itself.

2.4H Query and review individual poles



1. Click the observation. In Stereonet analysis use Selection tool = Click poles. Click a colored pole: Measurement pole shows Dip and Dip direction for its original plane, plus observed set, feature, outcrop, north reference and stable ID. Pole trend/plunge are different quantities. Shift-click adds another observation; circle/freehand or row checkboxes select a group. Review overlapping observations by their rows/IDs.

2. Check the physical measurement. Compare these angles and identity with the notebook, compass and feature photograph. A legitimate separated pole is useful geology, not automatically a bad reading. The field live stereonet and Kinematics/Engineering plots also support pole queries.

Query empty net space if needed. Stereonet analysis, Engineering and phone Kinematics show a Cursor plane for a click away from a measurement. It is the plane whose pole would be at that location, explicitly not a saved observation or a new record. The net center means a horizontal plane with undefined direction. A click on a recorded pole instead returns its exact stored angles and identity.

3. Keep an explicit population. Engineering input scope starts at All plotted measurements. Selecting one pole for query does not silently restrict the next kinematic run. Choose Selected plotted measurements only when that smaller population is intended. Filters/exclusions still apply first; read the plotted count before running.

2.4l Exclude or delete only reviewed observations

1. Prefer reversible exclusion during interpretation. Exclude selected from analysis keeps the saved observation and removes it from the plotted analysis population; Include selected again reverses that choice. Do not delete measurements just to improve clustering or obtain a favorable FS.

2. If deletion is justified, select exact rows/poles. Choose Delete selected measurements… and inspect every stable ID, source, outcrop, set and angle. Close cancels without a write. Type DELETE and choose Delete reviewed measurements only when the reviewed records are the intended ones.

3. Understand the destination. A saved field measurement is deleted locally and queues its normal cloud deletion when backup is enabled. Its outcrop/set definition and independently saved discontinuities remain; their historical source references are retained. Imported/portable snapshot rows are removed from this local analysis only. Source/account/revision changes invalidate the review.

4. Recover in the correct place. Undo analysis edit restores imported rows and interpretation. For a deleted saved field measurement, close analysis, set App view to Field, open Data > Field checks & deletion recovery, and choose Undo last field deletion. Then reload field data in analysis. That tool retains only the last field deletion; keep an independent file before larger cleanup. Cloud completion needs sync/readback, and historical copies may remain.

2.4J Choose and check the familiar equal-angle stereonet

1. Start with the Wulff net. Live stereonet, Desktop linked stereonet, Stereonet analysis and Kinematics now open on lower-hemisphere Equal angle (Wulff). The curved reference grid is spaced 10°. It is the same reference sphere as before, projected differently; it does not correct a field measurement or alter a calculated factor of safety.

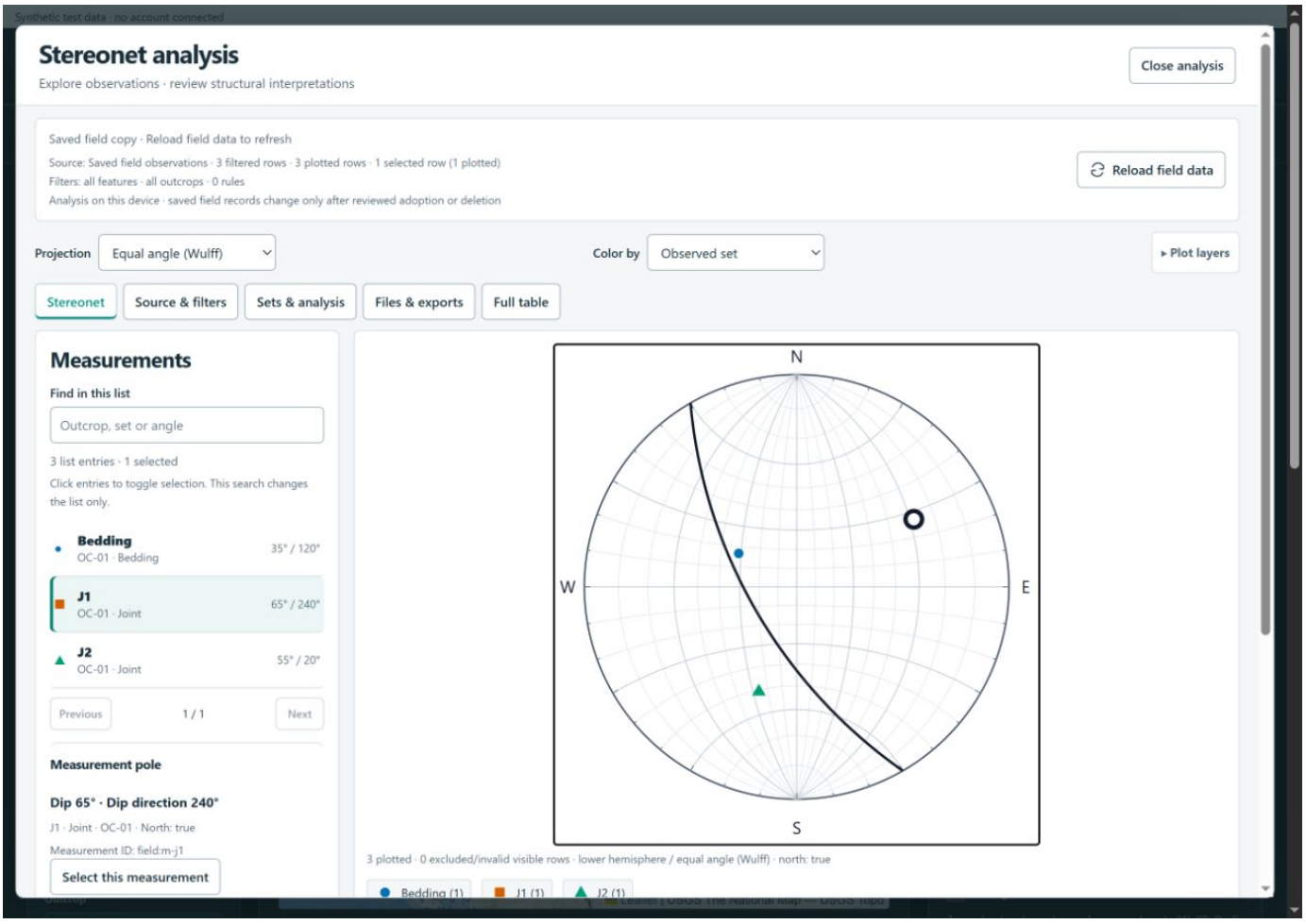
2. Keep the interpretation straight. A symbol is the pole perpendicular to the measured plane. Shallow planes stay near the center, steep planes near the rim. Pole direction points opposite plane dip direction. Colors and shapes identify recorded sets. Tap a pole and verify the displayed **plane** dip/dip direction against the observation; do not read its pole trend/plunge as the plane angles.

3. Use the alternative deliberately. Choose Projection > Equal area (Schmidt) to compare the population with an equal-area plot. All poles, curves and selection/query coordinates move consistently. Measurements, north reference, cluster assignments, means and kinematic classifications are unchanged. Density interpolation and the sampled peak may change because different pixels sample different spherical directions.

4. Recheck the caption before sharing. Exported SVG/PNG and saved views identify their projection. Explicit Load view restores that view; older views without a projection load as their original equal-area net. Ordinary analysis opening starts at Equal angle and Observed set, while retaining data, filters and saved interpretations. Record the population and north reference with any figure.

Further reading: Theory K2/K3/K8/K27-K27A derives pole coordinates, the grid, inverse click queries and density. Snyder (1987), USGS Professional Paper 1395, explains stereographic/equal-area projection foundations. Screen distance between two poles is not their true spherical separation; use the angle/statistics tools.

2.4J.1 Read the desktop Wulff plot and its recorded pole query



Actual local app preview with three synthetic planes. The 10° Wulff grid, observed Bedding/J1/J2 population and selected mean-plane curve use one projection. The plot caption states equal angle (Wulff). Saved field observations are unchanged. Use the visible Projection selector to compare Equal area, or click the measurement list/pole to inspect recorded angles and identity. Desktop places J1 details beside the plot; phone controls retain their existing layout.

Browser control checked Bedding 35°/120° in both projections. The same synthetic snapshot had 3 valid poles in both views. Independent tests check horizontal/vertical endpoints, great-circle plane membership, cursor inverses, cones, density response freshness and saved-view/portable-file compatibility. Synthetic checks are not instrument calibration.

Protocol 3: Complete the RMR assessment

Work through all five base inputs for the same rock domain, then consider the excavation-related orientation adjustment. The detailed observation methods stay inside this protocol.

Where in the app: Field > RMR inputs; supporting joint evidence may also be recorded under Discontinuities.

Do in this order	What you should have when finished
3.1 Intact strength	Observed hardness or independent tested basis
3.2 RQD: choose A or B	Core determination OR explicitly identified outcrop estimate
3.3 Discontinuity spacing	Representative perpendicular spacing and survey basis
3.4 Joint condition	Persistence, aperture, infill, roughness and wall weathering together
3.5 Groundwater	Observed condition with date and seasonal context
3.6 Rate, review and save	Five base ratings; optional purpose-specific orientation adjustment

3.1. Estimate intact rock strength with the R0-R6 reference

In the app: *Observed hardness; Strength rating; Strength rating source*

Observed hardness in this app is a field intact-rock strength grade. It is not Mohs mineral hardness and is not an exact UCS test.

Equipment / evidence: Representative hand specimen where permitted, geological hammer and knife; eye protection and suitable sampling controls.

1. Choose representative intact material, avoiding a pre-existing joint as the fracture path. Compare fresh and weathered specimens separately if they differ.

2. Read Hardness field reference (R0-R6) beside Observed hardness. Compare thumbnail, knife and hammer response with the displayed descriptors; record the actual response in notes.

3. Very weak material may indent or peel; stronger material requires hammer blows to fracture; extremely strong material may only chip. Specimen size, shape, moisture and hammer technique affect the result.

4. Select the supported grade. The app derives the corresponding field-estimated RMR strength rating. If the material straddles grades, retain the uncertainty and specimen description in notes.

5. A tested result can have a different RMR basis. Choose Independent strength assessment / test and preserve its value and method in Hoek-Brown inputs instead of silently changing the observed grade.

Worked entry: Select R3 - medium strong; note “one firm geological-hammer blow fractured ~3-in intact fresh specimen; not along bedding; dry; preliminary field estimate.” The reference band is 25-50 MPa, not a test result of 37.5 MPa.

If unknown: Choose Not assessed if no defensible observation can be made. Do not assume a strength solely from lithology.

Watch for: Only test a safe, permitted specimen; never hammer an unstable face. A small thin chip breaking easily does not necessarily establish weak intact rock.

Read further: R4, R5. See the source guide for links and relevant pages.

A weathered surface is not the whole specimen



Photo P05. The end of a fallen volcanic column in Yellowstone shows differences between its exposed outer zone and interior. Record surface alteration separately from intact material strength; neither JCS nor a weathering grade can be read reliably from this photograph alone. NPS / Jim Peaco. Source; Public domain (NPS credit).

Compare the weathered exterior with the interior of this fallen volcanic column. Do not assign an R0-R6 grade from the photograph. Test a suitable representative specimen under the adopted field procedure and record whether it came from a weathered wall or fresher rock. The R0-R6 chart is available beside Observed hardness in the app.

Quick reference: field strength grades

Grade / approximate UCS	Observed field response
R0 / 0.25-1 MPa	Thumbnail can indent the material.
R1 / 1-5 MPa	Knife peeling is possible; firm hammer-point blows crumble the material.
R2 / 5-25 MPa	Knife peeling is difficult; a firm hammer point makes a shallow indentation.
R3 / 25-50 MPa	Knife does not peel it; one geological-hammer blow fractures a suitable specimen.
R4 / 50-100 MPa	Several blows are needed to fracture a suitable specimen.
R5 / 100-250 MPa	Many blows are needed to fracture a suitable specimen.
R6 / >250 MPa	The geological hammer tends to chip the specimen.

Paraphrased field descriptors from Marinos & Hoek (2000), Table 1 [Reference R5], matching the app's hardness reference. These broad bands are field estimates, not measured UCS. Compare suitable specimens of comparable dimensions and condition; never infer an exact midpoint test result from a grade.

RMR uses the chosen field grade unless you deliberately select an independent strength-test basis. If a specimen response is ambiguous, record the range and reasoning instead of forcing an unjustified grade.

3.2 Choose the RQD evidence route

Use route A when representative core exists. Measure the core run using the adopted rule, then use that result only for the represented domain.

Use route B when making a defensible outcrop estimate. Identify its survey and estimation method; do not present it as core-measured RQD. These are alternatives, not two entries to average.

If neither route is supported, leave RQD unknown. A supported rating category may be entered without fabricating a precise percentage; document the basis.

3.2A. RQD: measure a core run before calculating the percentage

In the app: *RQD (%); RQD rating; Observations / field notes*

Rock Quality Designation is originally a core-length index. It is neither percent recovery nor a visual percent of unbroken rock in a photograph.

Equipment / evidence: Organized core box, run/depth labels, ruler, logging procedure, camera; drilling and handling-break information.

For these examples, qualifying intervals are sound lengths longer than 100 mm (0.328084 ft). Follow the adopted project rule for an interval exactly at the cutoff.

1. Confirm the start/end of the run and the drilled interval. Arrange core in order. The denominator is the total run length, including lost core, not just recovered material.

2. Identify natural discontinuities and distinguish drilling/handling breaks where evidence supports it. Fit genuine mechanical breaks back together and treat them as one original piece; do not reunite natural joints.

3. Measure qualifying sound pieces along the core centerline. Use the adopted 100-mm threshold consistently: 100 mm = 0.328084 ft. Published shorthand “4 in” is approximate (4 in = 101.6 mm); apply the project’s exact boundary rule.

4. Sum qualifying lengths and divide by the entire run length, then multiply by 100. Record recovered short pieces, unsound material and losses separately in the core log.

5. In the outcrop record, enter the calculated RQD only if that core interval is relevant to the mapped domain. Record borehole, run depths, core diameter, method and why the core represents this outcrop.

Worked entry: Synthetic 5.0-ft run: qualifying sound lengths 1.2 + 0.9 + 0.7 + 0.6 = 3.4 ft; short pieces total 0.6 ft and unrecovered interval 1.0 ft. RQD = 3.4/5.0×100 = 68%; recovery = 4.0/5.0×100 = 80%. These are different values.

If unknown: If core quality, run length or break origin is unresolved, leave RQD unassessed and preserve the evidence for review. Unknown is not RQD zero.

Watch for: Direction matters: a borehole nearly parallel to joints may show high RQD in a jointed mass. RQD does not replace orientation, spacing or joint-condition logging. For soundness and exact cutoff rules, follow the specified test/logging standard.

Read further: R2, R4, R11. See the source guide for links and relevant pages.

Visual method: preserve the core evidence



Photo P15. Ordered core boxes from Onkalo, Finland illustrate why run markers and original core order matter. RQD requires run length, soundness, and natural-versus-drilling-break judgment; do not calculate RQD from this overview photo. kallerna. Source; CC BY-SA 4.0.

CORE RQD: sound qualifying lengths / total drilled run length × 100

Keep the core in run order; re-fit proven drilling breaks before measuring.



Example: qualifying sound pieces total 7.0 ft in a 10.0 ft run.

RQD = 100 × 7.0 / 10.0 = 70%. Missing core stays in the denominator.

Schematic fragments are not drawn to the example lengths; use the worked lesson.

This second arithmetic example uses 7.0 ft / 10.0 ft = 70%; the measurement lesson uses 3.4 ft / 5.0 ft = 68%. They are independent invented examples. Neither is calculated from the photograph.

3.2B. RQD without core: make an explicit outcrop estimate

In the app: *RQD (%); RQD rating; Observations / field notes; Discontinuity notes*

The app accepts an RQD number but has no dedicated RQD method selector. Therefore the basis must be written in notes. A field estimate must remain distinguishable from measured core RQD.

Equipment / evidence: Tape, exposed scanline, joint-position sketch, compass/clinometer and repeat lines in other directions.

For these examples, qualifying intervals are sound lengths longer than 100 mm (0.328084 ft). Follow the adopted project rule for an interval exactly at the cutoff.

1. If the project accepts an outcrop estimate, define a visible line that simulates a 5- or 10-ft run. Record endpoints, line bearing/inclination, lithology and why the window is representative.

2. Mark natural fracture intersections along the line. Measure each intact interval, apply the adopted soundness and qualifying-length rule, and sum qualifying intervals divided by line length ×100.

3. Repeat in other suitable directions or faces and retain the individual results. Do not simply assign 100% because one line happens to parallel the dominant fractures.

4. If vegetation or inaccessible cover conceals part of the line, do not treat it as intact rock. Use a fully exposed window or document that a meaningful estimate is unavailable.

5. Label the entered value “outcrop scanline estimate, not core RQD”; include the raw line measurements and uncertainty. Use a supported category without an invented exact value if evidence only supports a range.

Worked entry: Training line 10.0 ft with qualifying intervals totaling 7.2 ft gives estimated RQD 72%. A second direction gives 54%. Retain both and explain any selected classification input; do not conceal the directional spread as precision.

If unknown: No representative exposed line and no suitable core: leave RQD blank. RMR may remain incomplete; this correctly describes the evidence gap.

Watch for: Another published approach estimates RQD from volumetric joint count (Jv). That correlation needs representative set spacings, a consistent metric formulation and attention to random joints; the app does not calculate it. Its originator warns that RQD-Jv relations can be unreliable. Do not count visible cracks in a photo and call the count Jv.

Read further: R2, R12. See the source guide for links and relevant pages.

3.3. Measure true spacing; do not confuse it with apparent spacing

In the app: *Discontinuity spacing (ft); Spacing rating; Frequency; Discontinuity notes; Comments*

Spacing is the perpendicular distance between adjacent planes in one set. Frequency is a count per unit survey length and depends on survey direction.

Equipment / evidence: Tape or ruler, identified set, compass/clinometer for the tape orientation.

1. Identify parallel or subparallel discontinuities belonging to one set. Measure several consecutive intervals, not just the largest gap.

2. Measure the shortest separation normal to those planes where possible. If the tape crosses obliquely, retain apparent spacing and survey orientation; label any corrected result and method.

3. A simple correction is true spacing = apparent spacing × sin(alpha), where alpha is the angle between the tape line and the joint plane. Alpha is not automatically the plan-view angle between strikes.

4. Record interval list, range, set, sample count and logging window in notes. Enter a defensible representative spacing in Field, explaining which set governs the selected RMR assessment.

5. For Frequency, write count/length and units explicitly because it is a text field, for example “8 natural J1 intersections / 20-ft line = 0.40 per ft.” Include line bearing and inclination.

Worked entry: Five true spacings 0.8, 1.1, 0.9, 1.4 and 0.8 ft average 1.0 ft; Field spacing 1.0 ft, J1, n=5 intervals. A separate apparent spacing of 2 ft at alpha=30° also corresponds to 1 ft true spacing.

If unknown: Leave the exact spacing blank if not measured. A supported RMR spacing category may be chosen, but document the estimate instead of inventing an exact average.

Watch for: Spacing, persistence and aperture are three different dimensions. Do not average all sets into one number without a stated classification basis; do not include excavation-induced cracks as natural joints without distinguishing them.

Read further: R2, R3. See the source guide for links and relevant pages.

Visual method: spacing and persistence

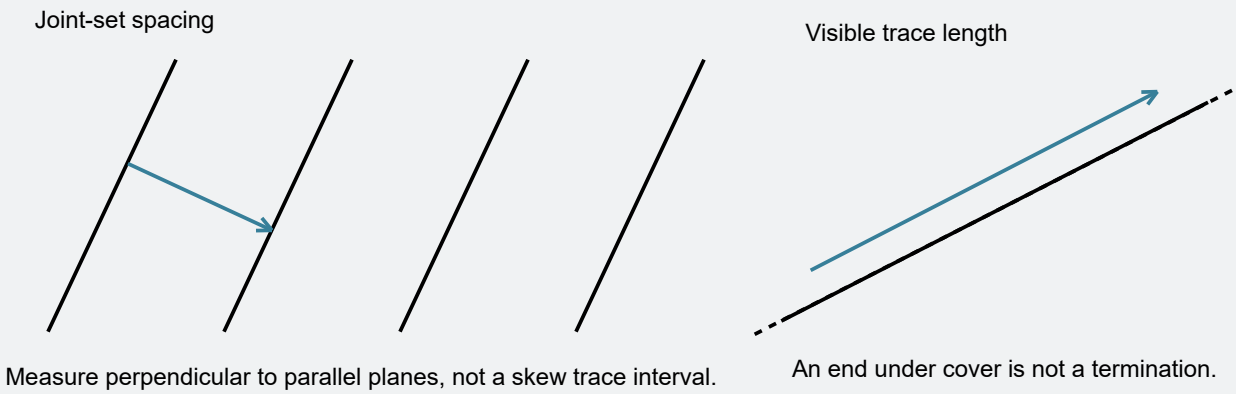




Photo P01. A jointed metamorphic rock face in Lamar Canyon, Yellowstone. Follow the separate fracture traces and note vegetation in openings. The photograph does not provide a calibrated spacing, aperture, or weathering grade. NPS / Jim Peaco. Source; Public domain (NPS credit).

Joint-set spacing is normal to the planes. Visible trace length lies along the trace on the exposure. Vegetation, an image edge and cover can hide a trace without proving termination. This photo has no reliable scale for either quantity.

3.4 Assemble the complete joint-condition description

Inspect the discontinuities that control the assessment, including weak seams. Record the observations below before choosing Discontinuity condition rating. The app uses one combined condition category, not a sum of separately entered roughness, aperture and persistence subratings.

Sequence: follow the trace and its terminations; measure opening and filling separately; describe small-scale roughness and larger waviness; check wall weathering; identify the feature and photos supporting the selected category.

Do not substitute whole-outcrop weathering for wall weathering. A clay-filled continuous plane may control the condition assessment even where adjacent joints are rough and fresh.

RMR boundary: JRC, JCS, friction angle and effective normal stress are not additional RMR base inputs. The shared observation methods below identify some Discontinuities / Barton-Bandis fields, but you do not need to complete that strength calculation to finish an RMR assessment. Keep the supporting condition evidence in notes or linked discontinuity records.

3.4A. Trace a joint and record its visible limits

In the app: *Length / Persistence (ft); Comments; Discontinuity notes; Visible trace length (ft); Length basis; First trace end; Second trace end; Trace direction on the plane; Trace evidence / endpoint notes*

Persistence describes the extent of a discontinuity. A surface trace is only the portion visible on the exposure, not proof of the full three-dimensional plane.

Equipment / evidence: Tape or safe laser range measurement, wide photo and sketch showing endpoints.

1. Follow the same joint trace without jumping to a nearby parallel crack. Measure the longest visible trace and state whether it is along strike, dip or an apparent section.

2. Inspect each end. Does the joint terminate in intact rock, end against another discontinuity, or continue outside the window/under cover?

3. Enter the positive Visible trace length (ft) as a number, then select Length basis and both trace ends. A hidden or beyond-exposure end requires Visible length minimum - full extent unknown. Retain any earlier Length / Persistence text separately; do not silently convert it into a measurement.

4. Record rock bridges, step-overs, segmentation and changing aperture/infill. Take an overview with marked endpoints and a scale.

5. Keep length range and exposure size in comments; use a separate discontinuity record where conditions change materially.

Worked entry: Visible trace length: 12 ft; Length basis: Visible length minimum - full extent unknown; first end: Terminates against another joint; second end: Disappears behind cover; trace direction: Oblique / other. Notes: east-face photo and endpoint sketch; full persistence remains unknown.

If unknown: Write “not measurable - covered” when no defensible bound exists. Do not use exposure width as the full joint length.

Watch for: “Continuous” is a description at a stated observation scale. It does not establish connection through the slope or across intact bridges.

Read further: R2. See the source guide for links and relevant pages.

3.4A.1 Save the trace and both endpoints

Actual app controls; synthetic training data. Scroll to reach fields outside the image.

1. Follow one feature. Trace it without jumping to a nearby parallel joint. Measure the visible length safely; do not use exposure width as a substitute.

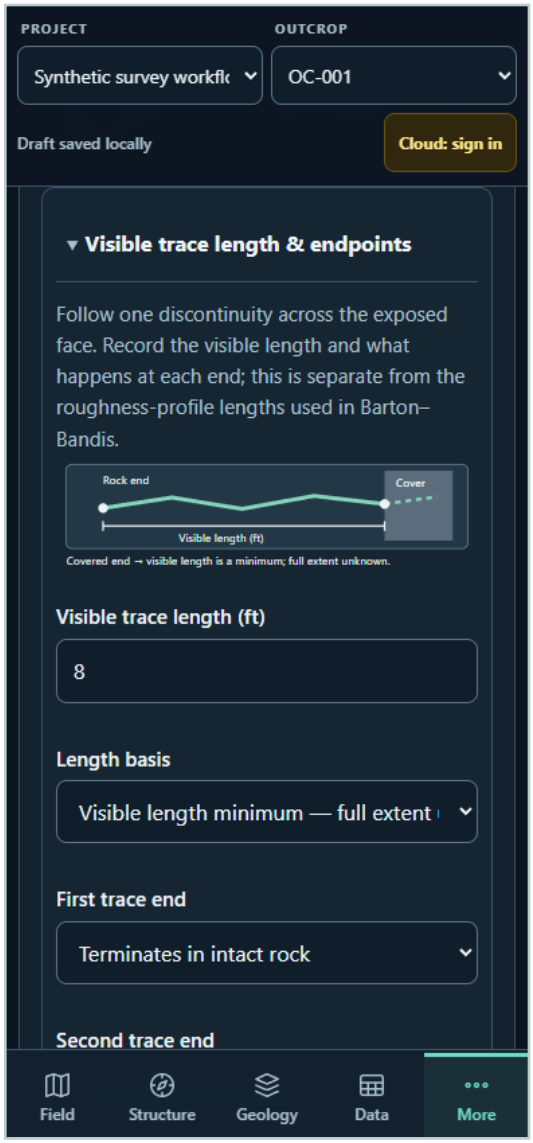
2. Enter Visible trace length (ft). Type only the positive number, for example 12. Put the bound in Length basis rather than entering ">12" in the numeric box. The older Length / Persistence text stays separate.

3. Select each end. Choose Terminates in intact rock, Terminates against another joint, Continues beyond the exposure, Disappears behind cover, or Unknown / not checked.

4. State Length basis. Choose Measured visible trace or Estimated visible trace for how you obtained the visible length. A hidden/beyond-exposure end selects Visible length minimum - full extent unknown. A measured length with unassessed endpoints is not proof of complete persistence.

5. Select Trace direction on the plane. Use Along strike, Along dip or Oblique / other as observed. Add the sketch/photo ID, endpoint references, segmentation and limitations to Trace evidence / endpoint notes.

6. Save and reopen the discontinuity. Check the length, both ends and basis together. These describe this exposure. They do not automatically supply slope-model persistence, connectivity or rock-bridge strength. See USBR Chapter 5, printed pp. 101-103.



3.4B. Measure opening and infill as separate quantities

In the app: *Separation / Aperture (ft); Infilling; Infill thickness (ft); Asperity height (ft); Comments*

Aperture is wall-to-wall separation perpendicular to the joint. Infill thickness describes the material between the walls; its mechanical effect also depends on rock contact and roughness height.

Equipment / evidence: Feeler gauge, crack comparator or caliper/ruler; safe accessible opening; close-up photo with scale.

1. Measure normal to the walls at several representative places. Distinguish a tight joint, an open void and a filled joint; do not pry it wider to obtain a reading.

2. Enter Separation / Aperture in feet, preserving a range or bound if appropriate. Keep the original small-unit reading in comments so conversion is auditable.

3. Describe infill composition, continuity, moisture and consistency. A soft clay seam, hard mineral coating and an open gap are different features.

4. Measure infill thickness normal to the walls. If using the Barton-Bandis applicability fields, enter its thickness separately from aperture.

5. Measure typical asperity height from a stated local baseline on the same profile scale and record the method. Do not substitute overall waviness amplitude without saying so.

Worked entry: A 1/8-in opening = 0.01042 ft. A 1-mm coating = 0.003281 ft. Notes: wall separation 0.01-0.02 ft; discontinuous clay coating; rock contact visible at high points.

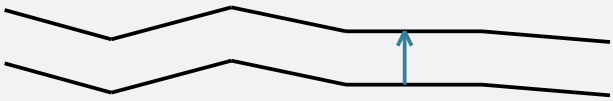
If unknown: For a closed joint below instrument resolution, write “closed; below gauge resolution” rather than claiming exact zero. Blank thickness means not measured.

Watch for: Do not confuse dark staining with clay infill. Do not assume rock-to-rock contact just because a surface is rough; thick weak fill may control shear behavior.

Read further: R2, R7. See the source guide for links and relevant pages.

Visual method: opening, filling and texture

Aperture: separation between joint walls



Measure normal to the walls at representative points.

1 mm = 0.00328084 ft

Infill thickness is separate.

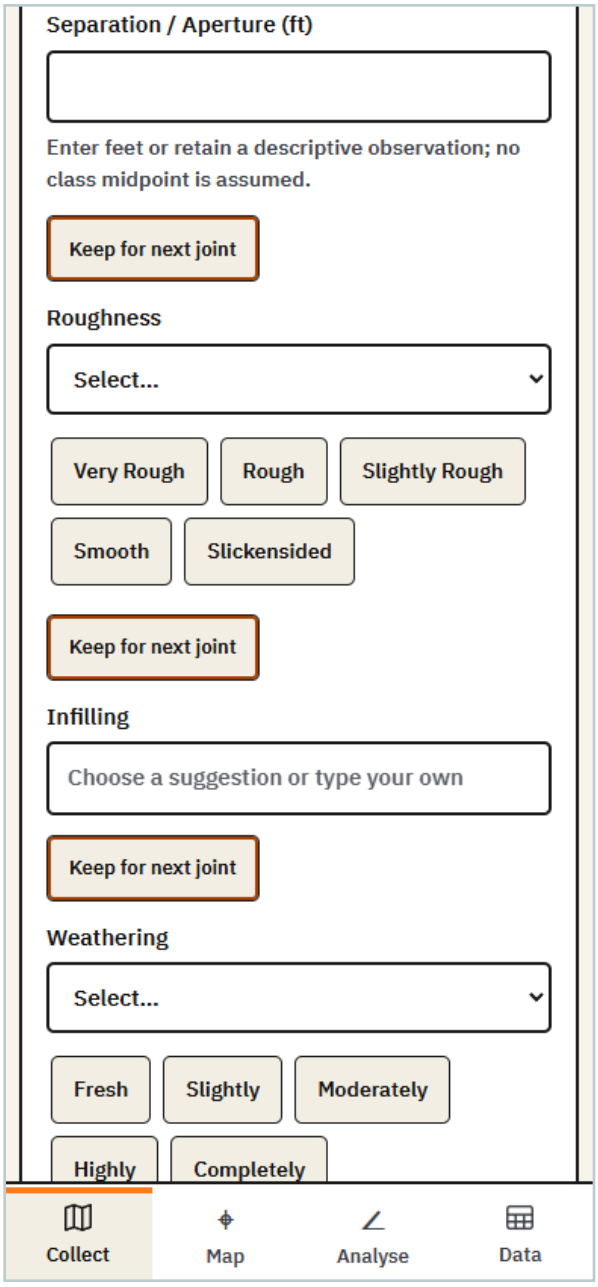
Record clean contact, coatings, soft fill and variability.

Do not round a small opening to 0.

Visual method: opening, filling and texture

(continued)

The fields remain separate because a wide opening, soft infill and rough rock-to-rock contact mean different things. Record the range and photograph scale in the comments. A coating thickness and an open air gap are not interchangeable.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

3.4C. Describe roughness and waviness for the condition rating

In the app: *Roughness; Comments*

The Roughness dropdown records a descriptive surface condition. It is not a JRC conversion table.

Equipment / evidence: Side lighting, hand lens, ruler/straightedge, representative accessible surface and photo scale.

1. Inspect the natural joint surface, not a fresh hammer break. Identify small-scale asperities and larger undulations separately.

2. View and, where safe, feel the surface along the likely movement direction and across it. Directional ridges or slickensides can behave differently in the two directions.

3. Select Very Rough, Rough, Slightly Rough, Smooth or Slickensided to match the observed surface. Describe steps, ridges, polish, striations and waviness in comments.

4. Photograph a close-up and a longer profile view with scale. Record larger-wave amplitude and wavelength in feet where measurable, plus profile/shear direction. Mark movement indicators and distinguish present polish from an inferred displacement history.

5. Measure a roughness profile separately if numerical JRC is needed. Repeat where surface character varies.

Worked entry: Roughness: Slightly Rough. Notes: small palpable asperities on a broadly planar face; ~0.4-ft undulations over 8 ft; smooth striae toward 120°. Numerical JRC remains unselected until profiled.

If unknown: If the joint wall cannot be seen, leave roughness unassessed rather than rating the exposed exterior of the block.

Watch for: A photograph is not a calibrated roughness measurement. Keep large waviness distinct from small asperities; Q-system Jr differs from JRC. Describing an undulating surface does not authorize an extra resistance angle in the slope model.

Read further: R2, R7. See the source guide for links and relevant pages.

3.4D Check wall weathering and select the combined category

Compare the actual joint walls with representative fresher material. Describe alteration, softened walls, coatings and filling in the discontinuity evidence. Reuse Protocol 1 weathering only where it describes this same material and surface.

Read the entire RMR condition option. Match continuity/persistence, roughness, separation, infill and wall weathering as a group; explain the governing feature and the reason for an uncertain or conservative selection. Keep raw measurements and the photo IDs.

3.5. Describe water today and preserve evidence of other conditions

In the app: *Groundwater; Groundwater score (derived); Water; Comments; Observations / field notes*

The app's water categories describe visible conditions. They are not measurements of pore-water pressure or a guarantee of the worst seasonal condition.

Equipment / evidence: Observation time, recent weather information, photo, collection/timing equipment only if a separate flow measurement is planned.

1. Observe the face before cleaning or disturbing it. Distinguish surface rain wetting from water emerging along a discontinuity.

2. In Collect choose Dry, Damp, Wet, Dripping or Flowing for the logged rock domain and record the date/weather context. The corresponding RMR groundwater score is derived.

3. In the individual discontinuity record use No, Damp, Wet, Dripping or Flowing for that joint; "No" means no visible water during inspection.

4. Document seep locations, staining, mineral deposits, vegetation, drain outlets and whether flow is continuous or intermittent. If flow is measured, record method, duration and units in comments.

5. Record recent rain/snowmelt and evidence that conditions change. Obtain piezometer or other justified pressure data for strength analyses when required.

Worked entry: Field: Damp. J1: Dripping. Notes: inspection 2 days after rain; drops at lower joint only; upper wall dry; iron staining extends higher; seasonal maximum unassessed.

If unknown: If water conditions were not observed, leave the category blank. Do not choose Dry merely because a photograph does not show water.

Watch for: A dry exposed face can still have pressure behind it. Entered Barton-Bandis effective normal stress must already account for the selected water pressure basis; do not convert a "Wet" dropdown to a pressure.

Read further: R2, R4, R6. See the source guide for links and relevant pages.

A seep is a time-dependent observation



Photo P18. Newton Cave Seep in Chiricahua National Monument during a dry visit in April 2021. The NPS report describes greatly reduced wetness on that visit. Record the date, weather, and observed condition; an earlier wet-season observation should not be copied as today's condition. National Park Service. Source; Public domain (NPS credit).

The source describes a greatly reduced, nearly dry seep during this visit. Record today's actual condition and recent weather, then preserve evidence of other seasons separately. Staining or an old wet photograph does not justify selecting Flowing today. Do not derive water pressure from a surface photograph.

3.6. Complete RMR from evidence, then check the category meanings

In the app: *RQD (%); Discontinuity spacing (ft); Groundwater; Strength rating; RQD rating; Spacing rating; Discontinuity condition rating; Groundwater score (derived); Orientation adjustment; Strength rating source; Rating override reason (optional)*

RMR is a classification assembled from five base ratings and an optional excavation-related orientation adjustment. A completed score is not a stability calculation.

Equipment / evidence: Measured/described observations above, the app's RMR dropdown wording and the proposed excavation/foundation orientation.

1. Check that observed hardness, RQD, spacing and groundwater describe the same assessment domain. Their supported ratings populate from observations; a precise RQD or spacing should not be invented just to fill a box.

2. Choose Discontinuity condition rating from the full description. Consider continuity, roughness, aperture, wall weathering and infill together; the current app uses a combined category, not separate summed subratings.

3. If observations only support an RQD/spacing category, leave the exact number blank and select the documented category. If an independent tested strength is used, identify the strength basis.

4. Resolve conflicts by checking the underlying observation. A documented Rating override reason can justify a different listed strength, RQD or spacing category. Groundwater remains tied to the observed water category; an override cannot authorize an undefined score or invalid numerical observation.

5. Choose Orientation adjustment only relative to the intended slope, tunnel/mine or foundation. The app does not infer favorability from an absolute strike/dip.

6. Review Base RMR and, if applicable, Adjusted RMR. Blank/incomplete is appropriate when required evidence is absent. Save outcrop after changes.

Worked entry: At a training locality, a continuous clay seam may govern the condition category even though adjacent clean joints are rough. Identify the governing seam and photos rather than selecting the best-looking rough surface.

If unknown: All five base ratings are required. Leave orientation blank if excavation geometry or purpose is not established; do not assume a zero adjustment means unknown.

Watch for: Exact numerical endpoints matter: RQD 25, 50, 75 and 90% give ratings 8, 8, 13 and 17. Spacing 0.19685, 0.65617, 1.96850 and 6.56168 ft gives 8, 8, 10 and 15. These are the actual rounded code thresholds, not a universal lower-rating rule. GSI remains an independent visual observation.

Read further: R4, R6. See the source guide for links and relevant pages.

Protocol 3 completion check

Before moving on:

1. Strength, RQD, spacing, combined discontinuity condition and groundwater each have a supported basis for the same domain.

2. Numerical observations and dropdown categories agree; any independent strength basis or rating override has a documented reason.

3. Orientation adjustment names the intended slope, tunnel/mine or foundation context. Blank is appropriate when that context is unknown.

4. Base RMR is distinguished from Adjusted RMR and from the independently observed GSI.

Save and check: Save outcrop and reopen the five ratings and both displayed totals. Saving a discontinuity alone does not complete the outcrop RMR record.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

Protocol 4: Characterize one joint for Barton-Bandis

Stay with one representative joint surface and shear direction through the complete sequence. Repeat this protocol for a different joint, materially different wall condition or analysis direction.

Where in the app: Collect > Joints; expand Strength test for Barton-Bandis.

Do in this order	What you should have when finished
4.1 Identify surface and applicability	Feature, orientation, wall material, contact, water and weathering
4.2 Describe the discontinuity	Trace limits, aperture, infill and texture
4.3 Profile and select JRC	Direction, trace, L0, observed range and justified calculation value
4.4 Rebound evidence if used	Raw readings and instrument/test conditions
4.5 Select supported JCS	Wall strength in psi and determination method
4.6 Select friction basis	Basic or residual angle with source
4.7 Define scale and effective stress	Ln, correction choice, stress and water basis
4.8 Review, calculate if supported, save	Complete evidence record; result only when inputs are justified

4.1 Identify the joint and check applicability

Preserve direction and identity. A dip quadrant constrains legacy conversion: N70W / 60 SW means RHR strike 110 and dip direction 200 degrees; 60 NE means RHR 290 and dip direction 20. Conflicting entries remain for review. Copying a reading or mean preserves manually entered feature and tool values. Untouched six-significant-digit mean fields save the exact source angles; editing an angle detaches the mean link. See 7.2P for recovery and review steps.

1. Active record. Check project/outcrop; identify Plane Type, optional station and Slope ID, Joint-wall rock type, Photo # and Comments. The wall material can differ from the outcrop lithology. Use one feature ID consistently in profiles and tests.

2. Orientation. Select dip direction/dip or RHR strike/dip; record north reference and measurement tool. Copy a saved Structure measurement only if it describes this plane. Copied orientation and later edits remain independent; verify the actual values.

2A. Default to average. In Structure choose the intended set, then in the discontinuity orientation chooser select Default to average. It copies the axial-normal mean of that set at this outcrop. Review the copied angles, north reference, count and scatter. Saved values remain a snapshot; Refresh from active set deliberately updates it. Mixed reference frames or invalid readings withhold the mean. A mean is an interpreted orientation, not an additional individual measurement.

2B. Embedded field references. Expand Guide beside each input for local procedure tables and measurement sketches; View full screen enlarges a diagram. The sketches explain measurement geometry and do not assign JRC or replace a calibrated JCS/friction test. They remain available offline after the app shell is installed. Source links are optional further reading.

3. Contact. Inspect whether the potential shear surface has unfilled rock-to-rock contact, is infilled without rock contact, or remains unknown. Select Surface applicability accordingly. Do not calculate rough-rock strength for an infill-governed contact.

4. Wall condition. Record discontinuity Weathering and Water for the actual surface today. Note coatings, alteration, moisture, season, representative fresh material and any difference from outcrop-wide observations. A visible seep does not measure pore pressure.

5. Plan the evidence. Mark the potential shear/profile direction and select representative accessible patches. Identify which profile, rebound and laboratory records can be obtained. Missing tests are follow-up items; they are not defaults.

4.2A. Trace a joint and record its visible limits

In the app: *Length / Persistence (ft); Comments; Discontinuity notes; Visible trace length (ft); Length basis; First trace end; Second trace end; Trace direction on the plane; Trace evidence / endpoint notes*

Persistence describes the extent of a discontinuity. A surface trace is only the portion visible on the exposure, not proof of the full three-dimensional plane.

Equipment / evidence: Tape or safe laser range measurement, wide photo and sketch showing endpoints.

1. Follow the same joint trace without jumping to a nearby parallel crack. Measure the longest visible trace and state whether it is along strike, dip or an apparent section.

2. Inspect each end. Does the joint terminate in intact rock, end against another discontinuity, or continue outside the window/under cover?

3. Enter the positive Visible trace length (ft) as a number, then select Length basis and both trace ends. A hidden or beyond-exposure end requires Visible length minimum - full extent unknown. Retain any earlier Length / Persistence text separately; do not silently convert it into a measurement.

4. Record rock bridges, step-overs, segmentation and changing aperture/infill. Take an overview with marked endpoints and a scale.

5. Keep length range and exposure size in comments; use a separate discontinuity record where conditions change materially.

Worked entry: Visible trace length: 12 ft; Length basis: Visible length minimum - full extent unknown; first end: Terminates against another joint; second end: Disappears behind cover; trace direction: Oblique / other. Notes: east-face photo and endpoint sketch; full persistence remains unknown.

If unknown: Write “not measurable - covered” when no defensible bound exists. Do not use exposure width as the full joint length.

Watch for: “Continuous” is a description at a stated observation scale. It does not establish connection through the slope or across intact bridges.

Read further: R2. See the source guide for links and relevant pages.

4.2A.1 Save the trace and both endpoints

Actual app controls; synthetic training data. Scroll to reach fields outside the image.

1. Follow one feature. Trace it without jumping to a nearby parallel joint. Measure the visible length safely; do not use exposure width as a substitute.

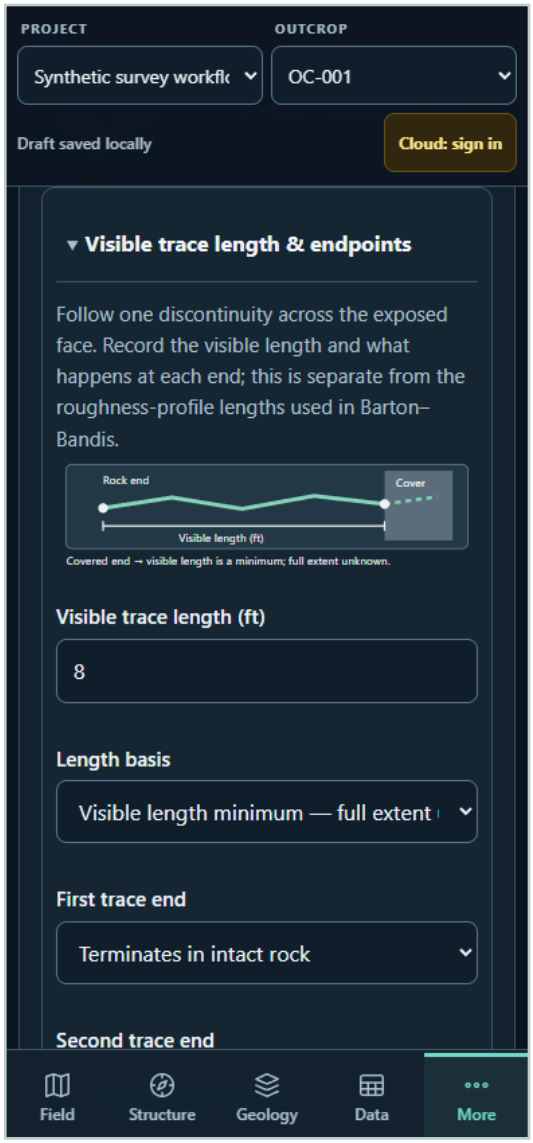
2. Enter Visible trace length (ft). Type only the positive number, for example 12. Put the bound in Length basis rather than entering ">12" in the numeric box. The older Length / Persistence text stays separate.

3. Select each end. Choose Terminates in intact rock, Terminates against another joint, Continues beyond the exposure, Disappears behind cover, or Unknown / not checked.

4. State Length basis. Choose Measured visible trace or Estimated visible trace for how you obtained the visible length. A hidden/beyond-exposure end selects Visible length minimum - full extent unknown. A measured length with unassessed endpoints is not proof of complete persistence.

5. Select Trace direction on the plane. Use Along strike, Along dip or Oblique / other as observed. Add the sketch/photo ID, endpoint references, segmentation and limitations to Trace evidence / endpoint notes.

6. Save and reopen the discontinuity. Check the length, both ends and basis together. These describe this exposure. They do not automatically supply slope-model persistence, connectivity or rock-bridge strength. See USBR Chapter 5, printed pp. 101-103.



4.2B. Measure opening and infill as separate quantities

In the app: *Separation / Aperture (ft); Infilling; Infill thickness (ft); Asperity height (ft); Comments*

Aperture is wall-to-wall separation perpendicular to the joint. Infill thickness describes the material between the walls; its mechanical effect also depends on rock contact and roughness height.

Equipment / evidence: Feeler gauge, crack comparator or caliper/ruler; safe accessible opening; close-up photo with scale.

1. Measure normal to the walls at several representative places. Distinguish a tight joint, an open void and a filled joint; do not pry it wider to obtain a reading.

2. Enter Separation / Aperture in feet, preserving a range or bound if appropriate. Keep the original small-unit reading in comments so conversion is auditable.

3. Describe infill composition, continuity, moisture and consistency. A soft clay seam, hard mineral coating and an open gap are different features.

4. Measure infill thickness normal to the walls. If using the Barton-Bandis applicability fields, enter its thickness separately from aperture.

5. Measure typical asperity height from a stated local baseline on the same profile scale and record the method. Do not substitute overall waviness amplitude without saying so.

Worked entry: A 1/8-in opening = 0.01042 ft. A 1-mm coating = 0.003281 ft. Notes: wall separation 0.01-0.02 ft; discontinuous clay coating; rock contact visible at high points.

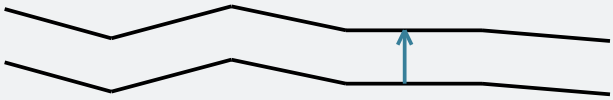
If unknown: For a closed joint below instrument resolution, write “closed; below gauge resolution” rather than claiming exact zero. Blank thickness means not measured.

Watch for: Do not confuse dark staining with clay infill. Do not assume rock-to-rock contact just because a surface is rough; thick weak fill may control shear behavior.

Read further: R2, R7. See the source guide for links and relevant pages.

Visual method: opening, filling and texture

Aperture: separation between joint walls



Measure normal to the walls at representative points.

1 mm = 0.00328084 ft

Infill thickness is separate.

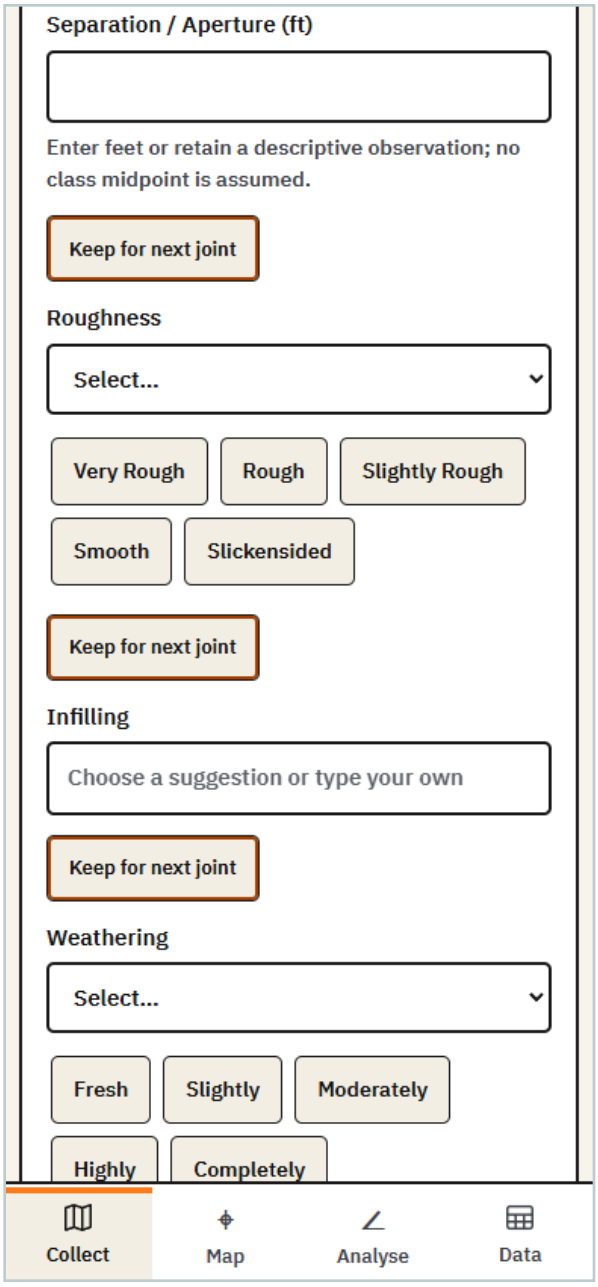
Record clean contact, coatings, soft fill and variability.

Do not round a small opening to 0.

Visual method: opening, filling and texture

(continued)

The fields remain separate because a wide opening, soft infill and rough rock-to-rock contact mean different things. Record the range and photograph scale in the comments. A coating thickness and an open air gap are not interchangeable.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

4.2C. Describe roughness and waviness before choosing JRC

In the app: *Roughness; Comments*

The Roughness dropdown records a descriptive surface condition. It is not a JRC conversion table.

Equipment / evidence: Side lighting, hand lens, ruler/straightedge, representative accessible surface and photo scale.

1. Inspect the natural joint surface, not a fresh hammer break. Identify small-scale asperities and larger undulations separately.

2. View and, where safe, feel the surface along the likely movement direction and across it. Directional ridges or slickensides can behave differently in the two directions.

3. Select Very Rough, Rough, Slightly Rough, Smooth or Slickensided to match the observed surface. Describe steps, ridges, polish, striations and waviness in comments.

4. Photograph a close-up and a longer profile view with scale. Record larger-wave amplitude and wavelength in feet where measurable, plus profile/shear direction. Mark movement indicators and distinguish present polish from an inferred displacement history.

5. Measure a roughness profile separately if numerical JRC is needed. Repeat where surface character varies.

Worked entry: Roughness: Slightly Rough. Notes: small palpable asperities on a broadly planar face; ~0.4-ft undulations over 8 ft; smooth striae toward 120°. Numerical JRC remains unselected until profiled.

If unknown: If the joint wall cannot be seen, leave roughness unassessed rather than rating the exposed exterior of the block.

Watch for: A photograph is not a calibrated roughness measurement. Keep large waviness distinct from small asperities; Q-system Jr differs from JRC. Describing an undulating surface does not authorize an extra resistance angle in the slope model.

Read further: R2, R7. See the source guide for links and relevant pages.

4.3. Measure a directional profile for a defensible JRC estimate

In the app: *JRC observed estimate / range; Selected JRC (0-20); JRC assessment method; Profile / intended shear direction (°); Measured profile length L0 (ft); Test/profile IDs, hammer serial/calibration, correlations, impact angle and assumptions*

Joint Roughness Coefficient is a dimensionless empirical index. Its estimate is tied to direction, profile length, measurement resolution and comparison method.

Equipment / evidence: Profile/contour comb or documented profile survey, paper and scale, straightedge, compass, reference profiles at known physical scale.

1. Choose and mark the intended shear direction on a representative exposed joint wall. Measure its azimuth and record the north convention in notes; the profile direction has no separate north-reference control.

2. Capture a profile along that direction using a comb or another documented method. Record the actual profile length L0, the sampling resolution and profile ID. Preserve the original trace with equal horizontal/vertical scales.

3. For standard-profile comparison, use the Barton-Choubey reference profile scale (about 100 mm / 0.328084 ft). Check a printed scale bar; a zoomed phone image is not necessarily full size.

4. Compare the complete profile shape with the reference bands, not one isolated peak. Repeat profiles in representative patches and record the range; describe substantial large-scale waviness separately.

5. Write the observed estimate/range in JRC observed estimate / range. Select a calculation JRC only when justified, and choose its assessment method. The app does not automatically take the midpoint of a range.

6. Record the selected value's rationale, scale and represented roughness in the test/profile notes. A correlation or shear-test back-calculation needs its documented method. Do not add that same roughness again through slope-model waviness; see Protocol 4.3A.

Worked entry: Example only: three profiles suggest JRC 6-8. Observed field: “6-8, profiles P1-P3.” Selected JRC: 6 for a stated preliminary lower-bound scenario; method: standard profile comparison; L0 = 0.328084 ft. This is an interpretation, not an automatic app selection.

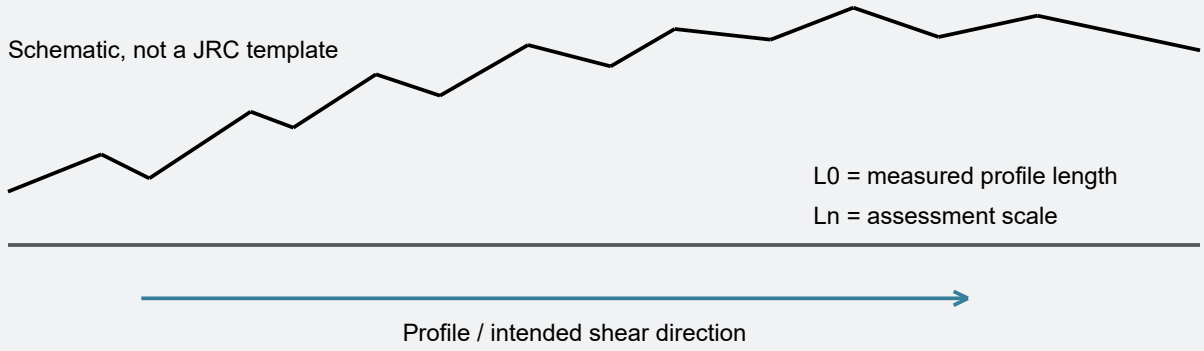
If unknown: If no valid profile or testing basis exists, keep the descriptive roughness and notes but leave calculation JRC blank.

Watch for: Never stretch a trace vertically, silently resize a long profile to a 100-mm chart, or reuse a value in a different shear direction without review. A photo of a wall alone does not yield JRC.

Read further: R7, R13. See the source guide for links and relevant pages.

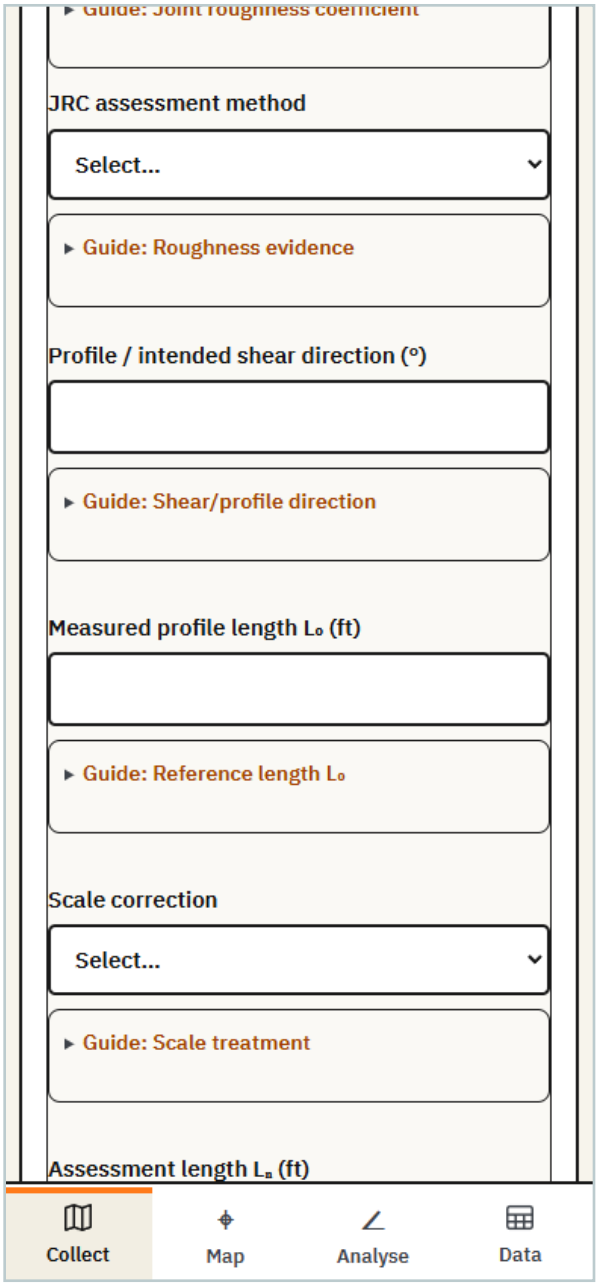
Visual method: make a directional roughness record

Trace the actual joint in the proposed sliding direction



Visual method: make a directional roughness record (continued)

Keep the original trace, its horizontal and vertical scales, direction, profile ID and length. The schematic above explains those records; it is not one of the numerical JRC reference profiles. Use the cited standard profiles or a documented correlation for the selected JRC.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

4.3A Keep observed waviness separate from added resistance

1. Describe what is visible. Keep the natural joint profile, intended shear direction, measurement resolution and scale with its ID. Describe small asperities and broader undulations separately. Record amplitude/wavelength where measurable, with a sketch or photograph; do not convert an undulation description directly to an analysis angle.

2. Preserve what the chosen JRC represents. State profile length, the assessment length and whether the selected JRC already includes the profile features relevant to movement. JRC and JCS are scale-dependent empirical inputs; a larger profile is not automatically comparable to the reference chart.

3. Identify what the test includes. Record whether the friction value is basic, residual or a fitted rough-joint peak value, along with stress range, moisture and displacement basis. Do not use a measured rough-joint peak angle as residual friction and then add the same roughness through JRC.

4. Save observations even when no extra term is justified. The Barton field shear screen has no Additional waviness input. In a separate slope case, No additional waviness (recommended) leaves the extra term at zero. That choice does not erase the observed undulations or certify the model.

5. Hand off evidence, not an automatic bonus. Supply the selected feature/profile/test IDs, scale, shear direction, contact/infill condition and uncertainties to the reviewer. A nonzero additional contribution needs independent justification for what the base law omits and why the implemented convention applies. Follow Protocols 6.2B-6.2C before entering it.

Read further: USBR Chapter 5, printed pp. 106-109 for descriptions; Barton and Choubey (1977) for the JRC-JCS-friction criterion and scale effects. These sources do not establish an arbitrary separate additive angle as a universal strength correction.

4.4. Collect and preserve Schmidt rebound evidence

In the app: *Joint-wall rebound readings (comma or space separated); Fresh reference surface rebound readings; Rebound hammer type; Hammer impact direction; Joint-wall condition during testing; Test/profile IDs, hammer serial/calibration, correlations, impact angle and assumptions*

A rebound number is an index response from a specified hammer and test setup. The app summarizes readings but does not convert them into strength.

Equipment / evidence: Appropriate calibrated L- or N-type Schmidt hammer, manufacturer procedure, support/clearance appropriate to the specimen, reference anvil and test log.

1. Follow the current adopted test method for surface preparation, block support, instrument checks, impact spacing and number of observations. Do not invent a test protocol from the app's text boxes.

2. Identify the joint wall being tested and its weathering/moisture. Record hammer type, serial, calibration/checks and impact orientation. Avoid loose unsupported flakes and visibly nonrepresentative spots.

3. Enter the individual valid joint-wall readings, separated by commas or spaces. Keep raw observations and identify excluded/invalid impacts with reasons in notes or the test sheet; do not quietly discard low readings.

4. If a fresh reference is tested, store its readings in Fresh reference surface rebound readings and identify its location/material separately. Do not substitute fresh rock for a weathered wall.

5. Select Hammer impact direction and joint-wall moisture. For inclined impacts, put the measured angle and any correction convention in notes.

6. Use the displayed count, arithmetic mean and range as a transcription check. It is not an automatic standard-compliant reduction or JCS calibration.

Worked entry: Training entry: wall readings "31, 34, 33, 32"; fresh reference "45, 47, 46, 44"; L-type, horizontal, damp. Notes identify instrument, locations and method. No JCS is produced by these four example numbers.

If unknown: If no hammer was used, choose Not used and leave readings empty. "Not recorded" is a provenance gap, not an orientation correction.

Watch for: Do not mix hammer types, impact directions, moisture conditions or lithologies in one unlabeled list. A concrete strength chart is not automatically applicable to rock.

Read further: R14. See the source guide for links and relevant pages.

Rebound equipment and test context



Photo P13. A rebound hammer is a specific test instrument, not an ordinary geological hammer. Check instrument type, calibration, orientation correction, and suitable surface support before collecting readings. Arjuncm3. Source; CC BY-SA 3.0.

This photograph identifies the instrument only; it does not demonstrate an approved test sequence. Instrument type, impact direction, calibration, surface support and moisture matter. Use the adopted rebound method and preserve the raw readings rather than writing a derived strength without its correlation.

4.5. Select joint-wall strength, not simply fresh-block strength

In the app: *Joint-wall compressive strength JCS0 (psi); JCS determination method; Test/profile IDs, hammer serial/calibration, correlations, impact angle and assumptions*

JCS is the compressive strength relevant to the joint wall. Weathering/alteration can make it lower than intact rock strength.

Equipment / evidence: Representative wall-material laboratory result, calibrated and documented rebound correlation, or justified site-specific evidence.

1. Identify the actual wall surface and condition that will resist shearing. Record whether it is fresh, altered, coated or soft.

2. Use a laboratory result on representative material or a properly calibrated correlation that matches hammer, rock, orientation and moisture. Preserve the correlation citation, units and test IDs.

3. Enter JCS0 in psi and select the method. If converting an MPa result, multiply by 145.0377.

4. If it is an engineering estimate, label it preliminary, retain the evidence/range and avoid false precision.

5. Check scale: JCS0 and the JRC0 profile must have compatible reference scales before applying a common scale correction.

Worked entry: Illustrative representative wall test 30 MPa converts to about 4,351 psi. This is not automatically the correct JCS for every joint in a 30-MPa rock mass.

If unknown: Leave JCS blank if unsupported; save characterization without computing strength.

Watch for: Original JCS(R) is a legacy field-sheet value not used in calculations. Do not treat its unexplained text or a raw rebound number as psi.

Read further: R7, R14. See the source guide for links and relevant pages.

4.6. Distinguish basic, residual and rough-joint peak friction

In the app: *Friction angle (°); Friction basis; Friction determination method; Surface applicability; Test/profile IDs, hammer serial/calibration, correlations, impact angle and assumptions*

The friction input requires a physical basis. Basic friction of fresh smooth rock and residual friction of a weathered/sheared surface are not interchangeable.

Equipment / evidence: Representative direct-shear/tilt-test report or justified published site-specific result; safe test setup and method when testing.

1. For residual friction, use a representative direct-shear result or documented correction/assessment of the relevant surface; record stress range, moisture and displacement basis.

2. A basic-friction tilt test uses prepared smooth, fresh, unweathered contact surfaces under a specified procedure. Record the repeat onset angles, specimen geometry and condition; sliding on a naturally rough block combines roughness effects and is not automatically basic friction.

3. Select Residual friction or Basic friction - fresh unweathered surfaces to match the evidence, then enter the selected angle and determination method.

4. Select Surface applicability after inspecting whether rock-to-rock contact is present. If thick weak infill prevents contact, the rough-rock model is not the governing strength model.

5. Retain the full test or reference basis in notes. Do not simply use the slope angle, angle of repose, or a kinematic threshold as tested friction.

Worked entry: Example: residual direct-shear result supports 27° on a weathered joint; select Residual friction and Direct shear test - residual. Do not replace it with 35° merely because fresh sandstone often feels rough.

If unknown: No defensible friction evidence: leave the angle blank. An engineering estimate must be labelled preliminary and evaluated as a sensitivity.

Watch for: Never tilt an unstable in-place block. The calculated Barton peak angle varies with stress and is not a universal kinematic friction angle. A rough-joint test can already include roughness; do not add its peak effect again in the slope case.

Read further: R7, R13. See the source guide for links and relevant pages.

4.7. Supply scale and stress assumptions only when they are known

In the app: *Scale correction; Assessment length Ln (ft); Measured profile length L0 (ft); Minimum effective normal stress σ'n (psi); Maximum effective normal stress σ'n (psi); Effective normal-stress basis; Surface applicability; Infill thickness (ft); Asperity height (ft); Test/profile IDs, hammer serial/calibration, correlations, impact angle and assumptions*

The optional Barton-Bandis calculation combines observations with engineering assumptions. Normal stress and assessment length are not measured by the phone.

Equipment / evidence: Documented block geometry, effective-stress calculation/model, water-pressure basis and compatible profile/test scales.

1. Identify the assessment length Ln along the relevant potential shear direction; it is not the arbitrary photographed width of the whole exposure. Preserve how it was established.

2. Choose Apply Ln/L0 correction only if both original parameter scale L0 and assessment length Ln are known and the method is applicable. Choose no correction only when the inputs already represent the assessment scale; document that basis.

3. Enter a positive effective normal-stress range in psi from the stated external model or justified sensitivity. Effective normal stress is total normal stress minus water pressure in consistent units.

4. Choose the exact stress-basis option and record total stress/water pressure/model scenario in notes. The app does not subtract water pressure again.

5. Review surface applicability and infill before Calculate Barton-Bandis. Save the discontinuity record after reviewing the inputs and any withheld-result message.

Worked entry: Illustrative arithmetic: total normal stress 50 psi less water pressure 15 psi gives effective stress 35 psi. Enter 35 psi as effective stress for that scenario, not 50 psi followed by an undocumented second subtraction.

If unknown: Unknown load or water pressure: preserve observations and defer the strength calculation. “Assumed effective stress range - sensitivity only” must remain explicitly an assumption.

Watch for: Do not scale parameters twice. The app withholds unsupported domains such as nonpositive effective stress, stress above JCS or excessive apparent peak angle; an error is not a reason to alter observations until a result appears.

App input checks: when scaling, L0 must be positive and Ln must be at least L0. The effective normal-stress range must have maximum >= minimum > 0. These are calculator limits, not instructions to invent missing test lengths or stresses.

Read further: R7, R8, R13. See the source guide for links and relevant pages.

4.8. Finish the discontinuity record without guessing legacy fields

In the app: *Station reference (optional); Plane Type; Joint-wall rock type; Measurement tool; Photo #; Original JCS(R); Frequency; Slope ID; Comments*

A useful discontinuity record combines feature identity, orientation, condition and provenance. Older field-sheet labels may not have an established meaning.

Equipment / evidence: Field notebook, source sheet if importing, photo/sample/profile index.

1. Use a clear Plane Type such as Joint, Bedding, Foliation, Cleavage or Fault. Explain any project-specific abbreviation in comments.

2. Choose the actual measurement tool: Geological compass, Phone sensor, Clinometer or Other with an explanation. Legacy B and C tool choices have no defined meaning in the app; do not select them for new observations.

3. Retain Slope ID and optional station when useful, plus Photo # and a frequency with explicit units and survey basis.

4. Original JCS(R) exists only to preserve an old sheet value. Keep it verbatim when needed, explain its source and use the supported JCS psi input for any calculation.

5. Before Save discontinuity, verify active outcrop, orientation/north, length/aperture units, observations versus assumptions, photo/profile links and reason for any blanks. Reopen the saved record to check it persisted.

Worked entry: New record: Plane Type Joint; Tool Geological compass; photo OC014_006; frequency “8 joints / 20 ft, scanline 090° horizontal”; legacy JCS(R) blank.

If unknown: Do not expand C/F, C, VW, B or C from memory if your project has no legend. Preserve historical text and identify the ambiguity.

Watch for: Duplicate last copies prior data: recheck every copied value and source before saving another feature. A template is not a new measurement.

Read further: R2, R3. See the source guide for links and relevant pages.

Protocol 4 completion check

Before moving on:

1. Identity/orientation: outcrop, feature type, wall lithology, bearing/dip convention, north, tool, photo/profile/sample IDs and comments agree.

2. Condition/contact: persistence and limits, aperture, infill description/thickness, asperity scale when used, descriptive roughness, wall weathering and water have been checked.

3. Roughness: observed JRC range, selected calculation JRC, method, direction and measured profile length L0 are recorded with the original trace. The selected number has a stated rationale.

4. Rebound route, if used: wall and fresh-reference readings, hammer type, impact direction, moisture, calibration and reduction/correlation evidence are retained. Raw rebound numbers are not JCS.

5. Strength and friction: supported JCS in psi with source; friction angle with basic/residual basis and determination source. Field hardness or an RMR rating is not a replacement for either.

6. Scale/stress: Ln and L0 support the chosen scale option; effective-stress minimum and maximum in psi have a stated total-stress/water-pressure or sensitivity basis. No double scale correction or second water subtraction.

7. Review Calculate Barton-Bandis only where supported. Record any withheld result or limitation; do not edit observations merely to make a number appear.

Save and check: Save discontinuity and reopen it. Check that characterization, test/profile notes and any supported calculation are retained. Save observations even when strength is deferred.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

Protocol 5: Observe GSI and assemble Hoek-Brown inputs

Make the visual GSI observation first. Add the other Hoek-Brown parameters only when that model is required and its applicability is supported.

Where in the app: Field > Observed GSI and Hoek-Brown inputs.

Do in this order	What you should have when finished
5.1 Observe GSI	Representative rock mass, chart position and range
5.2 Establish intact UCS	Value in MPa, method and specimen/domain basis
5.3 Establish mi	Testing or a documented applicable rock-type reference
5.4 Establish D and applicability	Excavation/disturbance scenario, affected zone and limitations

5.1. Estimate GSI from a representative rock mass, not a single block

In the app: *Observed GSI (0-100; visual estimate); Observations / field notes; Observed GSI carried into Hoek-Brown*

GSI describes rock-mass structure and discontinuity surface condition. The app intentionally stores a visual estimate and does not calculate it from RMR.

Equipment / evidence: Whole-exposure view plus accessible wall observations, GSI chart beside the input, photos of the assessed domain.

1. Define the rock domain and assessment scale. Step back enough to see block arrangement/interlocking, then inspect surfaces close up where safe.

2. Open GSI chart - view reference. Read the structure descriptions and select the relevant row region; do not match a sketch alone.

3. Read the surface-condition descriptions and choose the appropriate column region using roughness, weathering and infill evidence.

4. Record a plausible range and reasoning in notes, then enter a representative visual estimate if warranted. Keep separate ranges for materially different zones.

5. Check applicability. A few dominant planes controlling a block failure need discontinuity analysis; the basic GSI/HB rock-mass model is not a substitute for those planes.

6. The same observed GSI appears in Hoek-Brown; do not create a second, inconsistent estimate just to produce a desired strength.

Worked entry: Illustrative note: GSI 45-55, selected 50; very blocky/interlocked domain with slightly weathered, moderately rough surfaces; upper 2-ft decomposed zone excluded and described separately. This number cannot be assigned from the training photograph alone.

If unknown: Leave Not assessed if exposure is inadequate or the chart is unsuitable. State why, rather than choosing the middle of the chart.

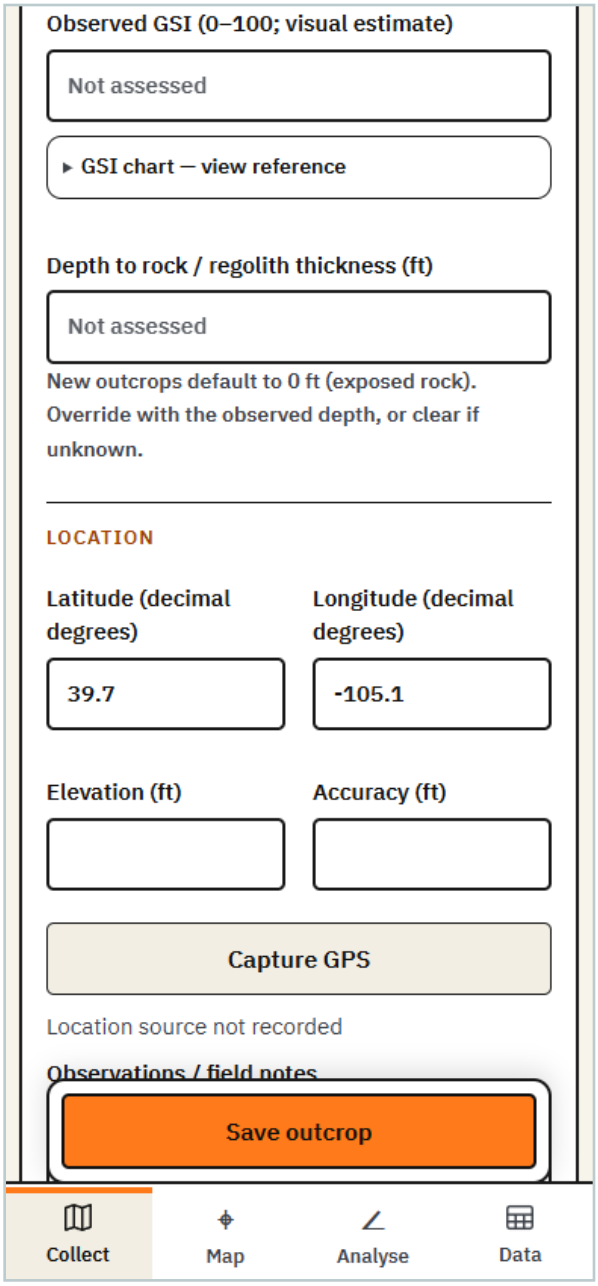
Watch for: Do not equate surface staining with the mass at depth. Do not use one weak seam to silently average away different domains; record the controlling seam separately. GSI is not a water-pressure measurement.

Read further: R5, R6. See the source guide for links and relevant pages.

GSI: inspect the mass, then use the chart

Use the chart beside Observed GSI as a field reference. The chosen value is a visual estimate. Record its range and the rock domain; do not back-calculate it from the displayed RMR.

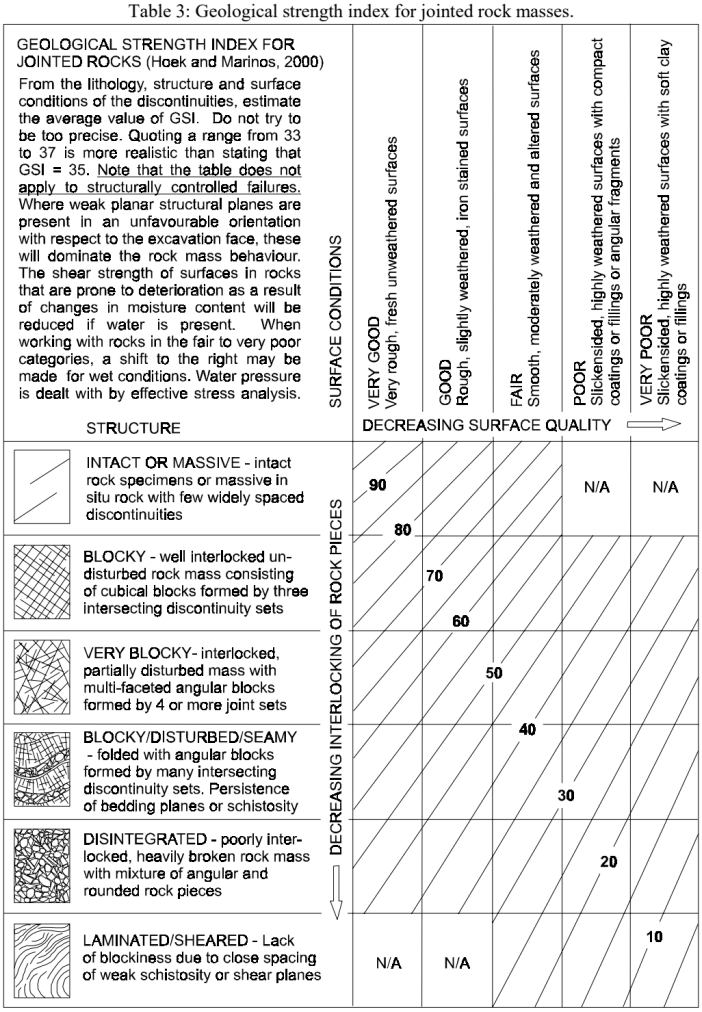
A single polished joint, one specimen or loose talus does not represent an interlocking rock mass. If a persistent plane controls the proposed mechanism, retain the geological observations and use a suitable structural analysis rather than forcing a homogeneous rock-mass interpretation.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

The GSI reference used by the app

Table 3: Geological strength index for jointed rock masses.



Marinos & Hoek (2000), Table 3, p.4 [Reference R5]. Reproduced from the supplied paper/reference image bundled in the app, unchanged. Zoom in to read the chart; assess its applicability before selecting GSI.

5.2. Enter intact UCS only with a stated determination method

In the app: *Intact UCS σci (MPa); UCS determination method; HB test IDs, source, orientation and assumptions*

Intact UCS is uniaxial compressive strength of rock material. It differs from whole-rock-mass strength and from joint-wall compressive strength.

Equipment / evidence: Laboratory report, documented point-load correlation or explicitly preliminary field-strength estimate; sample IDs and orientation.

1. For a laboratory result, confirm specimen identity, units, lithology, moisture and loading direction relative to bedding/foliation. Use the representative result selected for the assessment, retaining the test range in notes.

2. For a point-load estimate, use a correlation calibrated or justified for that material and size correction. Do not apply an unexplained universal multiplier.

3. For a field-strength estimate, use the observed grade as an approximate range and explain how any numerical value was selected. The app does not automatically turn R0-R6 into an exact UCS.

4. Enter Intact UCS in MPa and select its determination method. If a report is in psi, convert: MPa = psi / 145.0377.

5. Record test/sample ID, date, moisture, orientation, source and range in HB notes. Preserve strong anisotropy instead of combining incompatible test orientations.

Worked entry: Laboratory result 8,000 psi corresponds to 55.16 MPa. Enter 55.16 only for that documented tested/selected result; do not relabel a field estimate as a laboratory value.

If unknown: Leave UCS blank when unsupported. GSI and field observations can still be saved without completing Hoek-Brown.

Watch for: Do not enter psi into the MPa box. A weathered joint-wall strength is not necessarily the intact UCS of the rock blocks.

Read further: R4, R5, R8. See the source guide for links and relevant pages.

5.3. Choose mi from testing or a documented rock-type reference

In the app: *Intact rock constant mi; mi rock-type reference; mi determination method; HB test IDs, source, orientation and assumptions*

The intact Hoek-Brown constant mi is a model parameter, not a directly readable texture or hardness grade.

Equipment / evidence: Representative triaxial test interpretation or the app's author reference table; rock identification and test orientation.

1. Prefer a documented laboratory triaxial fit when representative data are available. Record the fitted range, specimen identity and procedure in notes.

2. For an early estimate, select the supported mi rock-type reference and read its stated spread/estimated status. Confirm that the rock and fabric resemble the reference basis.

3. The selected reference populates mi and its basis. If you edit the number, document why the override is warranted.

4. For foliated or bedded materials, record loading orientation and applicability; an intact parameter normal to fabric does not describe sliding along that fabric.

5. Leave uncertainty visible and test plausible parameter ranges during later engineering analysis.

Worked entry: App reference example: Sandstone selects mi 17 with cited spread ±4. Entered value remains a rock-type reference estimate unless supported by site tests.

If unknown: Leave unassessed if the material cannot be matched or tested; no universal default mi applies to all rock.

Watch for: mi is dimensionless. Do not substitute friction angle, RMR, GSI, or a rock-strength grade.

Read further: R5, R8. See the source guide for links and relevant pages.

5.4. Choose D for the relevant excavation and damaged zone

In the app: *Disturbance factor D (0-1); D field scenario; Rock-mass applicability; HB test IDs, source, orientation and assumptions*

Disturbance factor D represents excavation/blast damage and stress relief in the model. It is an engineering selection informed by evidence, not a handheld field measurement.

Equipment / evidence: Excavation history, blast/production records when available, face inspection, design geometry and disturbance reference chart.

1. Identify whether you are assessing an undisturbed natural mass, an existing excavation, or a proposed future excavation.

2. Observe/document blast scars, open relaxation fractures, overbreak and visibly damaged-zone extent; distinguish them from natural joints.

3. Open the D disturbance reference chart and select the closest justified scenario, or enter a documented value from 0 to 1. Its scenario values are guidance, not automatic proof.

4. Specify the zone to which D applies. Do not assign damage seen only at the face to the entire rock mass without justification, or use natural-outcrop D=0 to represent a future blasted slope.

5. Select Rock-mass applicability honestly: jointed mass without dominant control, structural control, or uncertain. The calculator withholds the rock-mass result unless the suitable option is confirmed.

Worked entry: Existing small civil cut with controlled blasting: D scenario 0.7 is an initial reference, with notes on evidence and affected-zone uncertainty. Natural outcrop logging can record undisturbed baseline separately from the proposed excavation scenario.

If unknown: If excavation method/history or mechanism is unknown, select uncertain applicability and leave unsupported D unselected.

Watch for: D is not the same as weathering or GSI. Choosing a scenario is not a field test and should not disguise the need for sensitivity and engineering judgment.

Read further: R8. See the source guide for links and relevant pages.

Protocol 5 completion check

Before moving on:

1. Observed GSI is an independent visual judgment, with its domain, range and basis recorded; it is not derived from RMR.

2. UCS, mi, D and applicability are supported for the same material and relevant excavation scenario.

3. Observed hardness, intact UCS and joint-wall JCS remain distinct evidence, even when a common test source is relevant.

4. If only GSI was assessed, save it and explicitly defer unsupported Hoek-Brown parameters.

Save and check: Save outcrop and reopen the GSI and Hoek-Brown fields. Confirm that a displayed calculated parameter does not hide a missing or provisional source input.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

Protocol 6: Collect inputs for slope screening

Add slope geometry and parameter provenance for kinematic screening. If an engineering case is needed, continue through the explicit model setup and review; do not treat a kinematic flag as a factor of safety.

Where in the app: Analyse > Kinematics; desktop Slope stability for a separate engineering interpretation.

Do in this order	What you should have when finished
6.1 Define the screening	Selected outcrops, slope face and consistent north
6.2 Model setup and evidence	Geometry, contact strength, copied profiles, loads and readiness
6.3-6.6 Analysis handoff	Factor basis, support search, bench comparison and result views
Review before handoff	Geometric possibilities remain distinct from design conclusions

6.1. Measure the slope face before a kinematic screening

In the app: *Slope dip (°); Slope dip direction (°); Joint friction angle (°); Lateral limits (±°); Automatically detected north reference*

Kinematics compares measured structures with a specified slope face and friction assumption. It identifies geometric possibilities; it does not establish a factor of safety.

Equipment / evidence: Compass-clinometer or documented survey geometry, representative joint data, friction evidence and a shared north reference.

1. Identify the slope surface being screened and the outcrops that reasonably represent it. An existing irregular face and a proposed design cut are different scenarios; document which is used.

2. For a planar accessible face, measure its orientation using the same true-dip method as the joint card. For a large inaccessible face, use a documented survey or geometric interpretation and state its uncertainty. Do not substitute apparent profile inclination for true face dip without a stated interpretation.

3. Enter Slope dip and the downslope-facing Slope dip direction, not its strike. A 60° face dipping east is dip 60°, direction 090°.

4. Supply a supported Joint friction angle for the relevant mechanism. A generic rock name or the Barton-Bandis peak angle at one assumed stress is not a universal friction input.

5. Lateral limits is an analyst-selected angular screening tolerance, not a property measured with the compass. Record why the chosen value is appropriate and explore sensitivity if it controls the conclusion.

6. All outcrops in the active project are included when none is checked; select a narrower scope only when intended. Read the automatically detected north reference, enter the slope in that frame, and run the screen. Mixed or unknown frames require explicit review; there is no confirmation checkbox.

Worked entry: Training scenario only: slope 60/090, friction 30°, lateral limits ±20°. These are separate inputs with different evidence requirements, not default design values.

If unknown: Unknown slope direction or friction: collect/document the missing information before interpreting a failure-mode screen. Keep outcrop measurements saved meanwhile.

Watch for: Do not use a reassuring stereonet result as a safety determination. Persistence, connectivity, water, loads and support belong to subsequent engineering assessment.

Read further: R2, R3, R7. See the source guide for links and relevant pages.

From field evidence to an engineering model

Input category	How it is established
Observe / measure	Face and upper-ground dip/bearing; height and benches; joints, traces, aperture and infill; crack position; visible seepage; installed support location/condition.
Obtain from tests / records	Unit weight, UCS/JCS, friction/strength envelopes, pore pressure, surveys, construction drawings, bolt/grout capacity and measured lock-off loads.
Engineering model choices	Effective normal stress and water-pressure distribution; cohesion and constitutive model; persistence/connectivity; seismic coefficients; support mobilization; section interpretation and uncertainty distributions.

A phone or an exposed rock face cannot establish every material, hydraulic or reinforcement input. Preserve field observations when selecting model parameters. A measured crack opening is not a measured water head; visible bolt length does not establish anchorage or capacity. Use tests, records and responsible engineering interpretation for these quantities.

The Slope stability editor provides input figures and field-specific validation. The separate Theory Manual explains the advanced geometry, material, water, load, support and calculation procedures. This practical guide does not claim to replace laboratory standards, design drawings or that calculation manual.

6.1A Choose which planes may be paired

1. Start from the relevant population. Check selected outcrops, included observations or means, north reference and slope face. Both phone and desktop kinematics start with all measurement pairs; no set assignment is required. Choose a narrower recorded-context scope only when intended. A pair is an orientation combination; recorded context does not prove that the planes meet in the rock.

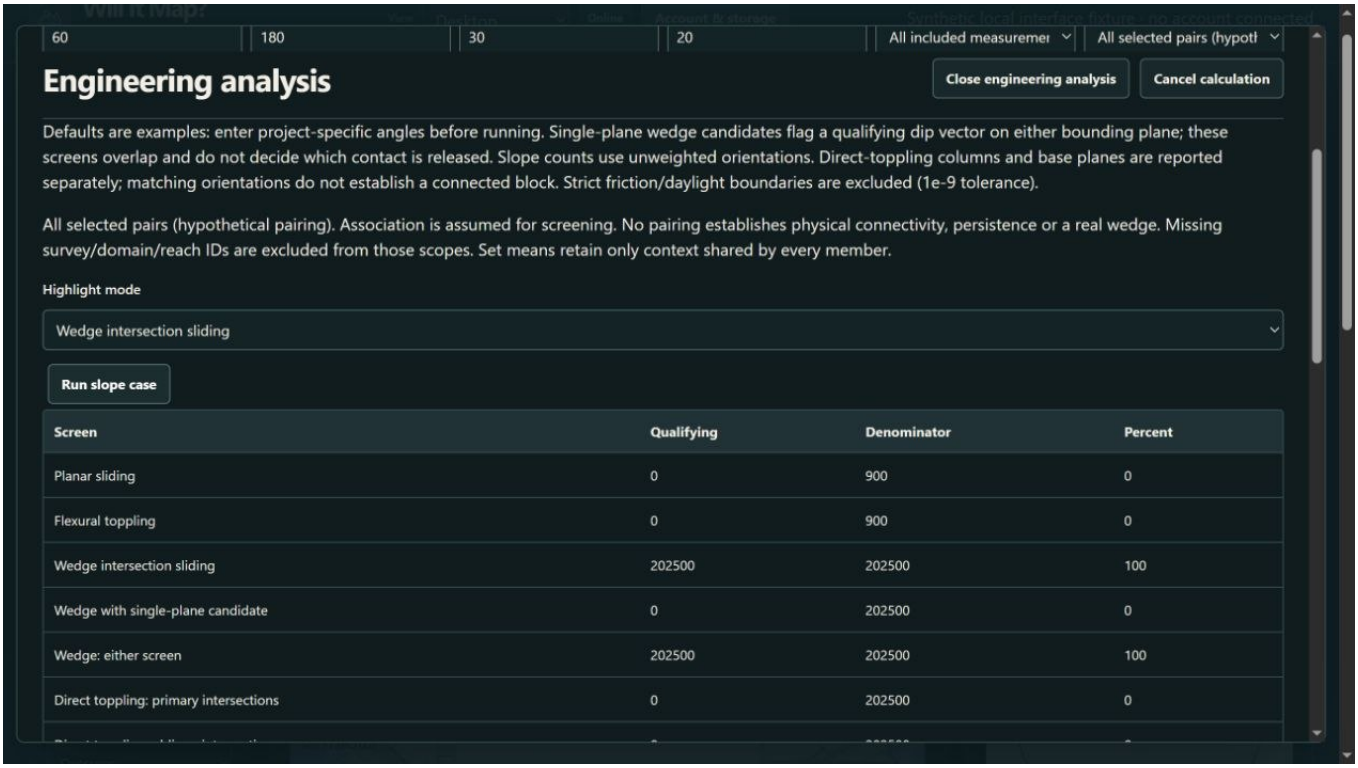
Choose this scope	What the app requires
Same outcrop	Matching project/outcrop IDs for app records. Imported datasets and older unnamespaced records have separate compatibility rules; see Theory K19.
Same recorded survey / exposure	Same nonempty project, outcrop and survey IDs.
Same geological domain and slope reach	Same nonempty project/domain IDs and matching nonempty slope-reach text.
Different interpreted sets (hypothetical pairing)	Different nonempty set IDs; physical co-occurrence is not established.
All selected pairs (hypothetical pairing)	All candidate pairs; this deliberately combines orientations without requiring a common recorded location.

2. Check missing assignments. Unknown legacy surveys/domains do not match each other. The new scopes exclude them; they are not repaired from current outcrop defaults. If observations are missing from a scoped result, return to their evidence before assigning context.

3. Check means. A mean only retains a context key shared by every member. A mean from multiple outcrops can therefore be excluded by Same outcrop. Inspect its member records; there is no averaged location that proves a block exists.

4. Inspect the candidate sources. Read observation IDs, revisions and available location/context details. Confirm physical co-occurrence and finite releases separately before building an equilibrium case. Do not turn a critical orientation percentage into a site failure probability.

6.1B Keep the correct kinematic denominator



Read all four counts: candidate pairs, scope-excluded pairs, parallel pairs and tested intersections. Tested = candidates minus scope-excluded minus in-scope parallel pairs. Excluded does not mean stable.

Worked counting example: four planes produce six pairs. If Same outcrop retains two pairs and one is parallel, four are scope-excluded and only one intersection is tested. Individual-plane modes still use all four valid planes.

A zero denominator is not zero risk. If the only same-survey pair is parallel, no intersection percentage can be supported. Use the displayed explanation and retain the missing evidence.

Export the basis. Keep complete analysis JSON and appropriate row/critical CSV exports with selected scope, source records and counts. Review stored context alongside raw orientations. Theory K19-K20 shows the full reproducible example.

These controls add no automatic sampling weights, persistence limits, cohesion, rock-bridge credit or factor of safety. Geometry, water, strength and releases remain separate engineering inputs.

6.2 Use map context and engineering follow-up

Field Map → Geology references

With a saved outcrop selected, use the saved location for Look up / refresh geology. Compare the map unit, descriptions, scale and source with your exposure. A nearby search samples points; it does not enumerate every rock type. Multiple maps can disagree or show bedrock beneath cover. Leave your field description intact and put the comparison in interpretation.

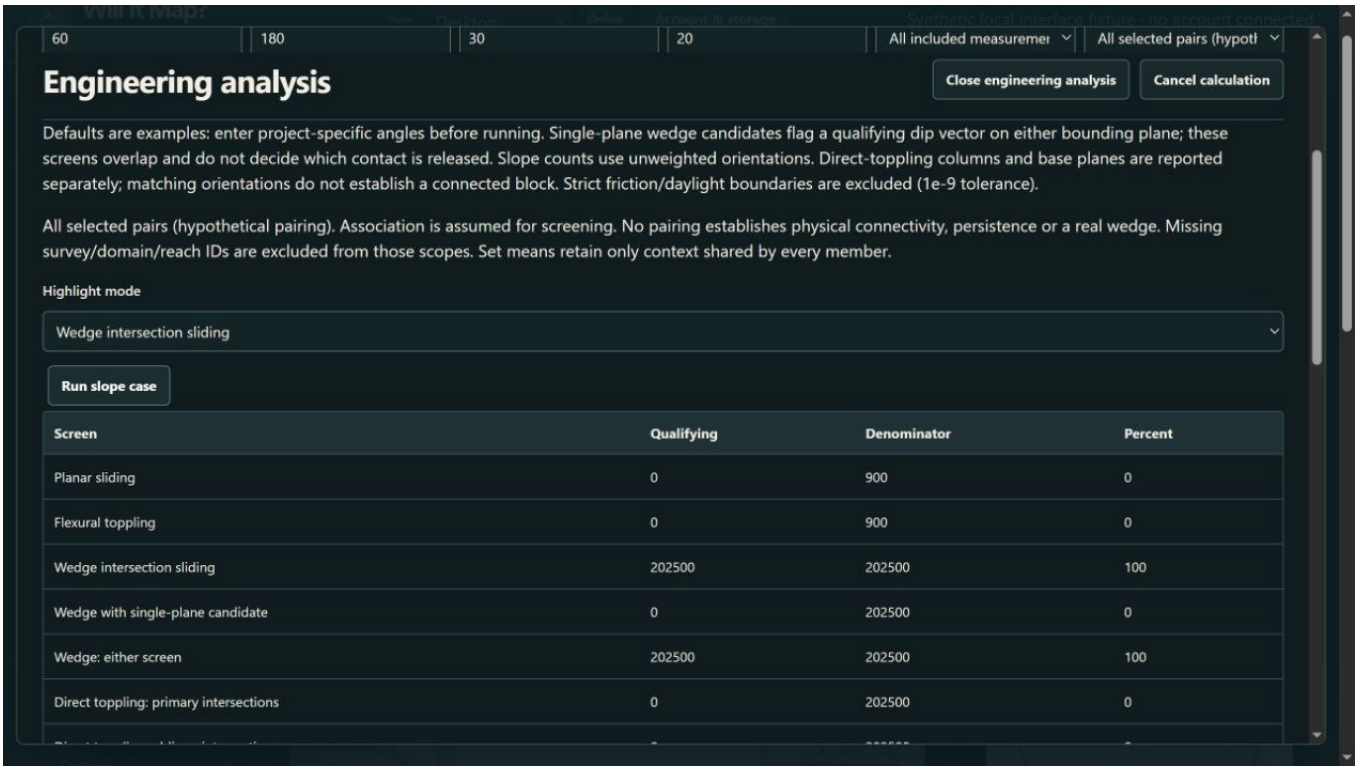
Create / refresh image produces a static geology overlay on a USGS topographic base. Check its center, width, legend and original sources. Save the PNG and Download references CSV for an independent field copy. These references are separate from field-record/GIS backups; new requests require internet and cached items can be evicted.

Kinematics and desktop follow-up

Use orientation populations with a common established north reference. For kinematic screening, measure slope dip and dip direction, and document a friction-angle basis; lateral limits are analytical assumptions. Screen results show geometric possibilities, not a measured hazard probability or factor of safety. Do not infer cohesion from an outcrop's appearance.

Desktop tables, filters and stereonet tools support review after the traverse. Preserve raw records and provenance when correcting values. The slope-stability editor contains geometry, loads, material and support assumptions that require an engineering model; they are not all quantities a logger can obtain with a phone. Use the separate Theory Manual for those calculations and input diagrams.

6.1C Run a full measurement population without sets



1. Select the source and scope. The retained result figure shows the earlier dialog; its controls now live in Cases & tools beside the main net. On phone Kinematics, no checked outcrops means all outcrops in the active project. On Desktop, open Stereonet analysis, load/import the required population and review filters/exclusions. Engineering input scope = All plotted measurements, then Cases & tools > Cases & sensitivity.

2. Enter the screening assumptions. Orientation population defaults to All included measurements - no sets needed. Pair scope defaults to All selected pairs (hypothetical pairing). Enter site-specific slope dip/direction, friction and lateral limits. The north reference is read from included records; there is no confirmation checkbox. Enter slope direction in that same frame. Mixed/unknown references still need explicit analysis-reference review; the app never silently declares them true north.

3. Run and check denominators. Run slope case visits every candidate pair. A 900-plane synthetic control has 404,550 candidates; 202,050 parallel pairs leave 202,500 intersections. The complete critical export includes all 202,500 qualifying cross-pairs for the stated example. These counts are not proof that those planes meet in the rock mass. Narrow scopes and interpreted means remain optional when geologically justified.

4. Export before closing the result. Report & exports provides complete analysis JSON and complete critical CSV, separately from plotted examples. Qualifying rows are batched in temporary device storage; missing/incomplete storage blocks complete export. There is no fixed 200,000-pair limit, but runtime, device quota, file sizes and battery remain constraints. Cancel stops an impractical run. Closing/changing inputs clears its temporary result, not saved observations.

6.2.1 Read the exposure before opening a slope case

1. Stand where the geometry can be seen safely. Identify the project, outcrop, survey/domain and slope reach. Take an overview photograph and a sketch with a scale, north and viewing direction. Preserve the original photo and survey references in the evidence notes; do not enter an interpretation as a new field observation.

2. Mark toe, crest and upper ground. The toe is the lower break where the modeled face starts. The crest is the break between that face and the ground behind it. Trace the upper ground behind the crest, including benches, irregularities and visible cracks. Show obscured parts as unknown. These are the boundaries of the proposed local model, not necessarily the highest and lowest points anywhere on the hillside.

3. Measure a defined reach and section. Record the face dip and dip direction, north reference, vertical toe-to-crest difference, and upper-ground orientation using suitable survey measurements. GPS elevation alone is not a reliable measurement of a small slope height; record the method and uncertainty. Keep horizontal distances, vertical height and distance along the face distinct. Mark where each value was measured.

4. Map the structures that could bound a moving body. Log bedding and relevant joints with their orientations, trace endpoints, spacing, condition and water observations. Follow Protocols 2 and 4. Look for lateral releases and rear boundaries; mark inaccessible or concealed continuation as an interpretation. A surface trace does not locate an entire hidden plane or prove that two traces meet inside the slope.

5. Keep three evidence lists. Measured: surveyed points, actual orientations and trace limits. Interpreted: representative section, plane continuation, candidate releases and dimensions assigned to concealed boundaries. Unknown: unexposed connections, pressure or strength without evidence. Describe uncertainty and sensible alternative cases instead of inventing values to close the shape.

Irregular or benched ground: preserve the actual profile. Use a separate reach or section only when the chosen idealization is defensible, and state what was excluded. Do not silently flatten benches, average several distinct faces into one slope, or treat several joint-bounded blocks as a single prism. The optional bench-comparison workflow has its own finite-envelope limits (Protocol 6.5); it is not general terrain or global rock-mass stability. If no supported idealization represents the concern, retain the observations and use a suitable separate analysis.

Further reading: FHWA Rock Slopes, FHWA-HI-99-007 (1998), for geology, groundwater and mechanism-based analysis; FHWA detail-line mapping field manual, Part G, for systematic exposure records. These support the evidence workflow; they do not certify a site-specific model.

6.2.2 Choose a candidate mechanism, not a verdict

Compare the mapped exposure and structural screening with the supported idealizations below. This is a model-selection aid, not a rule that predicts failure. More than one candidate can require separate cases; kinematic possibility supplies neither connectivity nor an FS.

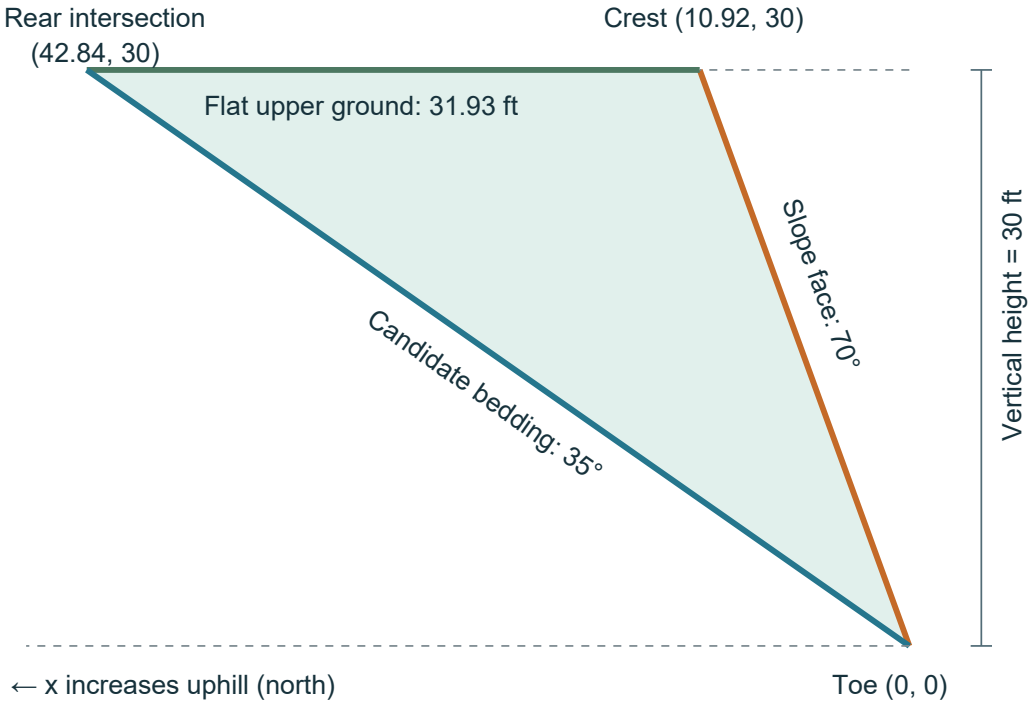
Observed or interpreted candidate	Model to consider and evidence still needed
One potential basal sliding surface	Planar sliding: a defined section through the face, upper ground and basal surface, plus a justified width and releases. The case represents that section/prism; it does not supply lateral confinement or persistence.
Two intersecting planes potentially bounding a finite body	Finite wedge: both true plane orientations, face and upper ground, and the dimensions/position needed to close the selected wedge model. Check the actual intersection and release conditions; a critical stereonet pair is not a surveyed block.
A distinct individual block on a base	Isolated block: supported block dimensions, base orientation, lever arms and relevant loads. This does not represent force transfer through a train of interacting columns.
Steep discontinuities dipping into the slope and a column-like mass	Interacting toppling: use only the supported column/base idealization and obtain the geometry and contact evidence it requires. Orientation alone does not establish toppling. Whole-slope block-flexure remains diagnostic, without an accepted whole-slope FS.
Complex, irregular or poorly exposed geometry	Do not force a match. Separate defensible local cases, obtain more information or use another suitable method. An unrepresented deep/global failure or rock-mass mechanism is not cleared by a stable local-block calculation.

Map measurements to the correct dimension. Planar height is vertical, and width is across the modeled section. For a two-joint wedge, H1 is the vertical toe-to-crest height at Joint 1; do not substitute the highest visible face. Isolated-block height is normal to its base. Toppling column width is normal to the joints, not an uncorrected apparent surface spacing. Open the matching input-definition figures before entering these values.

Check directions before copying a set mean. A direction names where a plane dips, not the direction in which you looked at it. Record the north reference. Planar uses a single interpreted section; oblique true dips require an explicit section interpretation (Protocol 6.2A). Do not change only the dip direction and silently keep an unrelated true dip.

6.2.3 Work a simple field-to-model section

Synthetic teaching scenario: a straight local face is 30 ft high, dips 70° south (180° true), and has flat ground behind its crest. A candidate bedding surface dips 35° south through the toe. Assume an interpreted 10 ft width across the section, with releases supported for the exercise. These are illustrative inputs, not observations at a real site and not a stability assessment.



Both dip directions: 180° true (south). View is a vertical north-south section.

Width = 10 ft perpendicular to this page; not visible in this side elevation.

The section is drawn at one horizontal/vertical scale. Toe, crest and rear intersection are defined by this idealized geometry. The rear point is where the interpreted plane meets the flat upper ground; it is not automatically a measured crack or proof of continuous bedding. No rear tension crack is included in this teaching case.

Build it: choose Planar sliding; establish true north; enter slope height 30 ft, slope dip 70° and section/dip direction 180°. Enter failure-plane dip 35° in that same section, upper-ground dip 0°, and width 10 ft. Keep the shared bearing consistent. Name the face and bedding surface; cite the sketch/evidence. Inspect the live side elevation. Do not press Calculate merely to obtain a picture; strength and loading still require their own evidence.

6.2.4 Separate measured inputs from model assumptions

Input / check	Teaching value	Evidence status in an actual investigation
Face height and dip	30 ft; 70°	Measure the defined toe/crest and local face. These values are synthetic here. Do not use distance along the face as height.
Face / section bearing	180° true	Measure face orientation; justify the chosen section. The example aligns the true dip directions.
Bedding dip / bearing	35° / 180° true	Measure actual bedding; interpreted continuation through the toe must be supported separately.
Upper-ground dip	0°	Confirm the profile behind the crest. A flat upper boundary is an explicit assumption here, not a missing value.
Across-section width	10 ft	Interpreted finite extent; document lateral-release/continuity evidence. A visible 10 ft trace by itself is insufficient.
Strength, water, loads	Not supplied	Unknown for this exercise. No dry assumption, friction, cohesion, unit weight, seismic action or support capacity is inferred.

Check the geometry by hand. With H = 30 ft and x positive uphill: crest x = H / tan(70°) = 10.9191 ft; rear x = H / tan(35°) = 42.8444 ft. Upper length = 31.9253 ft. Basal length = H / sin(35°) = 52.3034 ft. The triangular section area is 0.5 × 30 × 31.9253 = 478.8800 ft²; multiply by the 10 ft width for 4,788.8000 ft³. Use unrounded intermediate values. Theory I10 gives the same steps.

Compare with the screen. The geometry-only check should show a 30 ft vertical span and about 4,788.80 ft³, with the crest near the steep face and the bedding extending farther uphill. Auto-fit changes picture size after edits; read the feet scale. If the shape vanishes, follow the geometry reason and the linked fields. Do not adjust an unsupported number simply to make it draw.

Before an engineering result: verify the actual release geometry, bounds and uncertainty; choose supported contact strength and stress range; establish water and loading scenarios; then Review setup, Calculate, inspect and preserve the case. A finite picture proves only that the entered idealization closes. It does not verify a hidden surface, establish a failure mode or show that the slope is safe.

6.2A Hand off field geometry to a planar section

1. Preserve the measured planes. Keep true dip/dip direction, north reference, feature ID and location in the observation record. The analysis case is a separate interpretation.

2. Choose the downhill section bearing. In Slope stability > Planar > Geometry, Section dip direction controls slope, failure-plane and inclined upper-ground bearings together. Their dip inputs are inclinations inside that same vertical section.

3. Resolve oblique observations deliberately. Changing the bearing alone does not convert true dip into apparent dip. The app does not perform that conversion. Establish justified section angles or choose another appropriate model; use Theory Manual I5 and the slope chapters.

4. Review imported conflicts. If saved directions disagree, read the listed originals, review the section bearing and all inclinations, confirm the interpretation checkbox, then choose Apply the shared section direction. The analysis-case directions change; original field orientations remain unchanged.

5. Use the input help. Open the field diagram to distinguish vertical height, face dip, upper-ground dip and failure-plane dip. These sketches define quantities; they are not measured or calculated slope geometry.

6. Follow the error to its field. Review setup and Calculate show linked input problems; select a link to open its setup step or editor. Recognized main fields receive focus. Supply supported missing numbers or correct the model. Final mechanical checks still apply. Blank is not zero.

Model boundary: a wedge is three-dimensional and permits different joint bearings. Do not apply the planar shared-direction rule to wedge data. Kinematic possibility and an equilibrium FS answer different questions.

6.2A.1 Start the slope case from its evidence

1. Describe the slope, then choose the mechanism. Open Slope stability from the desktop structural workspace. In Geometry, name the case, establish north and enter the slope/upper-ground description. Choose planar sliding, finite wedge, isolated block or interacting toppling columns as appropriate. A kinematic flag supplies no dimensions or strength by itself.

2. Select the relevant contact orientation early. In Choose field measurements, interpreted means or manual entry, choose Orientation population, Apply to contact and Source orientation, then Apply orientation. Review the outcrop/population and north reference. The slope-face orientation is entered separately; manual contact entry remains available.

3. Treat the selected source as a captured observation. The case keeps the chosen source information; later field edits do not automatically refresh it. Editing an analysis angle does not change the original measurement. Reselect or revise the case deliberately when the interpretation changes.

4. Give important surfaces useful names. In Model surfaces & assignments, select the stable role, such as Failure plane or Joint 1, and add a descriptive name such as Bedding at north cut. Keep the role visible. Naming a surface does not locate it, create another plane or assign strength.

5. Enter dimensions with their correct definitions. Follow the field diagrams. Planar height is vertical; use the specified wedge H1 definition; isolated-block height is normal to its base; toppling column width is normal to the joints. An exposed trace length is not automatically a block width or full three-dimensional persistence.

6. Locate an applicable rear crack. Planar and two-joint wedge crack geometry is under Geometry. Its pressure/head controls are under Water & loads; they share the same case definition. Explicit basal-wedge cracks remain with the positioned geometry and its crosslink. Do not enter a second crack to account for water.

Planar section reminder: all relevant planes belong to one interpreted vertical section. A true dip from an oblique field plane is not automatically converted when you change its bearing. Follow Protocol 6.2A and Theory I5.

6.2A.2 Inspect live geometry before accepting the model

1. Enter supported dimensions and orientations, then inspect the changing shape. The setup figure uses the actual model vertices and faces, not a fixed template. Select a named surface or listed value to find its input. A missing value remains missing; the picture does not supply it. On desktop, choose Show input diagram to open this additional sketch; Hide input diagram closes it. The right-side Live geometry stays available. The compact phone view keeps the setup sketch visible.

2. Read the view and scale. Side elevation shows section proportions for planar, isolated-block and toppling models. For a wedge, use 3D geometry or Plan view to inspect the joint intersection and footprint. One uniform scale applies horizontally and vertically; oblique and plan views foreshorten some lengths and angles. Plan view cannot show vertical height.

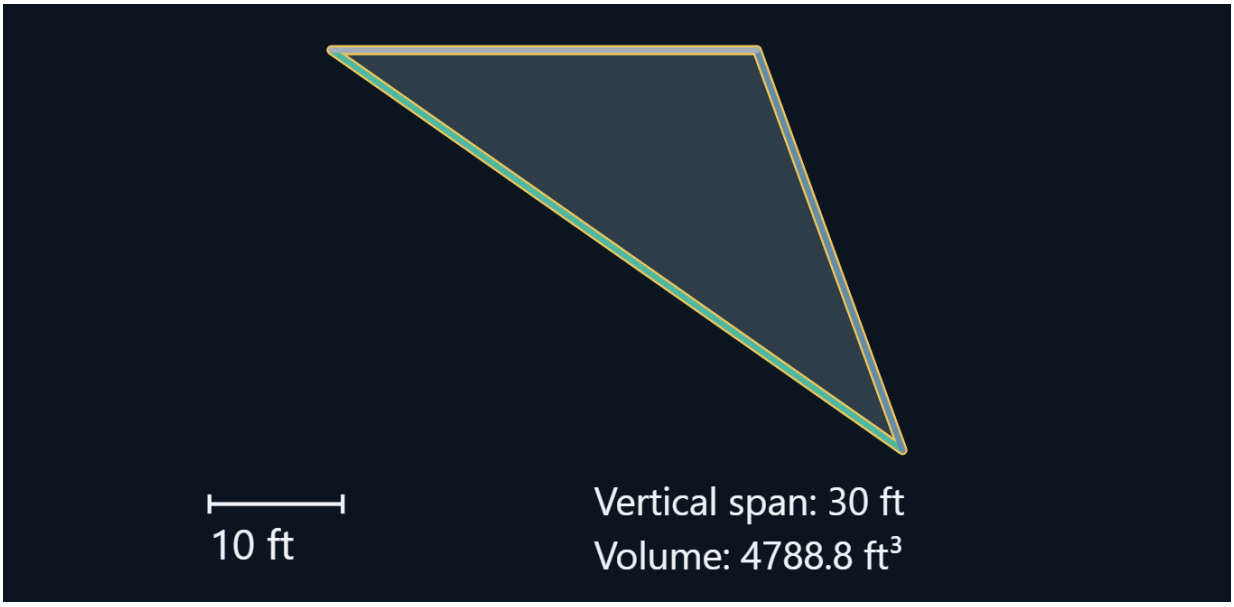
3. Check numeric size, not screen size. The frame automatically fits the current shape. A larger model can therefore look equally large on the phone. Read the feet scale, Vertical span, Volume and entered dimensions. Vertical span is the current body's total vertical extent, not necessarily wedge H1 or block height normal to its base. Changing the view does not correct an angle or unit mistake.

4. Treat a missing shape as a correction task. If the inputs are incomplete or no valid finite geometry forms, the previous shape disappears and the reason is shown. Use the input links, correct the evidence or interpretation, and check again. Do not reuse an earlier valid image to judge the changed case.

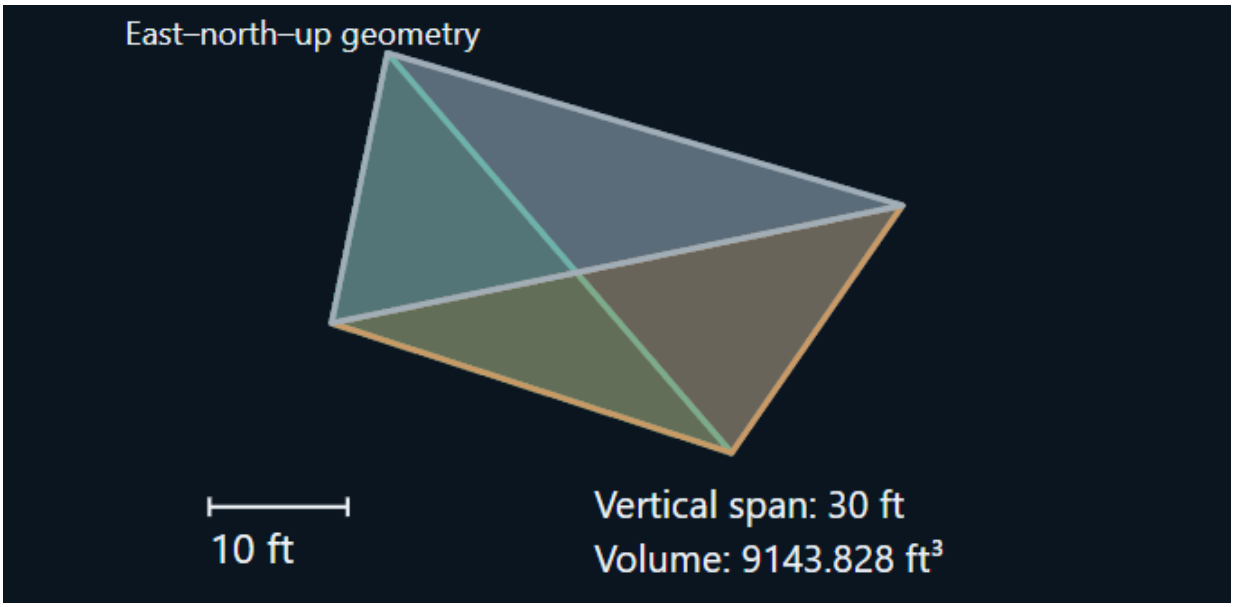
5. Open Input definitions - reference sketch only for input meaning. That collapsed reference is illustrative and not to scale. It explains surface roles and measurement definitions; it is not the entered model. Keep an unsupported measurement blank while obtaining the evidence.

6. Continue to strength, water and Calculate. Geometry can display before strength or loads are complete. The separate model preview allows further inspection, but only Calculate evaluates the supported mechanics. A visible body or volume does not establish contact, equilibrium, bolt engagement or an accepted FS. Whole-slope block-flexure results remain diagnostic.

6.2A.3 Check the entered shape and its scale



The worked planar section (6.2.3-6.2.4): actual setup figure with 30 ft height, 70° face, 35° bedding, flat upper ground and 10 ft width. It shows a 30 ft vertical span, a 10 ft scale bar and 4,788.8 ft³ volume. Compare this shape with the labeled section. This is a geometry preview, not a stability result.



Separate wedge example: the oblique 3D view shows the actual finite block. Its vertical span is 30 ft and its scale bar is 10 ft. The frame auto-fits both examples, so compare the numerical sizes, not the size of the pictures. Use Plan view for the footprint; the definition sketch remains a separate reference.

6.2A.4 Change mechanisms without replacing another draft

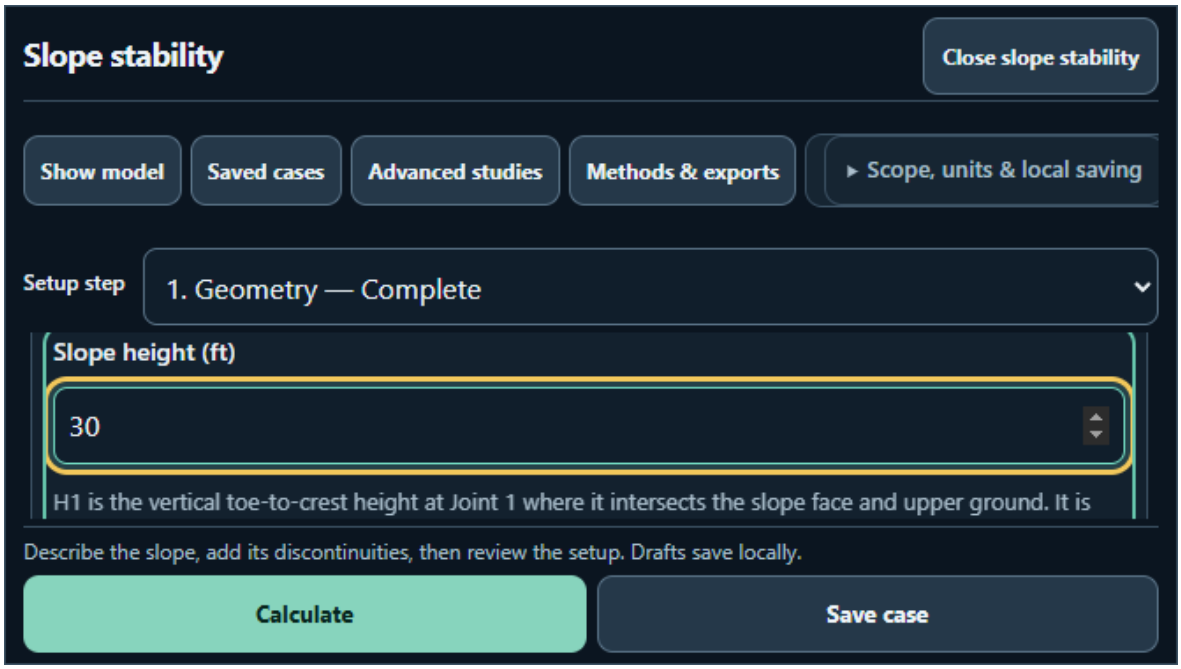
Use the mechanism selector to continue an existing model. Each mechanism has a local working draft. Changing the selection reopens that draft; it does not make the previous geometry valid for the new failure mode. Save named cases for deliberate alternatives.

Use Start another mechanism with this slope deliberately. For planar and wedge cases, this action can copy the slope, upper ground, their names and north reference into a new target draft. Define the new contacts and review its model conventions. Contact strengths, assignments and interpretations are not automatically transferred.

If the target draft already exists, it is protected. The inline message says No inputs have been replaced. Choose Open existing wedge draft (or planar) to continue that draft, or Cancel slope copy to stay here. The copy action does not offer to discard the target. Export or save important alternatives first; one working draft is not a revision archive.

On a short or landscape screen, use Setup step. The compact layout can hide Back/Next to preserve editing space. Select the desired setup step directly and use the model toggle when more input space is needed. Scroll the active editor; a linked issue should reveal the affected control. These layout controls do not change the model.

Before leaving: check the model name, case name, north reference and contact assumptions. Restore previous inputs is only the current session's previous-input control, not a permanent history or a replacement for saved case files.



Actual compact landscape layout with synthetic inputs. Setup step selects the editor; the focused height field and Calculate/Save case actions remain reachable. A completed input section is not an accepted FS.

6.2B Select joint strength from the evidence

1. Establish the contact and expected motion. Use the relevant joint surface, direction, scale, infill/wall condition and moisture. The outcrop record is evidence; the engineering case is a separate interpretation. A rock name or RMR/GSI value does not choose a joint-strength law.

2. In Slope stability > Materials, open Choose a strength law from the evidence. Check each available contact separately. Use a supported linear Mohr-Coulomb envelope, an applicable JRC-JCS Barton-Bandis criterion, or a power curve fitted to representative shear data.

Choose	Check before calculation
Mohr-Coulomb	Appropriate friction/intercept over the effective-stress interval. State peak/residual condition and whether roughness is already represented.
Barton-Bandis	Applicable rock contact; residual friction; JRC and JCS at the intended direction/field scale. Do not apply the length correction twice.
Power curve	Known fit interval, units and represented surface state. Retain original test data and coefficient source. Do not extrapolate merely because a number is returned.

3. Enter supported parameters and evidence. Record test/profile IDs, stress interval, water and scale basis in Geometry, strength, water and load evidence. Thick weak infill requires its own applicable strength basis; rough rock-wall parameters do not automatically describe it.

4. Start with No additional waviness (recommended). Zero avoids adding a separate contribution without evidence. It is not a guaranteed lower-bound design value or a substitute for choosing the correct base law. Protocol 6.2C explains the advanced option and existing saved values.

5. Calculate, inspect and preserve. Review validity warnings, effective compression, contact areas and resistance components. Save the case and export its calculation package with the evidence. Original field observations are not rewritten by changing an analysis law.

6.2C Review an additional waviness term explicitly

Default: Additional waviness = No additional waviness (recommended), with the extra angle at zero. This does not mean the joint is physically smooth. Keep zero when tests, the fitted envelope or JRC already represent the roughness in question.

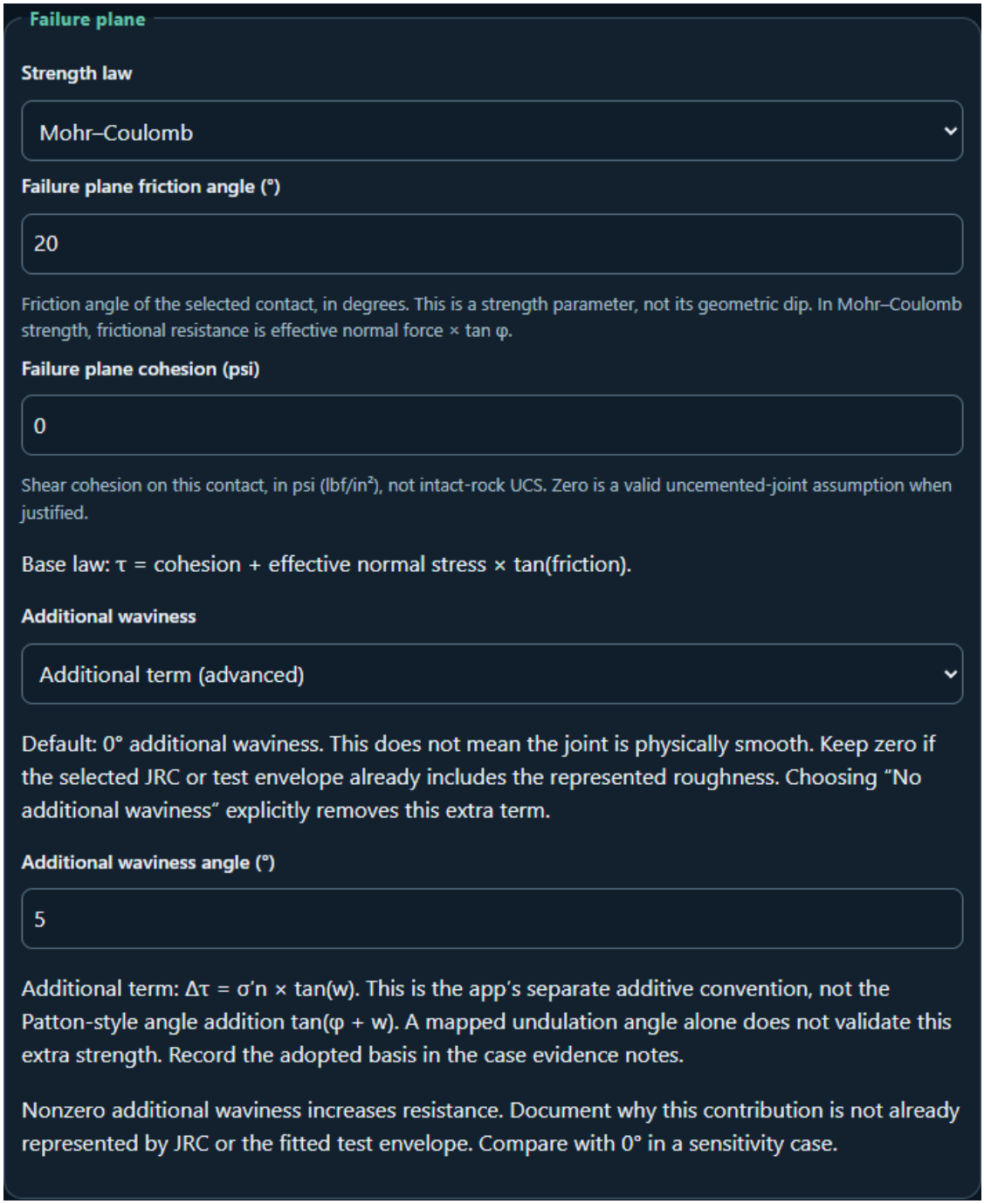
Advanced: choose Additional term (advanced) to expose Additional waviness angle (degrees). At a retained compressive contact, the app adds an extra shear stress equal to effective normal stress times tan(angle). It does not put that angle inside tan(friction + angle). Theory S6B works both expressions by hand; a released contact receives no shear contribution.

Existing cases: saved/imported nonzero angles open the advanced controls unchanged. Switching strength laws preserves the angle. Review its source before recalculating; the update does not automatically set existing values to zero.

Deliberate removal: choose No additional waviness to set the draft angle to zero, then Calculate, review and Save case. Merely opening the case does not make that edit. Advanced with a zero angle has the same numerical extra resistance as the default.

Evidence required: explain the omitted contribution, directional scale and why the additional-term convention is appropriate in Geometry, strength, water and load evidence. Do not duplicate roughness, imply that the term is a Patton model, or change a value only to obtain a passing FS.

6.2C.1 Read the strength controls before saving



Actual updated Materials controls with synthetic data: friction 20 degrees and additional angle 5 degrees. These are teaching values, separate from Theory S6B's 30/10-degree arithmetic example. The additional angle is an analysis choice, not a direct field observation.

6.2C.2 Reuse contact properties deliberately

1. Establish one valid contact first. Follow Protocols 6.2B-6.2C. Select the contact and enter the supported shear law and parameters. Record test/profile IDs, stress interval, condition, direction, scale and any represented roughness. A rock name alone is not evidence for a property set.

2. In Materials, use Named contact properties. Open Create or update a property set, enter a distinct profile name and property evidence, then Save current contact properties as new profile. Save, Copy selected profile with a new name and Update selected library profile change only the library. They do not apply it to a case.

3. Select the intended contact and Apply selected profile. Review the copied law, parameter values and evidence. The case retains the assigned name, revision and snapshot. Orientation, geometry, water and other contacts remain separate; no field observation is rewritten.

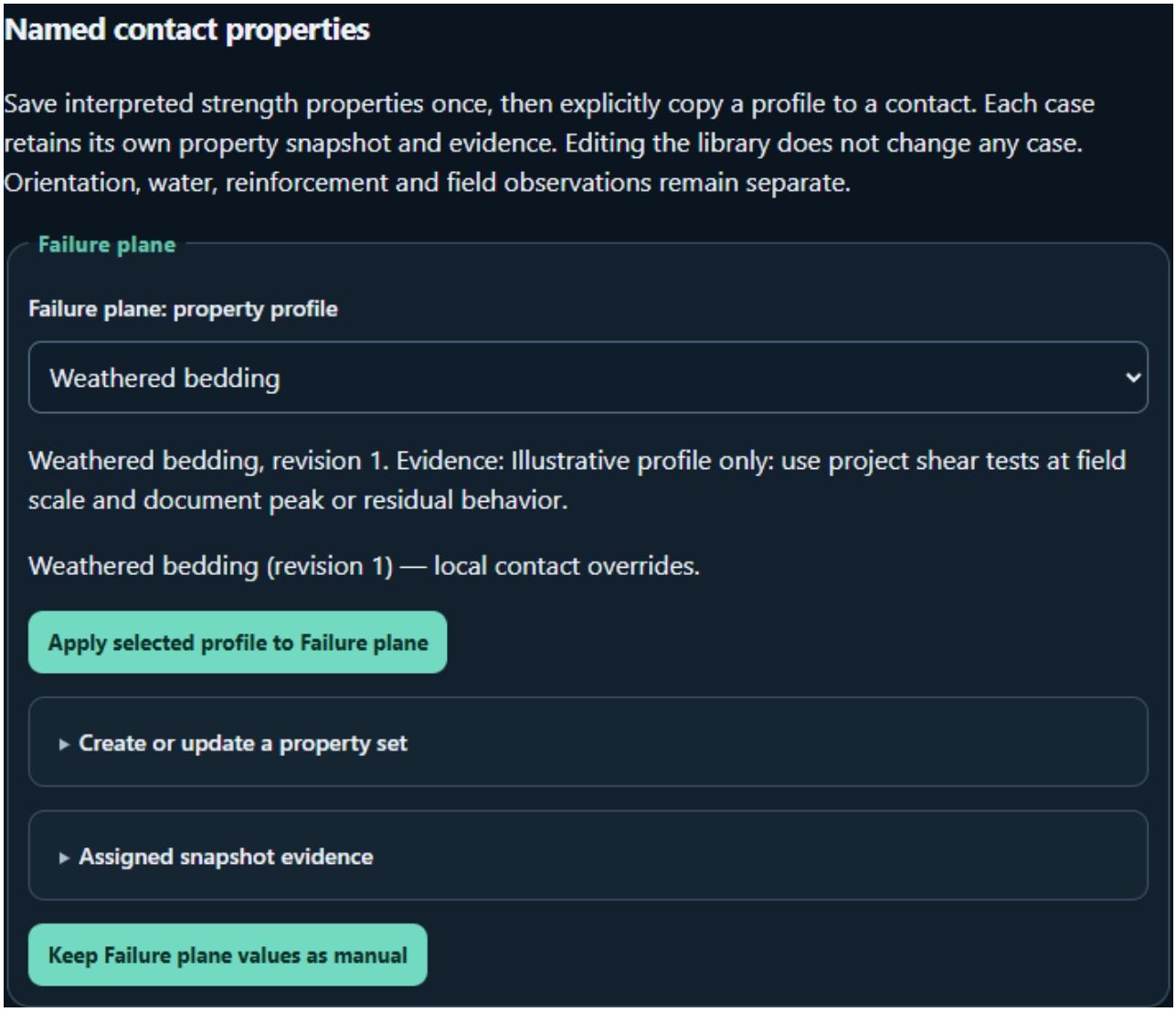
4. Review overrides explicitly. Editing the contact after assignment creates local contact overrides; those current case values govern its calculation. The assigned snapshot is retained for comparison. Do not assume the profile name proves the values still match it.

5. Treat a library update as a separate action. Editing a reusable profile does not update cases that already received it. Review and explicitly apply it when justified. Assigned snapshot evidence remains with the case even if the library copy is unavailable. Keep contact values as manual removes the assignment and retains the current values.

6. Respect model compatibility. Named intercolumn profiles and the verified block-toppling model require zero intercolumn cohesion. Nonzero cohesion stays manual within block-flexure diagnostics; it does not yield an accepted whole-slope FS. Toppling profiles do not accept nonlinear strength or additional waviness. Reject an incompatible profile instead of silently adapting it.

Before saving: verify every contact, any nonzero additional waviness, and the actual units. Named profiles improve consistency; they do not establish site suitability or remove the need for engineering interpretation.

6.2C.3 Check the assignment and its overrides



Actual current Materials controls with synthetic teaching properties. A profile assignment is a copied case snapshot. Later library changes and case-specific overrides require deliberate review.

6.2D Review loading assumptions before Calculate

1. Open the optional sections that apply. Water, seismic action, reinforcement and other loads can remain collapsed for a simple case, but read their summaries. Closing a panel does not turn off a value already entered.

2. Confirm the physical assumptions. Check dry versus pressure/head-defined contact water, any separate ponding, kh and kv, support entries or prescribed forces, external loads and design factors. Do not call the model dry or unreinforced solely because its editor was closed.

3. Open Review setup. Read the geometry/north, contact properties, source interpretations and explicit loading summaries. Follow every missing/invalid-input link to the relevant step. Recognized main fields receive focus; advanced issues open their editor. Correct the actual value or evidence and review again.

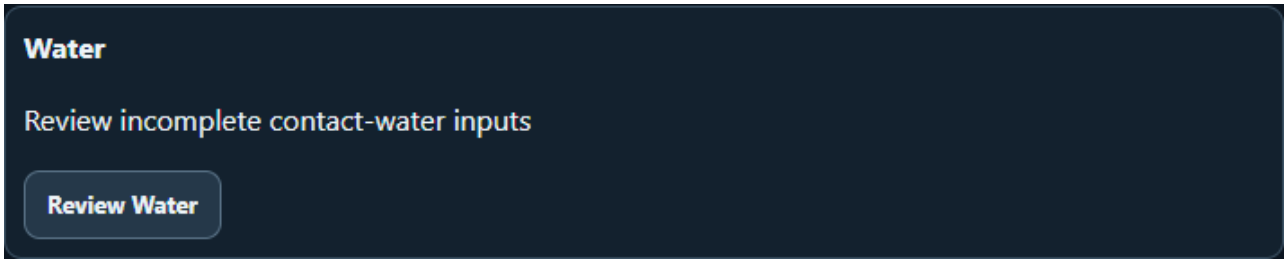
4. Resolve warnings with judgment. A changed angle may be a deliberate section interpretation; an empty evidence note remains a documentation gap. A complete input list does not prove a physically possible block or a valid engineering model. An unresolved or withheld result is not safe.

5. Calculate and inspect the result. The solver still checks geometry, stress/contact conditions, support engagement, force equilibrium and model limits. Inspect forces, areas, water and governing mechanism. Whole-slope block flexure remains diagnostic with no accepted whole-slope FS.

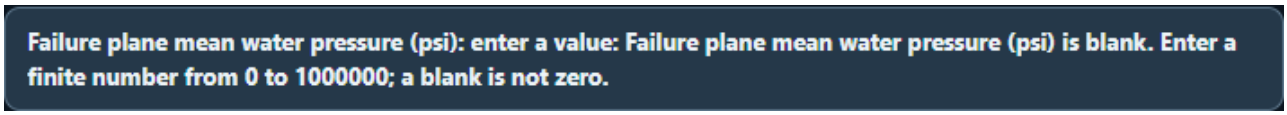
6. Save and preserve. Use Save case, then Saved cases > Export all slope cases for saved cases and their assigned snapshots. Export property library separately for reusable profiles; follow Protocol 6.2E. Export the calculation package for inputs, evidence, result and version. Field-data upload does not back up these local engineering cases.

6.2D.1 Use the readiness links and assumption summary

Read the assumption first. In this actual Review setup example, one contact pressure is blank. The Water card says the inputs are incomplete; it does not describe the case as dry. Review Water opens that setup step.



Use the specific correction link. The issue below names Failure plane mean water pressure (psi). Select it to open and focus the affected input. Enter a supported pressure, or an explicit zero only when the dry/zero-pressure assumption is justified.



Then review again. The other cards summarize seismic action, reinforcement, external loads and factors. Inspect those assumptions even when their editors are closed. A complete input set still requires calculation and engineering interpretation.

Actual current controls with synthetic teaching inputs. These linked checks establish input completeness and consistency; Calculate still performs its mechanical checks. Neither the summary nor the corrected blank is an engineering approval.

6.2D.2 Resolve blank seismic and derived-water inputs

1. Distinguish a missing seismic coefficient from zero. Both kh and kv must be explicit finite zeros for No seismic action. A blank, null or invalid value should show Prescribed seismic coefficients when the draft reopens. Follow the correction link and enter a supported value. Choosing No seismic action deliberately sets both coefficients to zero; record why that assumption is appropriate.

2. Review the chosen groundwater model. A derived groundwater surface replaces contact mean pressures during calculation. Imported or older unfinished drafts can still contain invalid stored means behind those derived controls. Do not declare the case dry merely because a disabled mean-pressure field is blank.

3. Use the explicit repair only after checking water assumptions. When shown, Use groundwater-derived contact pressures requires valid groundwater and ponding inputs. It replaces only invalid stored contact/crack means with zero placeholders; valid stored means remain. The actual calculation still derives pressures from the selected groundwater definition.

4. Review and Calculate again. Check the calculated water forces and the geometry on which they act. This repair does not solve groundwater flow, supply a missing water level or change a derived model into a dry one. Preserve the evidence for the water scenario and any pressure assumptions.

If the repair refuses to proceed: correct the groundwater/ponding inputs first. A custom mean-pressure model must instead have supported explicit contact pressures. Do not keep entering zeros simply to suppress validation messages.

6.2E Transfer properties and recover a local-save conflict

1. Preserve three different kinds of work. Save case creates a named scenario. Saved cases > Export all slope cases exports those saved cases and their assigned snapshots. In Named contact properties, Export property library saves the reusable library separately, including profiles that have not been assigned to a case. Keep both files when transferring work.

2. Import reusable profiles deliberately. Use Import property library file in Named contact properties. Valid profiles are added; identical ID/content repeats are skipped. Conflicts become distinct imported copies. Existing profiles, cases and assignments are not overwritten. The file limit is 2 MB and the resulting library limit is 100 profiles; invalid or oversized imports leave it unchanged. Inspect evidence, then explicitly Apply selected profile to the intended contact.

3. If Local save failed reports another tab changed the workspace, keep the conflicted tab open while exporting. Export its saved cases, current draft and property library as needed. The library export reads the current in-memory profiles, so a newly created profile that failed to save can still be preserved.

4. Reopen the safely stored workspace under the same account. Import the valid library file, inspect any imported copies, apply the intended profile explicitly and save the reviewed case. Import saved cases separately when required. Compare inputs and evidence; the app does not merge competing engineering interpretations automatically.

5. Treat unfinished draft JSON as a manual recovery record. Methods & exports > Export current draft JSON preserves the current unfinished input. It is not a validated case and there is no automatic draft importer. Retain the file while manually reconstructing or obtaining help with unsupported/invalid entries; do not assume it can be imported through the saved-case control.

6. Verify the files. Check that downloads exist and reopen representative saved cases or imported properties. The calculation package preserves the computed case/result/version. Field-cloud backup does not back up this local engineering workspace, and these exports do not promise recovery of an invalid legacy case.

6.2F.1 Choose the reinforcement system

Before starting: finish the candidate geometry, controlling joints, water and loads. Identify the installation face and competent anchorage region. Collect steel specifications, head/plate details, bond evidence and test requirements. A bolt pictured on the slope is not proof of engagement or an adequate installation.

1. Open Setup step > Reinforcement, then Add reinforcement. Follow Reinforcement design step, the expandable groups and their Next buttons. Work through all five groups for each proposed support; retain separate named cases for design alternatives.

2. Decide how resistance develops. Under 1. Choose the reinforcement system, choose active or passive Force application. Active means a retained applied pretension; passive resistance develops with rock movement under the selected mobilization assumption. The app does not calculate the displacement required. A proof-test load is not permanent pretension.

3. Decide how geometry is checked. Choose a single checked bolt, a generated pattern or an explicitly justified force-only model as applicable. A count greater than one in a checked group assumes identical engagement. A pattern checks the distinct generated head positions. Isolated-block support uses its separate force-height/moment assumptions.

4. Choose the capacity model you can support. Grouted, mechanical, specified and other models have different required data. Their capacities describe a load path, not interchangeable product labels. The new planar/wedge entry is a one-bolt, passive, fully grouted 20 ft trial with zero plate capacity credited. This is an editable starting point, not a completed design.

5. Retain existing evidence. Existing supports keep their saved values until edited. A historical capacity copied from the original entered force remains legacy-force. Review or replace its definition, enter an engineering basis, and use Confirm independent capacity evidence when offered. Repeating the same force does not establish an independent capacity.

Next: select material properties, then locate the bolt and establish anchorage. Theory E4-E6 and E22-E28 show the separate geometry, resistance and load checks.

6.2F.2 Select the bar and steel properties

1. Open 2. Select the bar and steel properties. Choose Bolt product or Custom product / manual steel capacity. Compare typical bar products and source values opens the published table. The four presets are Grade 75 #8/#10 and Grade 150 nominal 1/1-1/4-inch threaded bars. Confirm the actual proposed product and retain its project certificate.

2. Read the properties separately. Steel area is the net threaded area, not an area calculated from nominal diameter. Minimum yield and specified minimum ultimate stresses give different load limits. The normal display gives feet, square feet, psi and lbf; custom product designation/area explicitly use inches and square inches. Do not substitute an observed break-test load for specified minimum strength.

3. Review the design procedure. A new product selection starts with FHWA FP-24 and test/design ratio 1.33. The catalog adds a conservative yield ceiling. The GEC 4 prestressed-anchor procedure is available only for the prestressing-bar class. Change the procedure/ratio deliberately if the project requires it. Theory E26-E27 reproduces the equations.

Worked checkpoint: Grade 75 #8 has area 0.79 in², yield 75,000 psi and ultimate 100,000 psi. Its loads are 59,250 and 79,000 lbf. The 60%-ultimate design stage is 47,400 lbf; the 80%-ultimate test stage is capped at yield, 59,250 lbf. Dividing by 1.33 gives a steel design limit of 44,548.8722 lbf. This is a steel component, not the entire anchor resistance.

4. Check what was filled. For grouted/mechanical models, selecting or applying a product fills Steel tensile capacity. A lower supported project value may be entered. For another capacity model, the product remains reference information. No product fills bond, plate, independent service limit or applied pretension.

5. Apply or discard manual edits. Expand Custom material properties and design basis. Record Material override evidence for changed source properties. Pending edits are saved but block calculation and a stale preview until Apply bolt-product edits or Discard bolt-product edits. The saved case retains the original source and separate overrides; later catalog changes do not update it automatically.

6.2F.3 Place and aim the bolts

1. Open 3. Place and aim the bolts. Trend points from the head into the rock toward the anchored end; positive plunge descends from horizontal. The slope dip direction is outward and normally opposite the inward bolt bearing. The orientation diagram explains this convention; it does not prove engagement.

2. Compare normal and chosen plunge. On a known conventional face, inward trend is face bearing +180° wrapped to 0-360°, and normal plunge is 90° minus face dip. A 70° face therefore starts at 20° down. Choosing 15° below perpendicular adds to this normal: 20°+15°=35° down. It is an optional adjustment, not the default or the same as 15° from horizontal.

3. Use dropdowns or explicit manual entry. Direction can copy the current inward bearing; angle options distinguish below-normal offsets from absolute plunges. Custom / manual input retains arbitrary valid numbers. Point into slope, keep plunge changes only the bearing; Use face-normal direction sets the eligible normal. Later slope edits never silently rotate existing bolts. Unknown/overhanging geometry may leave directions blank.

4. Locate every head. The new checked spot entry uses the eligible face center as a trial. Change the installation face or position to match the design. For a pattern, enter horizontal spacing, spacing along the face, offsets and edge clearance. Along-face spacing is not vertical rise. Menu spacings are entry shortcuts, not safe-design prescriptions.

5. Check assumptions before proceeding. A group count assumes identical engagement; use a pattern for distinct head positions. The isolated-block model starts uphill and horizontal, with a separate application height. Confirm that the intended line crosses the releasing joints into stable rock; length is established next.

Inspect the planar/wedge model: Show bolts draws checked shafts and actual patterns. Specified forces have no shaft to draw. Use Transparent block to see crossings. Green, red and dashed amber describe geometry only, not capacity or FS. See 6.2F.9 before interpreting the colors.

Reference context: FP-24 §260.08(a) uses normal or 0-5° downward from normal unless plans differ. GEC 4 describes common general ground anchors at 15-30° below horizontal. Neither establishes a universal optimum; the app permits deliberate alternatives with an engineering basis.

6.2F.4 Establish length and anchorage

1. Open 4. Establish length and anchorage. Select Total bolt length or a custom value. FHWA describes 20 ft as typical for slope-stabilization anchors; the new passive grouted entry uses it only as a trial. Check the actual head, release-surface crossing, tip and competent region. A longer menu choice does not automatically establish adequate anchorage.

2. Distinguish geometric embedment from bond. Minimum geometric embedment, not bonded length is the required axis length beyond the modeled joint. It starts blank and must be supported by design. It does not measure rock quality, supply bond strength or verify the hole. The embedment diagram labels these separate quantities.

3. Choose the grout arrangement. Fully grouted - follows total length keeps bonded length equal to total length. Specified bonded length from tip describes a shorter bond interval ending at the tip. Enter the actual installation. For active anchors, establish free-stressing length, stable bond zone and staged grouting; final full grouting alone does not demonstrate that the anchor could be stressed correctly.

4. Establish site resistance. Enter qualified Bond strength per unit bolt length (lbf/ft), plate/anchor components and Bolt capacity evidence for the selected law. The new passive trial credits zero plate resistance; edit it only with support. Product steel data do not provide bond, stable-rock quality or accepted installation resistance. Review both relevant bonded interfaces and project test results.

5. Reproduce the meaning of the lengths. For a teaching full-grout bolt L=20 ft crossing a joint 8 ft from the head, geometric length beyond it is 12 ft. With qualified q=1,000 lbf/ft, zero plate and steel capacity 44,548.8722 lbf, the simplified grouted envelope is min(44,548.8722,8,000,12,000)=8,000 lbf. The two bond terms come from the 8 ft and 12 ft segments. Theory E28 explains the assumptions.

6. Establish the independent system limit. Carry the governing usable resistance and its basis into Step 5, Qualified service limit per bolt. Do not copy desired force, steel ultimate or a table value without checking the complete load path. Unknown is distinct from an explicit zero. The result audit shows which checks are supplied and which remain unchecked.

6.2F.5 Set loading and review the checks

1. Open 5. Set loading and review the checks. For active support, enter retained pretension per bolt from the installation/design basis, not proof load. For checked passive support, review the available resistance and orientation efficiency. These are different mechanisms; the app does not predict displacement-dependent mobilization.

2. Read the independent limits. Active pretension above an applicable diagram or qualified service limit is rejected, not lowered. Checked passive axial capacity uses the smaller available limit before orientation efficiency. A diagram of 4,000 lbf, service limit 3,000 lbf and efficiency 0.6 gives 1,800 lbf; active 2,500 lbf remains 2,500, while 3,500 lbf fails the service limit. Force-only passive demand and separate shear follow their stated limit checks.

3. Resolve pending edits and Calculate. Apply/discard product edits and any optional steel-helper draft first. Review engagement, crossing, embedment, controlling resistance and effective contribution for every generated head. A valid material certificate cannot make an unengaged bolt contribute. Recalculate after each changed assumption.

4. Inspect project factors and report evidence. Applicable support divisors act on entered forces, capacity components and service limits together after validating original demands; certificate/catalog properties remain unchanged. The report preserves source values, overrides, bases and the actual contribution. A high FS does not prove bond, corrosion protection, construction acceptance or compatible displacement.

5. Save case and export the calculation package. Reopen the case and check its product snapshot, custom changes, units, direction, capacity law, service limit and accepted steel checks. Keep certificates and field tests with stable reference IDs outside the app. A working draft is not a design revision archive or proof of cloud backup.

Completion check: all five groups describe the same installation; head-to-tip direction, release-plane crossing and stable anchorage are supported; applied force differs from resistance; each active/passive assumption and legacy qualification is explicit. Whole-slope block-flexure remains diagnostic with no accepted FS.

6.2F.5A Use the separate certified-ultimate steel helper

1. Open Check tendon steel and load stages. Enter Certified minimum ultimate tensile load (lbf), Maximum test load / design load and Steel certificate and design basis. Use specified minimum tensile strength times certified steel area, not an observed break-test load. Nominal diameter alone is insufficient. The screen uses ultimate prestressing-steel limits, not a universal yield-based rule for every bolt.

2. Read all three stages. The FHWA GEC 4 screen gives design≤60%, lock-off≤70% and maximum test≤80% of certified specified minimum ultimate load. The required test multiplier can further reduce the permissible design load. It does not establish head, bond or ground resistance, and no resulting value is automatically copied into force or service capacity.

3. Work a teaching example. For specified minimum ultimate 100,000 lbf and test/design 1.33, the ceilings are design 60,000, lock-off 70,000 and maximum test 80,000 lbf. The 80,000/1.33 test restriction is 60,150.4 lbf, so 60,000 lbf governs. At test/design 1.5, the test restriction instead governs at 53,333.3 lbf. Theory E24 gives each arithmetic step.

Published scale example: GEC 4 Table 9 lists a Grade 150 nominal 1-inch bar, tabulated area 0.85 in² and specified minimum 150,000 psi: ultimate 127,500 lbf and steel ceilings 76,500 / 89,250 / 102,000 lbf. This separate helper uses certified ultimate evidence; it is distinct from the Step 2 product catalog with its additional yield guard. Neither is a recommended retained load.

4. Save or discard the pending edit. Helper values are preserved as a pending draft across other edits/navigation, but are not an accepted check. Calculate is blocked until Save FHWA steel check validates and saves them, or Discard steel-check edits restores the previous saved check. Remove FHWA steel check clears saved and pending information. Inspect the new result only after recalculating.

5. Apply the correct stage to the active input. A saved screen rejects active retained pretension above 70% of ultimate. That lock-off check does not by itself qualify the selected design load. For the example, 65,000 lbf passes the steel lock-off ceiling but exceeds the 60,000-lbf design ceiling; it still needs an appropriate load-stage/design basis and independent system checks. Passive capacity is not a lock-off load.

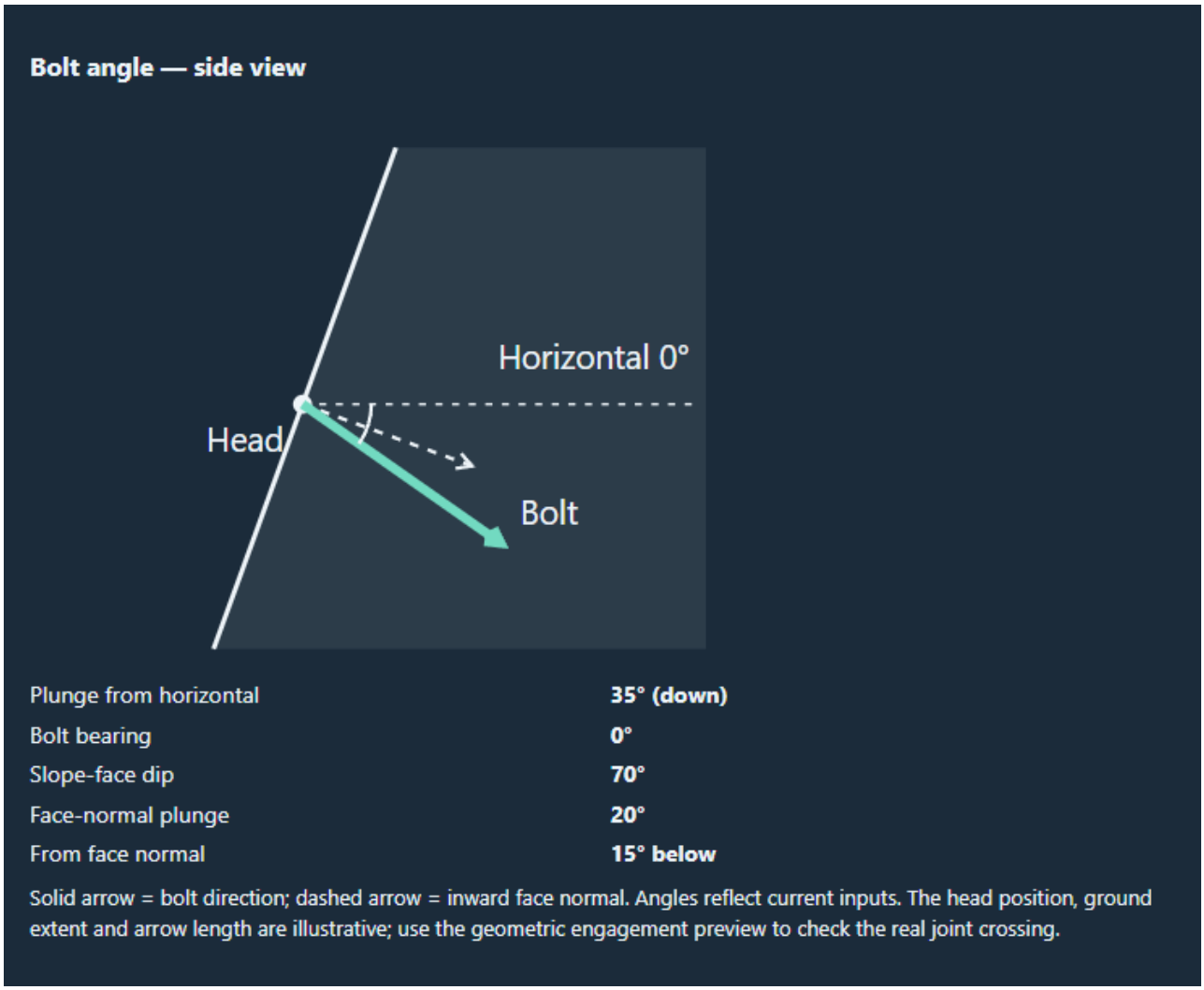
6. Use the project test specification. FP-24 §260.09(b), p.199, uses proof 1.33 times design and lock-off at design after acceptance. Other ground-anchor contexts, losses and project requirements differ. There is no universal pretension force. Keep the acceptance-test record separately; this software does not perform a field pull test.

6.2F.6 Read the selected material and source



Current Step 2 controls captured in an unclipped source-component fixture, with original Grade 75 #8 values before custom overrides. The steel limit includes the yield guard and selected 1.33 test/design ratio. No site bond or system service resistance is supplied.

6.2F.7 Distinguish the normal from the selected plunge



Current Step 3 reference figure captured in the same unclipped source-component fixture. A 70° slope has a 20° downward normal; a deliberate 15° below-perpendicular choice gives 35° down. Verify the actual modeled joint crossing separately; this illustrative diagram does not establish it.

6.2F.8 Separate length, crossing and anchorage



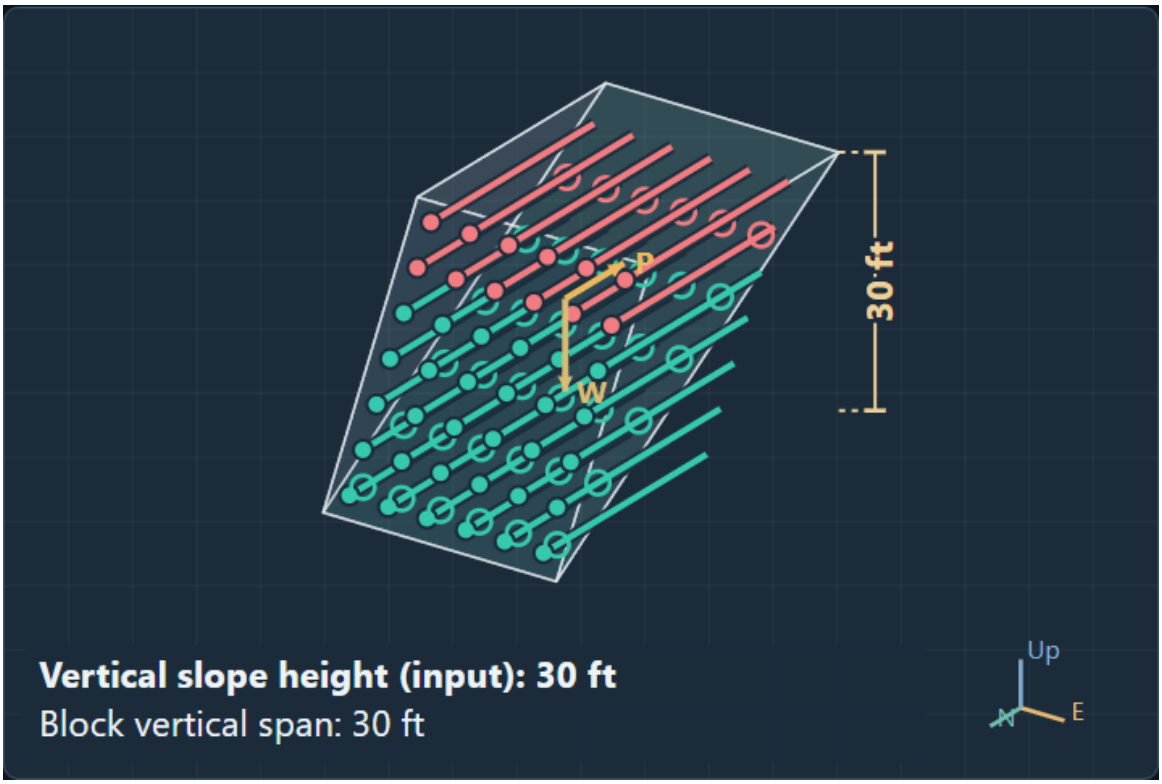
Current Step 4 reference figure captured in the source-component fixture, using synthetic inputs. The displayed 40 ft length, 9.743 ft crossing and 30.257 ft beyond the joint illustrate the definitions. Site resistance and competent anchorage still need independent evidence; this is not an accepted anchor design.

6.2F.9 Inspect bolts and patterns on the model

1. Show the current planar/wedge installation. Show bolts and Transparent block start on; Bolt labels starts off. Checked shafts need actual head/length/direction; a specified force does not supply these. Circles mark heads and rings known joint crossings. The view fits full shafts, so compare numeric dimensions rather than screen size.

2. Interpret the status narrowly. Green means geometric engagement passes; red means it fails; dashed amber means required embedment is unchecked. None establishes steel, bond, service capacity or FS. Missing/invalid head, direction or length and off-face heads are omitted with reasons. The picture never borrows old-result shafts after input changes.

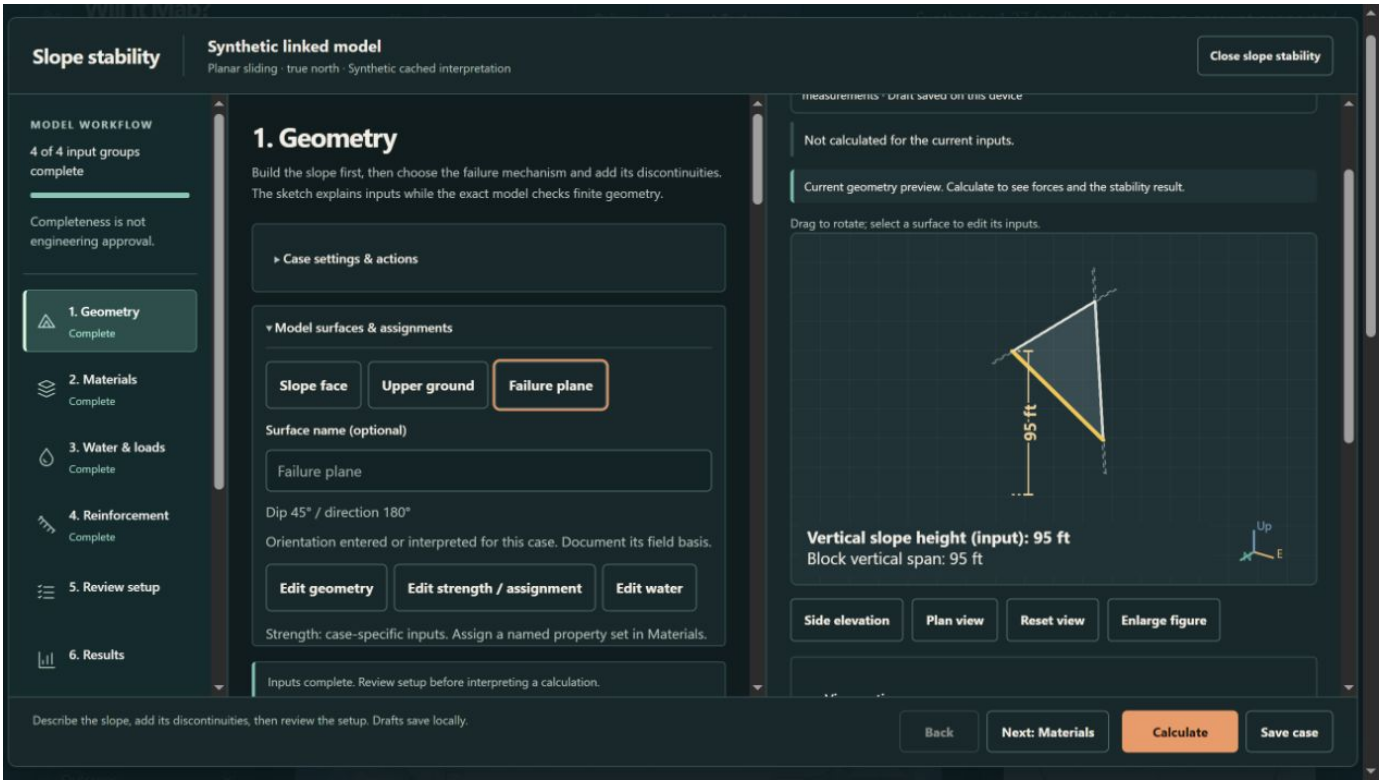
3. Check groups and display limits. Count greater than one at one checked head shows one equivalent shaft, not invented locations. A pattern uses the actual generator; up to 200 shafts display, with total/omission counts. Labels show the first 12 and expanded details the first 30. These are display limits, not a change to the analyzed pattern.



Actual source-model display with a synthetic 42-head generated pattern. Use face picking for existing surface controls; shafts are not direct edit handles. Revise reinforcement through its five steps, then Calculate and review credited support. Geometry colors do not certify an anchor design.

6.2G Build and review the case on desktop

Continue from the collected evidence. Open Slope stability for a separate engineering case. The desktop view places workflow navigation, current inputs and the actual model together. Open Case settings & actions to name the case, check its Common north reference, or use New/Example/Restore/Save as new. These are the same controls in all six steps; expanding them does not change the case. Choose its mechanism in Geometry and retain the source population.



Actual desktop workspace with synthetic teaching inputs. The shape uses the current geometry; its presence is not proof of complete properties, loads, support capacity or admissible equilibrium. The same input definitions apply in the compact view.

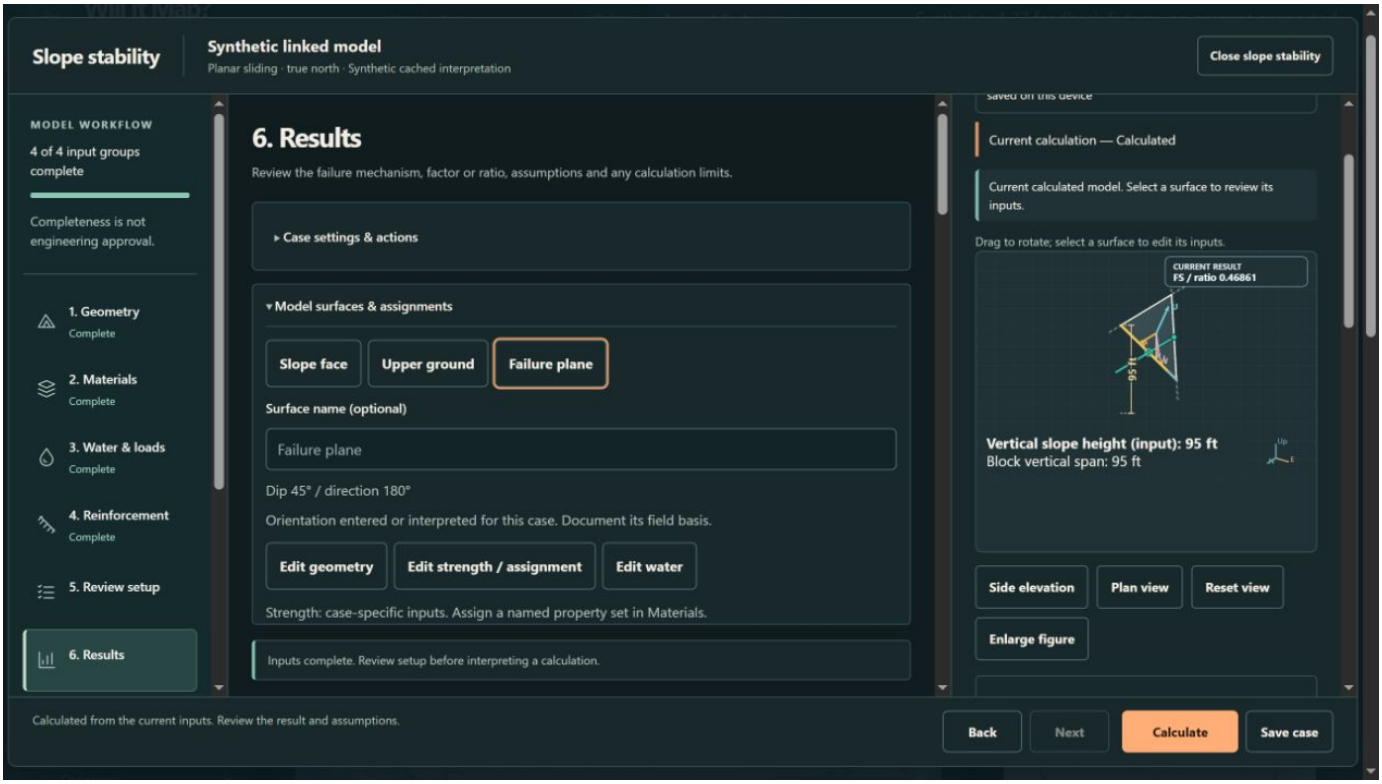
1. Work through the model. Follow Geometry, Materials, Water & loads and Reinforcement. Show input diagram opens the additional sketch; use the nearby definitions and source charts. Preserve observations separately from interpreted geometry, properties and loading. Protocols 6.2A-6.2F supply the decisions within these steps.

2. Read the model and readiness. Compare the block and bolts with the field sketch; check the feet scale and dimensions. Focus model enlarges the view; Restore split view brings inputs alongside it. Use Review setup and its correction links. The four-group completeness indicator is an input check, not a stability conclusion.

3. Calculate, then preserve. Calculate from the completed inputs and inspect Results. A change invalidates the old result; calculate again before interpreting it. Save case and export a slope case file. These local engineering cases are separate from field cloud backup and from the reusable property library.

6.2H Read results and preserve the engineering package

Read the result in order: status and mechanism first, then the stated FS or ratio, block geometry/volume, forces, contact and support checks, and limitations. A missing, rejected or diagnostic result is not safe. Whole-slope block-flexure remains outside an accepted equilibrium FS.



Synthetic 95 ft planar case with entered water, loads and support; calculated sliding factor about 0.46861. This is a layout demonstration, not a site assessment. Its four complete input groups do not establish safety; inspect the force/contact audit and assumptions.

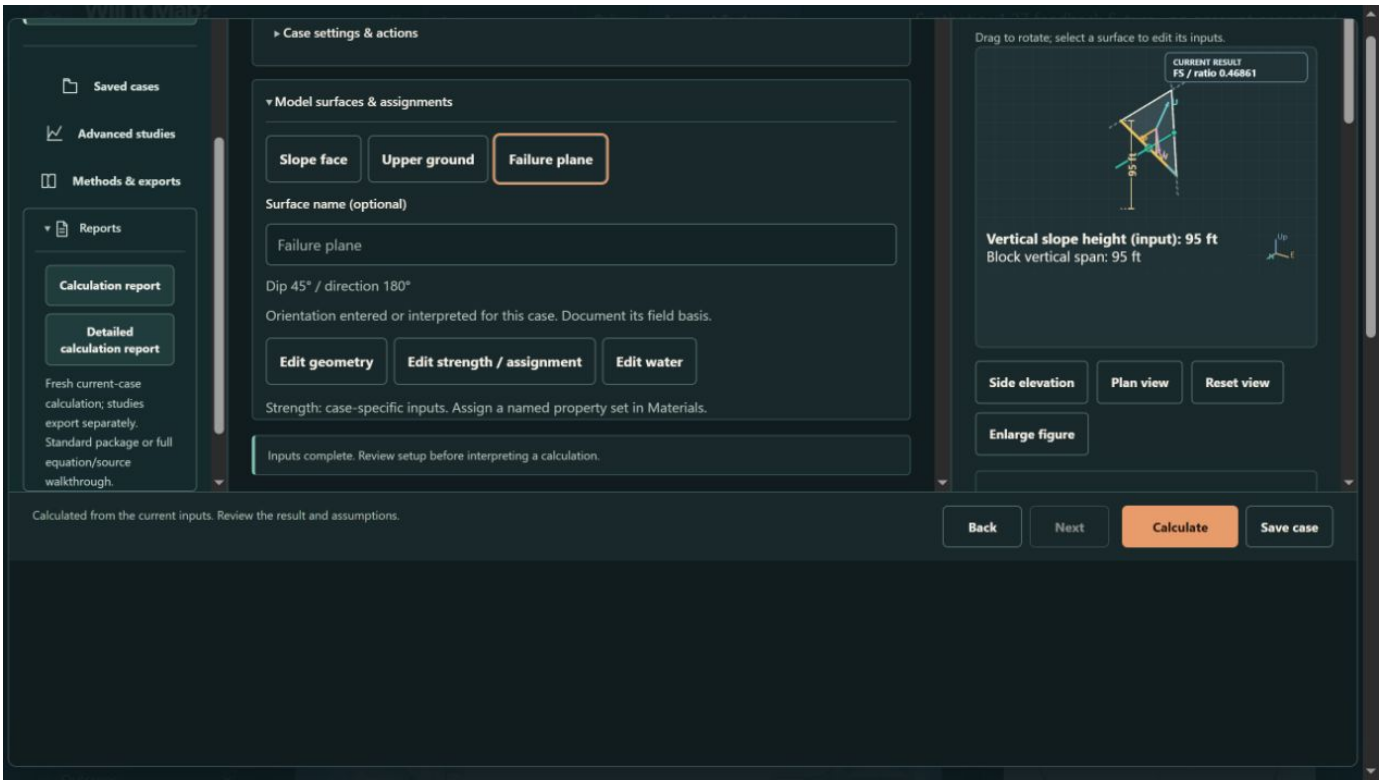
1. Preserve the complete comparison. Advanced studies contains applicable sensitivity/uncertainty, joint-combination and bench workflows. Check scope and assumptions before running them. Filters change the view, not the original population; preserve rejected/unresolved outcomes and the full study export as well as any filtered table.

2. Keep result meanings separate. A sliding factor, overturning ratio, toppling strength-reduction factor and diagnostic threshold answer different questions. Read the status and supporting audit; do not rank unresolved cases as though they were safe numerical values. The theory manual retains the exact definitions.

3. Preserve scope and inputs. Save/export the reviewed slope case, complete study JSON/CSV and any filtered comparison. A result report is a separate single-case package, described next. Neither a result table nor a downloaded study means the engineering cases entered field cloud backup.

6.2l Generate and check the calculation package

Open Reports in the workflow tools, then choose Calculation report or Detailed calculation report. Check the current case first. The report creates a fresh calculation snapshot; it does not merely print the last visible number. Enter Project / reference, Prepared by, Report revision and Report notes with the intended review and delivery context.



Shared Reports menu on the current synthetic case. The standard and detailed reports remain different outputs; each has one live action. The menu opens report metadata and fresh generation, rather than exporting the last displayed result.

1. Generate and read. Choose Generate report. Desktop places metadata beside the paper preview; compact screens put controls first. Inspect identity, geometry, units, input sources, force/contact calculations and limitations. Metadata changes invalidate the preview and downloads until generated again.

2. Save the appropriate files. Download calculation package ZIP preserves the calculation package. Download printable report and Print / Save PDF provide reading/printing routes. Optional studies export separately; they are not automatically attached to the single-case report.

3. Verify the handoff. Open the saved files and confirm case, version, assumptions and review status. Retain raw observations, reviewed cases and reusable property-library backups alongside the report. A polished report is not independent engineering approval or evidence of cloud backup.

6.2M Use Live Geometry as a six-step visual check

Geometry: orbit the actual modeled block and inspect the named slope, upper ground and failure faces. Show surrounding slope draws dashed, translucent extensions of entered faces to add context; these are a schematic extension, not surveyed terrain or extra modeled mass. Turn the layer off to compare the analyzed block alone.

Materials: inspect the colored contact faces and their entered property labels. Unit weight applies to the modeled block. The drawing does not infer internal lithologic zones or assign properties from nearby outcrops.

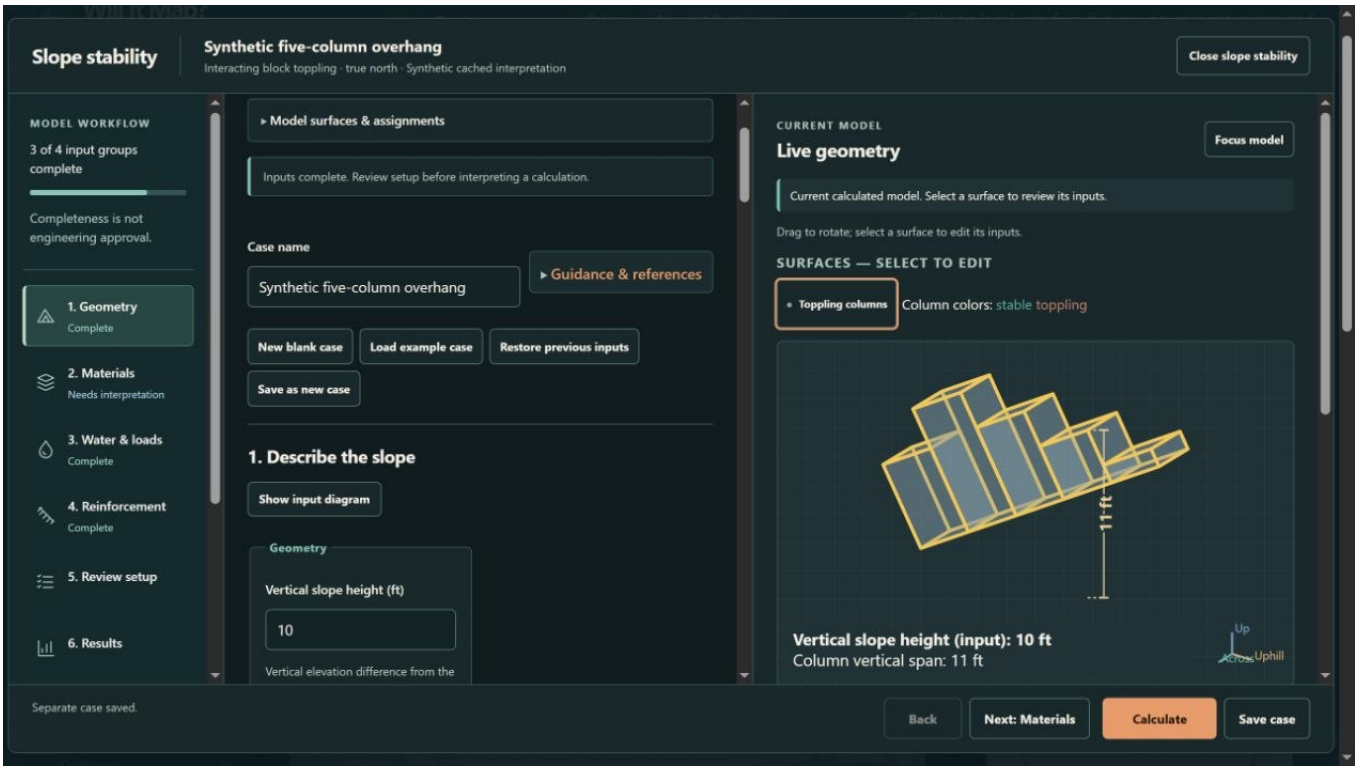
Water & loads: inspect entered wetted-face previews and load arrows. If hydraulic inputs are incomplete or invalid, the preview says so instead of fabricating a water surface. This is an input check; calculated forces appear only with a current result.

Reinforcement: inspect each entered bolt or pattern and its displayed geometric engagement. Visibility is not proof of steel capacity, bond capacity or acceptable factor of safety.

Review setup and Results: Review combines the entered layers so mismatched assumptions can be found. Calculate explicitly; Results then adds the current computed status and force view. Recalculate after changing any input. The numerical result panel and calculation report retain the authoritative values and qualifications.

Use the camera: drag the model to orbit without selecting page text; zoom and use named-face controls as needed. Export current model view SVG only after noting its active step, camera and case. A model screenshot is supporting communication, not a substitute for the input record or calculation report.

6.2N Build a toppling section manually, including an overhang



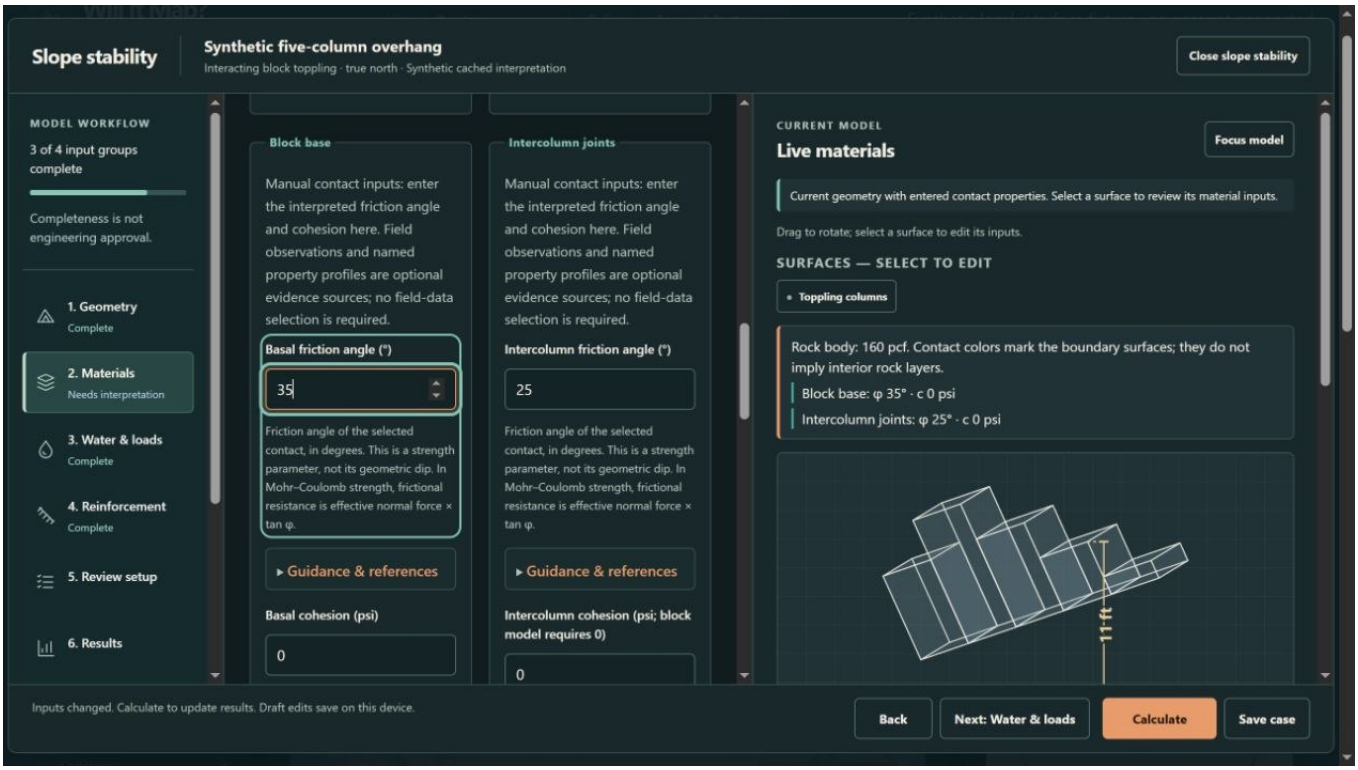
1. Define the physical section. Photograph/sketch the toe, crest, upper ground, steep joints and stepped lower boundary from a safe location. Use a section normal to the relevant face. Map bearings are not the signed section inclinations used here. Enter manual values in Slope stability > Interacting toppling columns; field readings/property profiles are optional evidence sources.

2. Enter Geometry as a group. Supply vertical heightH, Slope face inclinationθ, Upper-ground inclinationμ, Overall stepped-base inclinationβ, Toppling joint dip into slopeψ, column widthw along the local base and across-slope depthd. The local base dipα=90°−ψ. θ=90° is vertical; θ>90° overhangs toward the exposed side. A 100° face is10° past vertical; do not enter80° and reverse a map bearing.

3. Verify the toe-supported domain. The rectangular midpoint generator requires θ≤180°−ψ; with ψ = 60°, the maximum is 120°. A 125° face is rejected and both face inclination and joint dip are linked for review. It would need unsupported partial columns which this generator does not represent. Do not change measured angles just to make it pass. Also require θ>β≥α and −ψ<μ<β.

4. Inspect Live Geometry. Column rectangles, stepped bases and negative-X overhanging crest are generated from the same inputs used by the solver. The midpoint idealization may differ from the real exposure, particularly at partial-column boundaries. Check widths, extents, assumed rear limit and toe support. A diagram cannot establish persistence or stability.

6.2O Complete base/intercolumn properties and check the result



1. Enter independent contacts in Materials. Manual contact inputs for Block-base friction/cohesion and Intercolumn joint friction/cohesion are separate groups. Type interpreted parameters directly; no field set/profile is required. Enter [contact] manually detaches a copied profile while retaining values for review. Use the field strength/roughness protocols and published references to justify each value; do not assume the base and steep joints have identical strength.

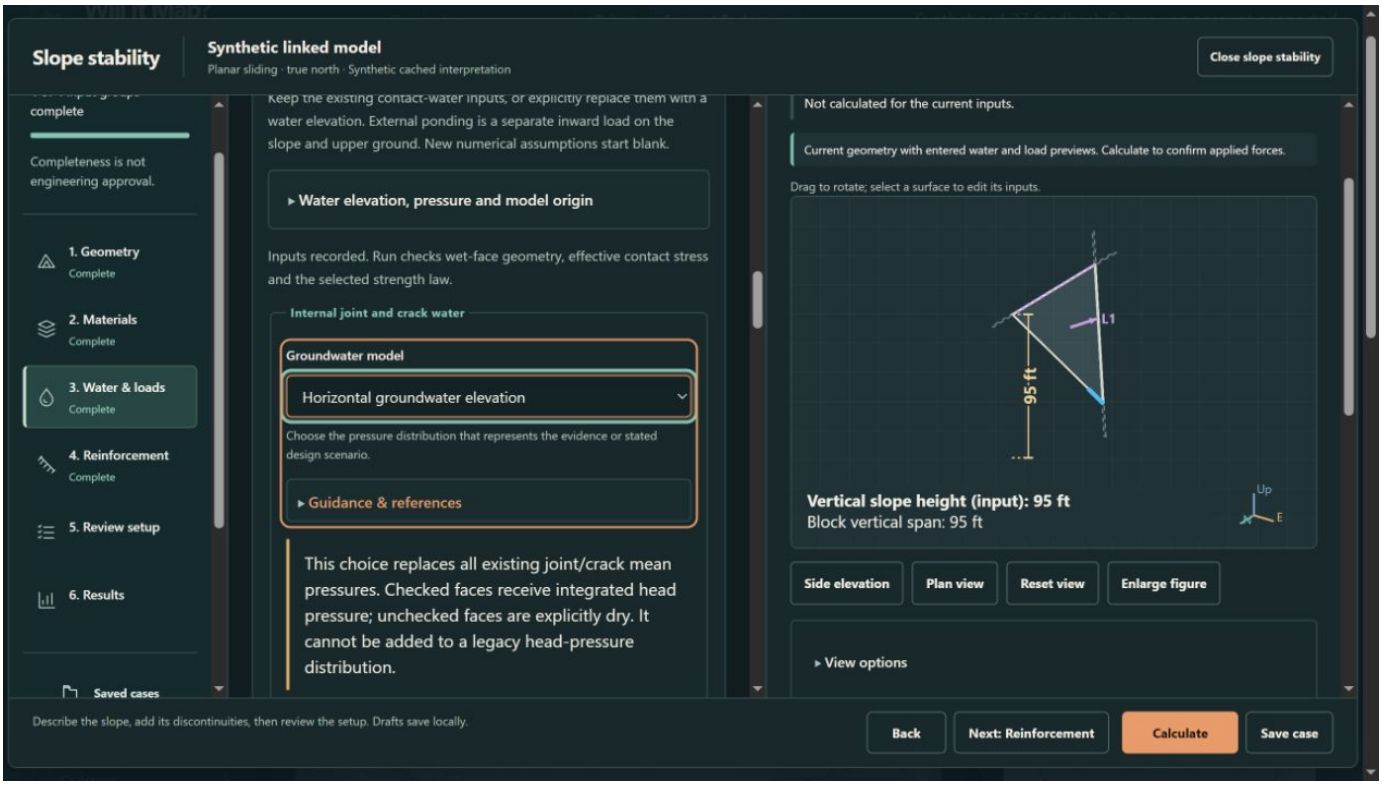
2. Complete the remaining model. Supply unit weight, explicit water/load assumptions and any justified reinforcement; Review setup, resolve missing inputs and Calculate. Geometric possibility, calculated FS and engineering approval remain separate. Save the named case and use its full report/column audit for review.

3. Reproduce the five-column control shown here. H = 10 ft; θ = 100°; μ = 0°; β = 30°; ψ = 60°; w = 4 ft; d = 3 ft; γ = 160 pcf; basal φ = 35°, c = 0; intercolumn φ = 25°, c = 0. No water, seismic action, support, external loads or factors. Five midpoint columns have volume 287.6419614357 ft³ and weight 46,022.7138297 lbf. Column 2 topples against its lower neighbor; column 1 reaches its sliding boundary. All contact audits pass at FS 1.0905252117. Theory S17C independently solves the coupled quadratic and reproduces the individual forces. S17B is a separate isolated-column control with β45° and w20ft; do not mix its inputs/results with this illustration. These are training cases, not recommended design defaults.

4. Retain the limits. Use the interacting block-column model only for its supported geometry and contact assumptions. Unsupported partial noses and inadmissible contacts yield no accepted FS. Whole-slope block-flexure remains diagnostic: overhang support does not resolve it or provide an accepted whole-slope flexural FS. Preserve the actual observed geometry when another method is required.

6.2P Inspect the block and its water / material inputs

1. Keep the actual block beside the decision. Live Geometry places the drawing before its longer details. Read case, mechanism, Common north reference and analysis source. The available-measurement count describes that source context; it does not mean every reading defines a block boundary. Draft saved on this device is not a named saved case or cloud backup.

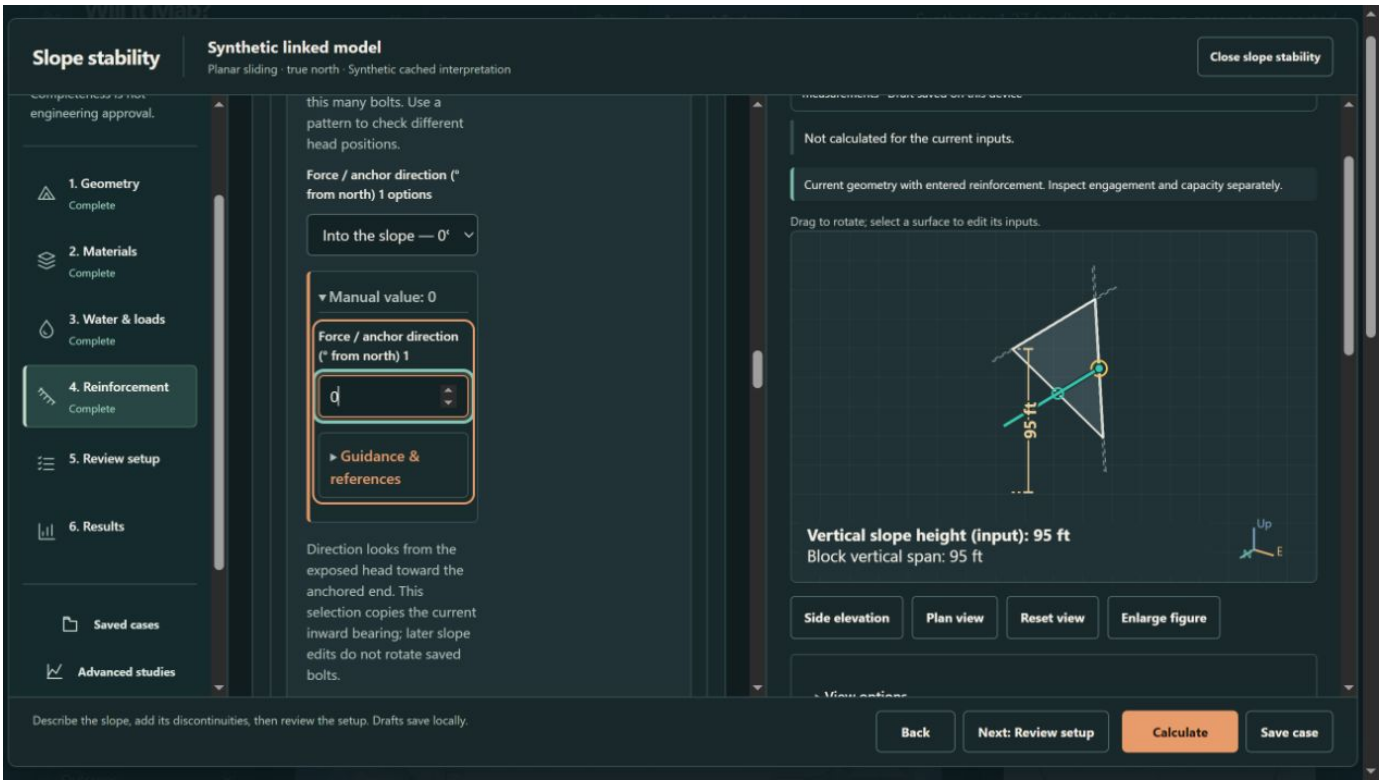


Actual synthetic example: clicking the entered blue wet area focuses Groundwater model. Purple L1 is an entered point-load arrow. These are previews, not calculated equilibrium or a design recommendation.

2. Inspect materials. In Materials, click the contact face to review its own strength inputs; Rock body · unit weight selects whole-block weight per volume. Input focus highlights the corresponding object. Contact colors locate boundary properties, not unobserved interior layers.

3. Inspect water and loads. In Water & loads, click a wet area, purple pressure area or named point-load arrow. If a mean water input is derived/inactive, the link opens the active water model instead. It does not change that assumption. Current-stage inputs offers labeled keyboard alternatives. Read Theory I26 and the hydraulic/load chapters for meaning and calculation.

6.2P.1 Inspect reinforcement and preserve the input basis



Actual synthetic Trial bolt A: the selected shaft focuses the same reinforcement layout/direction. The 100 ft teaching length isolates the link; it is not a typical bolt or length recommendation. Gold inspection rings and geometric-engagement colors mean different things.

1. Choose the same definition. In Reinforcement, click the shaft or its Current-stage inputs button. Review head location, inward direction, plunge, length, pattern and embedment together with the capacity procedure in Protocol 6.2. A force-only definition has no invented shaft. Click inspects; drag rotates/pans without assigning anything.

2. Read both directions. Focusing a model-linked field highlights its contact/object. Inspection is view-only: it does not enable water or seismic forces, copy an outcrop mean, choose material properties or overwrite bolt angles. Use the existing explicit selection/apply controls for an actual change.

3. Keep context and limits. A missing/deleted definition is identified instead of opening another load or bolt. Surrounding dashed slope extensions remain schematic and excluded from modeled volume/FS. Geometric engagement alone is not an adequate anchor system or acceptable result.

6.2Q Finish with current results and the right saved copy

1. Read relevant fields. Short meanings, units and Guidance & references remain beside core/advanced inputs. Keep blanks when evidence is missing. Hiding a panel does not change its values or turn blank into zero. Deliberately changing a physical model follows its own validation/removal rules.

Check	What the workflow preserves
Point / pressure load example	While editing, switching to pressure hides the point components but keeps them in the raw draft. A blank pressure stays incomplete. Returning to point restores its magnitude, trend and plunge. Canonical saved cases contain the chosen validated model; keep raw draft JSON if inactive details matter.
Input changed after calculation	The old result/force overlay clears. Result out of date appears and Calculate becomes Recalculate. Run it again; moving the camera or inspecting a field does not refresh the answer.
Current calculation	This describes freshness for the current inputs. Read status, mechanism, FS/ratio and all qualifications. It is not engineering approval.
Preserve	Save case, export its case/raw draft as appropriate and use Reports for the calculation package. These local engineering files are separate from field cloud backup.

Field measurement, RMR, Barton-Bandis, visual GSI/Hoek-Brown and the independent slope-hazard protocol remain unchanged. Continue those complete procedures and use Theory I25-I27 for this interface, rather than replacing field evidence with a convenient graphic.

6.2R Follow the existing slope calculation sequence

1. Keep the engineering input order. Geometry → Materials → Water & loads → Reinforcement → Review setup → Results is unchanged. Use Back/Next or the labeled step buttons. Read the case name, mechanism, Common north reference, source and draft/result state throughout. Scrolling is unchanged; Jump to current inputs and Jump to live model remain keyboard alternatives.

2. Make each decision with its reference. Definitions, input diagrams and Guidance & references remain beside the relevant field. Keep physical geometry, contact shear strength, whole-block unit weight, water, loads and reinforcement distinct. Record your evidence. Blank required inputs stay incomplete; a convenient default or graphic is not a design recommendation.

3. Calculate, then read. Review setup identifies missing inputs and their correction links. Calculate uses current inputs. In Results, read mechanism, factor/ratio, contact state, assumptions and limits; open Full forces, contact reactions, moments and geometry as needed. A complete input group or current result is not approval of the design.

4. Revise deliberately. Editing after calculation clears the old answer and marks it out of date. Recalculate before interpreting it again. Save case is a distinct local action; export the case/draft and optional studies you need. Reports retains the standard and detailed package choices. Closing/reopening retains the saved device draft; an unfinished draft is not automatically cloud-backed engineering data.

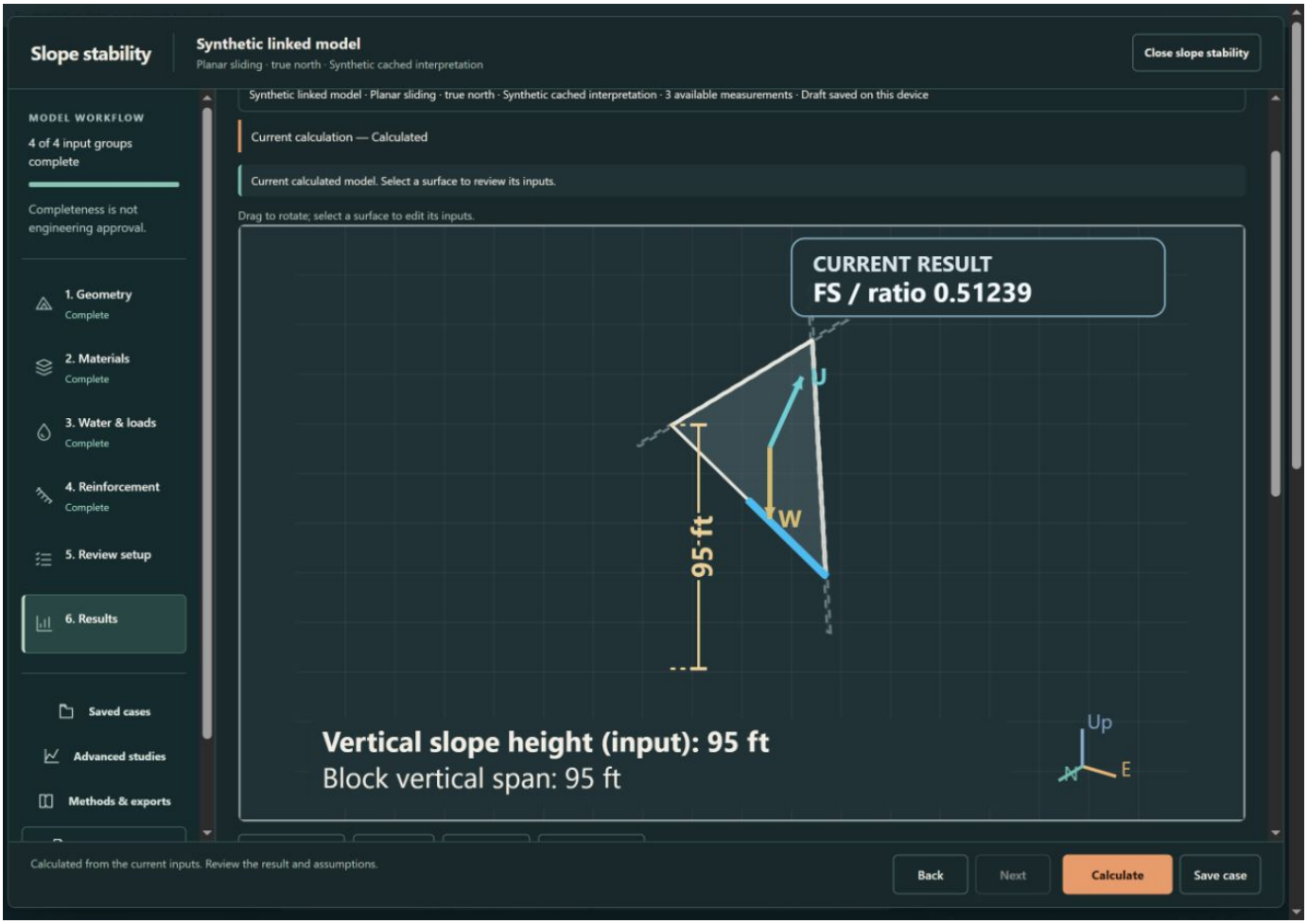
6.2S Preserve strengths and check head-water footprints

1. Keep the contact decision explicit. Save case and Save as new validate a case without replacing the current editor entries. Switching Barton-Bandis or a power curve back to Mohr-Coulomb activates the displayed friction/cohesion. Assessed valid MC entries remain in the saved case even while unused; they do not add resistance to the other law. Unassessed inactive MC entries stay blank on saved-case reload, including a wedge's third basal contact. Current device drafts retain raw unused entries. Correct a reactivated blank input before calculating. Re-entering an unchanged geometry value must never repair a hidden strength mismatch.

2. Read the wet geometry for the selected model. Mid-height/toe head modes show the lower fraction of the failure plane prescribed by percent filled, measured vertically from the toe; they require no rear crack and horizontal upper ground. Crack-head and crack-only show the wet portion of the actual crack measured vertically above its base. Positive crack-head depth also wets the complete prescribed basal contact; crack-only keeps the base dry. Zero fill/depth is dry. Overflow beyond the crack is outside this model. A whole-face mean pressure is a separate assumption; it does not reveal a measured wet extent.

3. Check both displays and forces. Live Water & loads, Results and the model SVG carry the prescribed wet footprints. Blue areas do not establish groundwater, drainage or safety; solver forces and their pressure audit remain authoritative. A calculated tooltip identifies mean pressure over the whole contact face, including its dry part; this is not the average over the blue area alone. Before calculation the head preview shows extent without an invented pressure. Incomplete inputs show a preview issue. The original water equations, sources and pressure unit conversions are unchanged.

6.2S.1 Read a prescribed partial wet footprint



Actual synthetic v1.29 Results / Focus model: 95 ft slope height, 85-degree face, 45-degree failure plane, 1 ft section width and a toe-head model 50 percent filled with 62.4 pcf water. The blue lower half of the plane is the prescribed wetted portion. U shows the calculated water resultant direction. The shown FS 0.51239 belongs to this entered geometry/strength/load scenario, not to a mapped site or a design recommendation.

Compare the selected model with the evidence. A mid-height distribution uses the same wetted extent with a different pressure distribution. Crack-head wets the crack and entire prescribed basal face; crack-only wets only the crack. A pressure tooltip marked whole-face mean includes dry area in its denominator. Save the current model SVG alongside the case and calculation package if this visual check is useful.

6.2T Understand a withheld toppling threshold

1. Read status before a number. Interacting block toppling audits the exact stable-side factor it returns and repeats the existing contact/moment checks immediately around it. If the threshold is an isolated numerical transition or neighboring contacts are inadmissible, FS is withheld as contact-unresolved. A recurrenceThreshold is retained only as a diagnostic; do not treat it as an accepted factor or a bench recommendation.

2. Inspect the evidence. Open Results → Threshold conditioning checks to see the nearby trial factors and column issues. The exact-factor table can pass while its neighboring contacts fail. Full result JSON and the calculation package retain the exact bracket, perturbation factors and column issues under thresholdAudit when available. The probes use relative offsets +/-1e-12 and +/-1e-8 without relaxing the existing force/contact tolerances. Review compression, shear inequalities, moments and geometry; do not adjust tolerances until a number appears. Theory S17D gives the steps and passing/adversarial controls. Whole-slope flexure remains diagnostic.

3. Keep the prescribed workflow. Geometry, Materials, Water & loads, Reinforcement, Review setup and Results keep their original inputs, references and scrolling. Confirm site geometry and method applicability independently. These checks do not replace engineering review or physical instrument calibration.

6.2U Rotate the model without changing its inputs

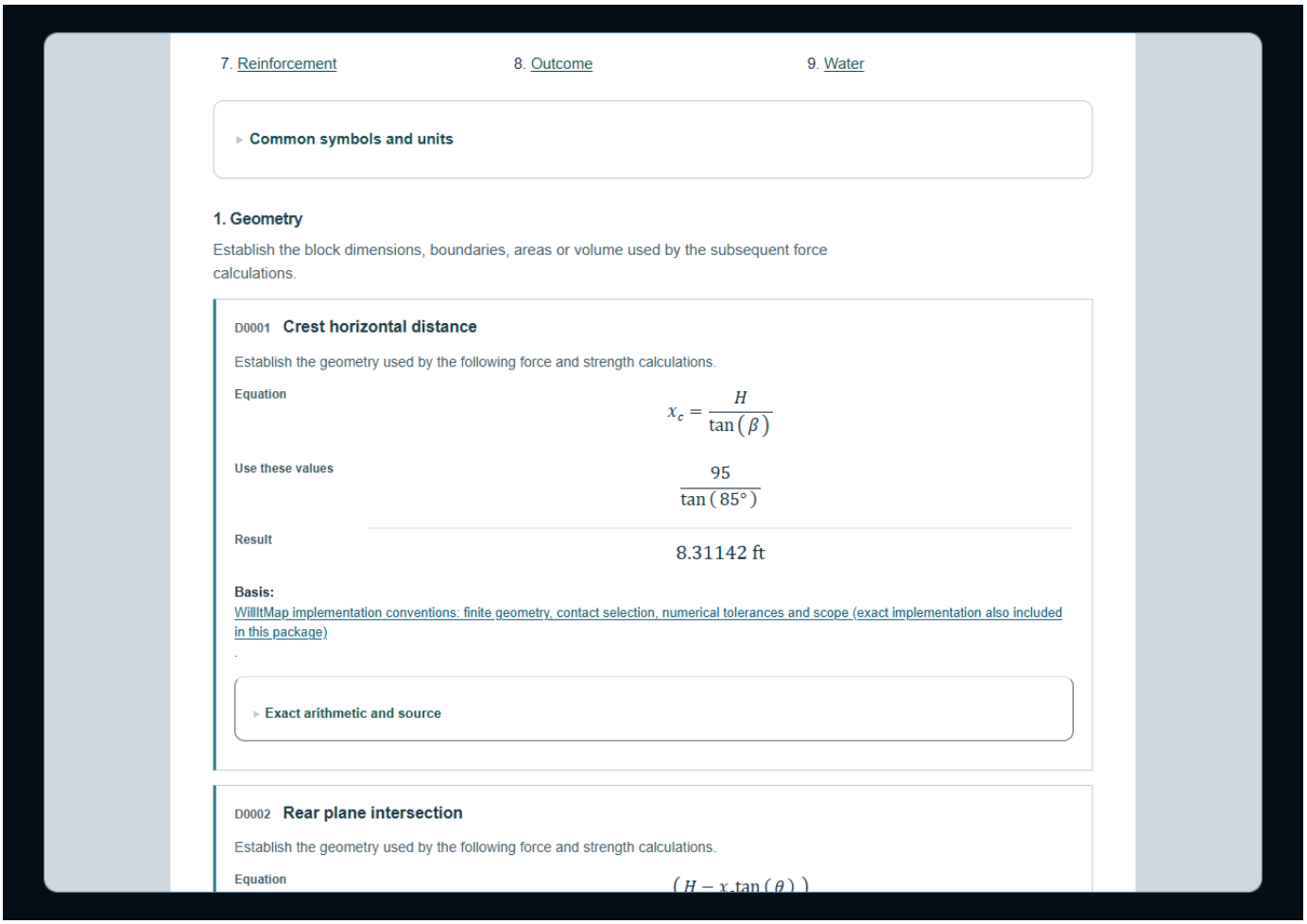
1. Choose the gesture. Drag action Rotate turns the screen-facing block with your movement around a fixed model center. Pan translates the whole drawing. A plan view turns around the screen normal; a side view tilts as you drag vertically. Use the angle sliders when a particular view bearing or elevation matters.

2. Keep one pointer in charge. One mouse or touch pointer owns a drag until release or cancellation. A second finger cannot reset the gesture. Automatic fit stays fixed during the drag. A canceled or lost-capture gesture cannot select a surface. If the view becomes confusing, choose Reset view, Side elevation or Plan view. These controls change the drawing only, never the geometry, reinforcement or calculation.

3. Check context. Continue using the six setup stages: contacts in Materials, water and applied forces in Water & loads, bolts in Reinforcement and calculated annotations in Results. Surrounding slope surfaces are context outside the failure block. Their display never adds weight or resisting force. A click without a drag still opens the relevant input.

6.2J Preserve a detailed, reproducible calculation

1. Select the report depth. After reviewing the engineering case, choose Detailed calculation report from Reports in the slope workflow tools. Calculation report remains the shorter alternative. Both recalculate the current case. Advanced studies are separate exports; preserve those separately when used.



Actual synthetic detailed-report interface with typeset worked calculations. It preserves an engineering case and its limitations; this example is not a site assessment.

2. Generate, then review. Enter the project/reference, preparer, revision and notes. Choose Generate report. Review case identity, feet/force units, input provenance, geometry, contact and reinforcement assumptions, result status and limitations. Read each group and step purpose, then the mathematical equation, substituted values, result with units and source basis. Fractions, powers and subscripts are typeset offline where supported; long or unsupported expressions retain linear notation. The feet, lbf and psi calculation basis is unchanged. Expand Exact arithmetic and source for the original digits and solver comparison. The group index and symbol key help locate the calculation. A blank or diagnostic result is not a passing design.

3. Save the whole package. Download calculation package ZIP retains the HTML, inputs/results, worksheet CSV/JSON and exact calculation source. Download printable report or Print / Save PDF provides a reading copy. Detailed reports can be long; use the shorter report when that is the appropriate deliverable. Changing metadata invalidates existing downloads until regenerated.

6.2J.1 Check the calculation handoff

4. Independently check a quantity. Start with the case inputs, reproduce the geometry, then follow load and resistance calculations using the displayed intermediate values. The reading copy uses up to six significant digits and thousands separators. Expand Exact arithmetic and source for the original digits and source basis; the worksheet CSV/JSON also retain full precision. Keep that precision until the final comparison. Small nonzero values use scientific notation; unavailable is never zero. The theory manual explains conventions and model limitations; the exact method appendix contains conditional numerical procedures that are not all separate worksheet rows.

5. Reproduce by software when needed. A reviewer with Node.js 22 or later can extract the ZIP and run node reproduce.mjs. It creates a new reproduction folder, checks source hashes and compares every calculated result without using the internet. A successful comparison demonstrates repeatability, not independent engineering approval.

6. Preserve the evidence and scope. Keep observations, reviewed case files, property-library backups and any separate study exports. Detailed reports intentionally include selected source observations and notes; review these before sharing. Local slope cases and report files do not automatically enter field cloud backup. Save the manuals separately before leaving coverage.

This report workflow does not alter outcrop logging, orientation measurements, RMR, Barton-Bandis, observed GSI or the independent slope-hazard procedure. Whole-slope flexural results remain diagnostic; a more detailed document does not resolve that engineering limitation.

6.2J.2 Read the calculation without losing its evidence

1. Follow the calculation groups. Use the group index, then read the purpose at the start of geometry, loads, strength or the named trial. Each step keeps its ID so it can be located in the worksheet CSV or JSON.

2. Read equation, values, result. The equation states the rule. Use these values shows the substituted numbers. Result gives the quantity and units. Check the symbol key and the model coordinate convention before comparing force components.

3. Expand when checking digits. The reading copy uses up to six significant digits and thousands separators. Exact arithmetic and source retains the original substitution, precise result, source basis and any recorded solver comparison. A rounded display value does not replace the retained input or result.

4. Read the governing outcome. A reconstructed intermediate ratio is not automatically an accepted factor of safety. Missing values remain unavailable; contact loss, unsupported conditions and diagnostic flexure retain their limits. Archive the whole calculation package and any separate studies.

This presentation update and the corrected matching-manual labels do not change field measurement protocols, calculation equations, numerical tolerances, record units or cloud schema. Physical-device and engineering acceptance remain separate.

6.2K Review analysis assumptions before calculation

1. Recheck the current geometry before using a bolt shortcut. Explicitly choose Into the slope or Perpendicular to slope face after a geometry change; those options use the current face. Existing manually chosen orientations stay unchanged until you request a new preset. For a 60-degree face dipping north, normal inward is trend 180/downward plunge 30. Overhang guidance follows the physical retained side. Always inspect the bolt engagement result.

2. Keep design factors through joint combinations. A named factor set and its values must appear in the combination audit and loaded case. The symmetric 50/119 and 50/241 wedge example changes from unfactored 1.63250 to design ratio 0.81625 with a friction-tangent divisor 2. A passing-looking conventional FS must not substitute for the requested factored ratio.

3. Read a toppling bench result in two stages: validFS versus target, then debris geometry/width where needed. A stable-side incipient column can participate within numerical tolerance. The retained example includes IDs 1-8, volume 1651.699443 ft3, backbreak 15.041029 ft and FS0.912016. Its assumed 47.452352 ft pile exceeds the 32.316273 ft face; width remains unresolved. Do not change repose just to force a recommendation.

4. Exact horizontal/vertical boundary orientations can lack a unique direction-side classification. Read the warning and keep them unresolved; an absent toppling flag does not establish stability. Whole-slope flexure remains diagnostic.

5. After changing maximum clusters, membership or angle, Compare again before accepting. Numeric filters compare values, not decimal spelling. Dip-direction 350-360 includes north just like350-0;0-360 is full circle and 0-0 is north only. Review included identities, exclusions and population counts before engineering use.

6. For a truly complete zero-break scanline, choose Confirmed complete interval: no natural discontinuities observed. Keep an empty fracture list and the measured interval/reference. A complete sound 10 ft interval calculates0 breaks/ft and 100 percent geometric RQD; blank input without explicit confirmation is not an observed zero. Core recovery and natural-break classification still govern measured core RQD.

6.2L. Check the displayed model against the active calculation

1. When changing from directly entered mean pressures to groundwater-derived pressures, review Geometry and Water together. The crack editor refreshes to the replaced pressure values. Editing only the geometry evidence note must not change those pressures. Complete the explicit correction action if the app identifies invalid stored values.

2. For an isolated block, inspect the active-support arrow after Calculate. Its application fraction is measured along the block-height direction from the base point. A 10 ft block and fraction 0.75 place it 7.5 ft along that direction; this is not necessarily vertical elevation. Recalculate after changing inputs. A shape preview alone is not a force result.

3. A narrow uncertainty distribution now uses a close-fitting numerical axis. Read the axis labels and the factor-one reference, which may lie outside the shown range. Counts, exclusions and the original study denominator are unchanged. Report dimension labels are separated from numbered surface markers.

6.3 Establish the design-value basis

Collect and preserve evidence first. Keep mapped geometry, north reference, joint IDs, persistence limits, water observations, material tests, load sources and proposed support details with their original units and provenance. A project factor is an engineering decision, not a new field observation. Use the original field record and a separate interpreted slope case.

1. Build a complete case. Open Slope stability, select the model, establish supported geometry/materials/water/loads, and Calculate. Resolve invalid inputs or unsupported mechanisms before comparing alternatives. Save case to retain a named scenario; unsaved draft edits are not a saved case.

2. Open Materials > Design factors (optional). Tick Apply a project design-factor set only when the design basis requires it. Enter Factor-set name and Factor-set basis / governing reference. Inputs should be characteristic/unfactored values appropriate to that basis; never apply the same factor once in the input and again here.

3. Supply the complete set. Friction tangent, cohesion/tensile strength, additional ground resistance and support capacity use divisors. Self-weight, water pressure, permanent loads and variable loads use multipliers. Classify each applied load as Permanent or Variable. The app provides no automatic governing-code load combinations or favorable/unfavorable action selection.

4. Check what changes. Friction factors divide tan(phi), not the angle in degrees. Dimensions and hydraulic heads stay unchanged. Non-unit material/ground factors require Mohr-Coulomb contacts; nonlinear strength laws are not silently converted. Read the entered-versus-design value audit and use the Theory Manual chapter on explicit action and resistance factors for exact transformations.

5. Calculate, review and Save case. When factors are enabled, the result is a design-value ratio under that named set; it is not the conventional unfactored FS. A ratio of 1 is the factored equilibrium boundary, not a project approval. Copy factor set from a saved case can reuse a basis, but each case still needs its own valid load classifications.

Handoff check. Record the governing design reference, factor set, selected combinations and acceptance target with the responsible reviewer. The app preserves source observations; it does not infer test values, design standards or a safe result from a completed form. Export the case and calculation package with their input/factor audit. Local analysis settings and reports are not a promise of online backup.

6.4 Search an explicit bolt-spacing grid

Evidence to collect. Document the finite slope/release geometry, discontinuity persistence and north reference; proposed installation face, anchor direction, length, edge clearance and geometric embedment; active/passive behavior; and qualified axial, shear, plate, bond/anchor capacities with their sources. A photograph, intact UCS or generic rock name does not establish a bolt capacity.

1. Define and check the template. In a complete planar or wedge case, open Reinforcement and create a geometric bolt pattern. Check the displayed head locations and each engagement/capacity assumption. Horizontal spacing is across the face; along-face spacing follows the inclined face, not vertical elevation. Save the applicable cases.

2. Open Find bolt spacing for a target FS. Select the geometric pattern template and every applicable current/saved case. Enter positive minimum, maximum and increment for both spacing directions (ft), an explicit target FS / design ratio and its evidence. All cases must share an established north reference and the same factor basis, or all be unfactored.

3. Run and review the whole search. Each selected case is tested with the common trial pattern replacing its geometric patterns; other support remains. A separate baseline removes all geometric patterns. Review failed, unsupported and unresolved cases, missed heads and inadequate embedment. None of those outcomes qualifies merely because other cases have a high FS.

4. Interpret the recommendation correctly. A spacing pair qualifies only if it meets the target in every selected case. The reported choice maximizes horizontal spacing times along-face spacing among qualifying tested pairs; it is not a continuous optimum or minimum construction cost. Scenario head counts repeat faces and are not a construction quantity. If the no-pattern baseline already meets the target, additional geometric patterns are not required by these selected scenarios.

5. Apply deliberately. Apply the recommendation only to the current draft that was included in the study, then Calculate, review and Save case. Other saved cases are not overwritten. Edits make old results stale; rerun before applying. Export the full study JSON plus separate-column CSV rows, including the baseline and unresolved results.

Limits and follow-up. At most 121 spacing pairs, 20 cases and 1,000 analyses including baselines. The fixed template and spacing increments constrain the answer. Shared spacing is not a common surveyed installation layout. No added model for installation tolerance, interacting rock cones, deformation demand or global cost is implied. See the Theory Manual reinforcement and bolt-spacing enumeration chapters.

6.5 Compare catch-bench scenarios

Evidence to collect. Survey vertical bench height, face inclination, flat upper ground, actual usable bench width and candidate geometry. Map finite releases/persistence and across-slope widths. Preserve joint-set spacing and the relevant toppling geometry. Record debris character, a supported loose/solid swelling ratio and repose angle, plus the access/maintenance width that must remain usable.

1. Prepare separate cases. Build, Calculate and Save the applicable planar, finite-wedge or interacting block-toppling cases. They must share one vertical bench height and flat upper ground. Use one common design-factor set or all unfactored cases; the selected cases are alternatives, not simultaneous volumes to add.

2. Open Advanced studies > Bench comparison. Select current/saved cases. Enter Candidate bench face angles, fixed available width or fixed inter-ramp angle, Target FS / design-value ratio, Empirical design quantile, Debris swelling factor, Debris angle of repose, Additional usable-width allowance and Bench scenario and design evidence. Lengths are feet, volumes cubic feet and angles degrees.

3. Respect the supported geometry. Wedges require the displayed finite two-joint/persistence assumptions. Planar sections require defined releases and width. Toppling uses generated dry block columns without prescribed per-column forces; explicit columns and whole-slope flexure do not qualify. A changed face angle regenerates geometry. Planar/toppling candidates stop at 89.9 degrees; 90 degrees is available only for wedge-only comparisons.

4. Compare and inspect the audit. Review available versus required width and expand Scenario audit: models, factors of safety and physical dimensions. Check formed/potential volume, backbreak, release width, spill and toppling column IDs. Toppling volume includes critical sliding/toppling columns and stable-side columns at incipient force or moment equilibrium within solver tolerance. Stable columns away from these limits are excluded. This scenario is not a final displacement or collapse simulation.

5. Keep unresolved outcomes visible. The geometric resting-deposit model requires a face steeper than repose; the new section-prism pile must fit below the finite bench height. An out-of-domain pile withholds a recommendation. Do not lower repose or omit an unresolved case to force a passing width. Backbreak and spill quantiles do not establish a joint probability, and this is not dynamic rockfall runout or catch-efficiency analysis.

6. Retain the comparison. Export CSV and the complete JSON input/scenario audit. Enter the selected geometry in its own case, then Calculate and Save case explicitly; a table recommendation is not an automatic geometry edit or construction approval. See the Theory Manual bench-comparison and resting-deposit geometry chapters; Spirin et al. (2025), section 3.2 gives broader bench-design context.

6.6 Filter results without changing their meaning

Where. Open Compound result filters under Advanced studies > Sensitivity & uncertainty or Joint combinations. These are analysis-view controls; they do not change the original field records, solved cases or full-study totals.

1. Create and name the filter. Choose an AND group when every condition must match, or an OR group when at least one must match. Select Accepted FS / design ratio, Block volume (ft³), Calculation status, Movement mode or Result class; choose a comparison and value. Add conditions or nested groups. Click Save and apply filter. Until then, the prior saved filter remains active.

2. Select excluded outcomes explicitly. A missing FS is not zero and fails ordinary numeric comparisons, including does-not-equal. Use Is missing / excluded, or Result class = unresolved. No-block and support-only-lift are separate classes; unresolved includes invalid input, unsupported motion, contact loss and other outcomes lacking an accepted factor. None of these means safe.

3. Preserve the original denominator. A filtered histogram/table names its filter and shows matching versus original rows. Full-study counts, reliability and conditional fraction below one still use the unfiltered sample population. Hidden sensitivity samples break the line; they are not bridged or plotted as zero. A fraction below one is not a site failure probability.

Worked view only. Among seven rows, suppose three accepted FS values are 0.8, 1.6 and 2.0; two rows are unresolved, one has no block and one is a support-only lift ratio. The filter FS < 1 OR Result class = unresolved shows three rows. The original accepted denominator remains three and its fraction below one remains 1/3. The filter did not produce a new failure probability.

4. Reuse and export deliberately. Saved result filter applies a saved name. Show all rows clears only the compound filter; existing basic combination filters may still hide rows. Export named filters JSON for reuse; Import filter library replaces saved definitions only after validation. Complete study CSV/JSON retains all rows; an explicitly filtered CSV records its view context. Store the exported file and confirm it opens; do not assume these local analysis settings or reports have synced online.

Bounds and review. Up to 20 names, 64 nodes, 4 group levels and 12 children/group; imports are limited to 128 KiB. Status/mode text comparisons are exact case-sensitive row codes. Filters contain structured comparisons, not executable expressions. Use the Theory Manual chapter on named compound result views for missing-value rules and denominator examples.

6.2W Review current calculations and source populations

Recalculate current observations. Field Kinematics refreshes source choices when reopened or after recorded observations change. Old results and exports become unavailable. Check selected outcrops, north reference and pairing scope, then Run again. All and None describe the selection after changing it.

Keep traceable inputs. Scanline observations need unique, nonempty IDs. Enter an explicit integer reproducible seed in uncertainty studies; zero is valid, blank is not zero. Import errors belong to the file and study errors to the study settings; a rejected file does not invalidate an unrelated active-case height or friction input.

Read the calculation basis. Mean pressure over a complete face is not wet length or peak pressure. The 95 ft planar example with a 45-degree base and 20 ft groundwater elevation has 134.3503 ft full base but 28.2843 ft physically wetted length. Check the integrated wet extent and the model's height convention, especially an explicit basal wedge.

Read uncertainty carefully. Approximate 95% Fisher mean cones now account for finite sample size within the concentrated-Fisher model. Independent observations and an adequate model fit are still needed. Mean confidence, individual variability and actual observed angular spread are different. Small-column toppling numerical scale checks do not validate whole-slope flexural force transfer; no accepted full-slope flexural FS is supplied.

Protocol 6 completion check

Before moving on:

1. Selected structure data and slope orientation use compatible north references.

2. Slope dip/direction are identified with the relevant face; friction and lateral limits have explicit sources or assumptions.

3. Possible mechanisms remain distinct from stability, persistence/connectivity or risk conclusions.

4. For an engineering case, named surfaces, copied property snapshots, local overrides and loading assumptions were reviewed; the calculated result and limits are preserved separately from raw observations.

Save and check: Preserve the model inputs/scenario and raw observations. Use the separate Theory Manual for the engineering calculations and model limitations.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

Protocol 7: Close and protect the field record

Close every outcrop visit with a saved-record check and a backup routine, whether or not every classification was completed.

Where in the app: Collect and Data; use the outcrop hub for Readings and Joints.

Do in this order	What you should have when finished
7.1 Reconcile the observations	Selected outcrop, photos, notes and completed protocols
7.2 Reopen saved records	Confirm readings and independent discontinuity records
7.3 Verify export and backup	Located backup file; queue/cloud check where enabled

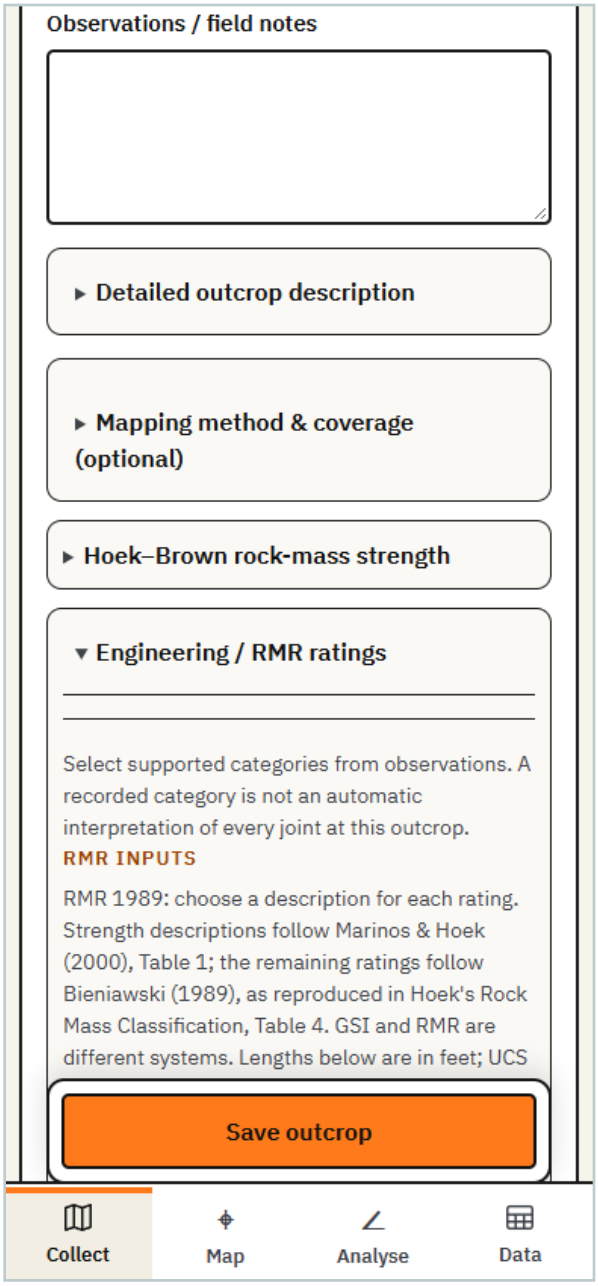
7.1 Close the outcrop before moving on

Return to Collect and save the final description. Confirm the outcrop ID, location, rock type, hardness/weathering, visual GSI if applicable, bedding, critical joints, regolith depth, notes, sample IDs and photo references. State what could not be observed and why.

Check for units and category contradictions. A blank RQD should stay blank unless a supported estimate or measurement exists. A missing RMR total can correctly indicate missing inputs. The notebook's missing-location/rock-type filter checks only those basics; it is not a complete geological QA certificate.

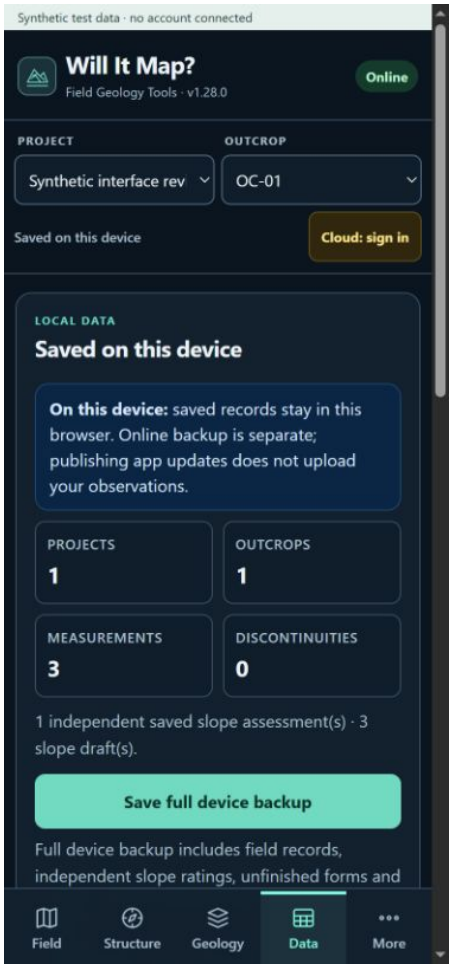
Open the saved records and inspect the counts and selected set. Review doubtful poles while the exposure is still available. For long exposures or changed conditions, create another outcrop instead of silently changing the location of an existing observation population.

For OC-014, the example closeout is: sandstone description saved; four bedding readings checked; J1 description linked; external photo log linked; RQD left unknown; limitations noted. This is better evidence than a fully populated form containing guesses.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

7.2 Verify backup and export



1. Check the saved record first. Data > Saved on this device shows all local projects and observations, plus independent saved slope assessments and unfinished slope drafts. An unfinished draft is not a saved observation. Reopen a representative saved outcrop and measurement before leaving it.

2. Save one full device file. Choose Save full device backup after important work. The prepared-file card shows its captured time and SHA-256, a download link and supported Share / Save to Files. On iPhone, choose Share then Save to Files if the automatic download is awkward. Open Files/Downloads and check the file; copy it to a separate approved location.

3. Acknowledge that exact file. Only after checking it, choose I saved this file on its card. This records which snapshot you checked; it does not claim a cloud upload. New or changed saved-record counts compare against that file, including independent slopes, not the later time you clicked. Unfinished work and deletions also need review; prepare a fresh file before any clearing.

4. Check online backup separately. Follow its primary action: sign in, enable backup for the owning account, sync, review conflicts/deletion, or Check cloud data. Check status remains visible beside the primary action. More backup actions & recovery contains diagnostics and Restore cloud records; conflict/error/deletion status opens its details. Offline cache & browser storage holds technical browser information. An empty queue, successful sign-in or green network indicator is not a readback match. Offline field collection still saves locally.

7.2 Verify backup and export (continued)

5. Use Desktop for specialist delivery. In Desktop > Files & recovery, project CSVs/JSON contain the selected project. Download GIS ZIP package contains all local projects and independent saved slopes. All slope assessments & drafts CSV covers all independent saved records and drafts, including the legacy draft, regardless of project selection. Filtered/selected Desktop table GIS/CSV has its separately shown scope. Keep JSON for app restoration; georeferenced external photos remain a separate archive.

6. Rehearse recovery safely. Data > Recover from a device backup always merges by record ID with review; conflicts and recovery material are retained. Desktop Files & recovery also has advanced merge/replace. Practice in an isolated training browser. Do not clear site data as an update step. Close all app windows and reopen online to activate a downloaded update. No single storage method guarantees zero loss.

7.2A Check the new evidence in exports and backup

1. Reopen the saved records. Confirm the project domain list, outcrop survey sessions and the survey/domain/reach assignments on the actual measurements and discontinuities. Check numeric trace length, basis and endpoints together.

2. Export a full backup. This release uses backup schema 6 for the added context. It still reads supported older backups without inventing missing assignments. Keep the schema-6 file for this app version or a later compatible reader; older versions may not open it.

3. Export GIS / CSV for querying. The package includes domain and survey tables as well as separate columns on observations. Preserve the complete project/domain and outcrop/survey relationship keys, especially for recovered project copies. Empty surveys/domains can be valid catalogue records without mapped observations.

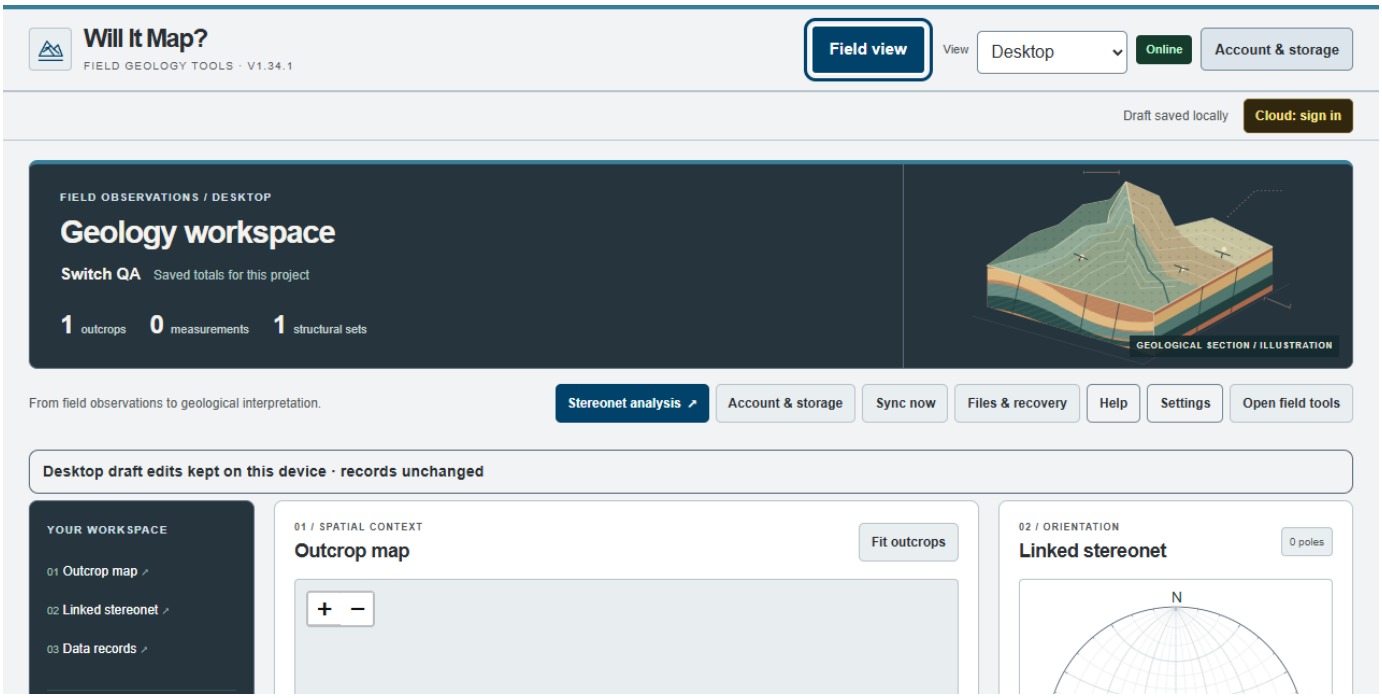
4. Inspect a few rows. Verify one normal trace and one Lower bound trace, one survey-linked measurement and any unassigned legacy record. A location point is not proof that its nonspatial attributes or catalogue relationships are complete.

5. Check backup status. A local save does not prove an upload. Use the existing account backup queue and cloud-data checks when enabled; keep a located export during fieldwork. Saved slope-analysis cases and studies still require their own exported packages.

Desktop review: trace cells can be edited with validation; domain and survey identifiers are read-only as ordinary cells. Use Assign survey / domain for a reviewed batch (Protocol 2.0C), or the field context controls for a new observation. Capture a dated full package when an engineering decision depends on a particular interpretation. Later parent description edits can change the displayed words while preserving IDs.

7.2B Review the traverse on desktop

After saving the field visit: choose Desktop view beside the app name to open Geology workspace for larger-screen review. Field returns to the compact collection forms. Both views use the same saved records; this is not another account or a new survey.



Synthetic switch check: one saved outcrop and one set, with an unfinished desktop edit. Field view is beside the app name. Data records continue below; totals are saved records, not proof of an uploaded backup.

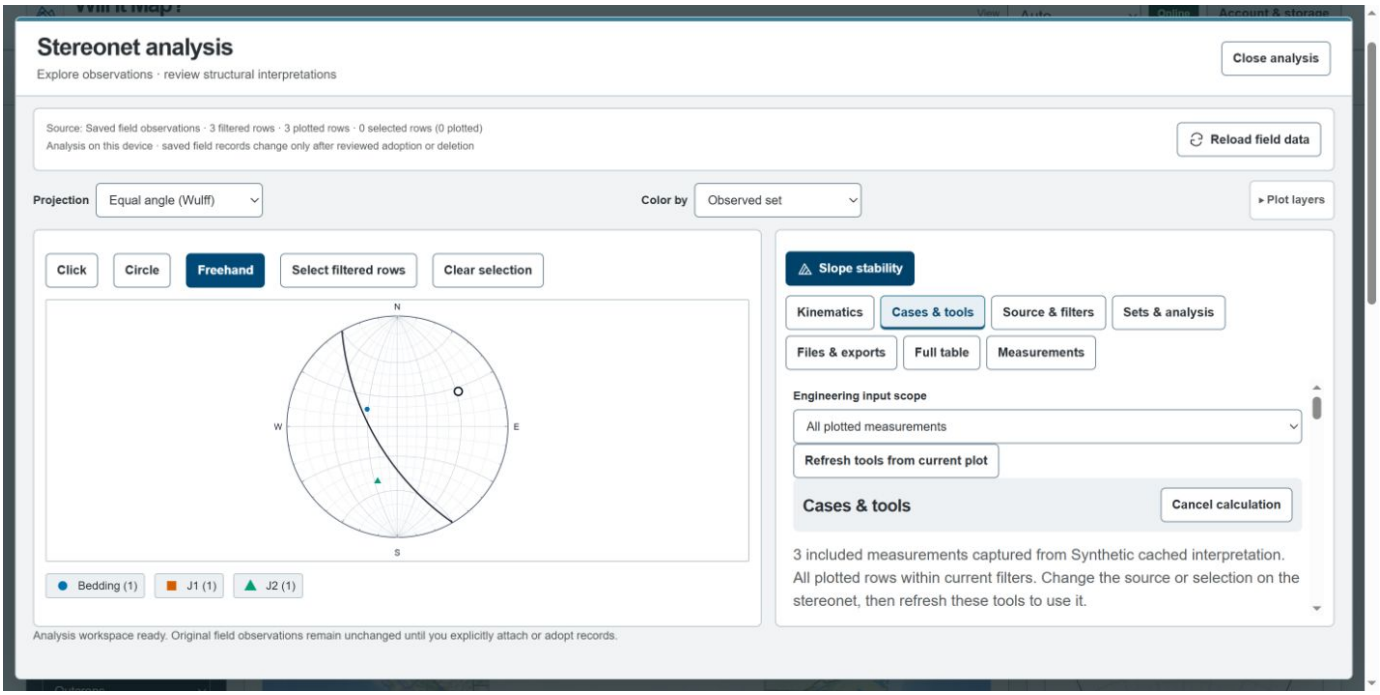
1. Establish scope. In the sidebar, choose Table, Project, Outcrop and Structural set as appropriate. Use Outcrop map, Linked stereonet and Data records to reach each review area. Compare saved project totals with the table's matching-row count; search/filter/selection can show a smaller population.

2. Inspect before changing. Select a row and read its Record details. Compare the map, orientations and external notebook/photo IDs. A missing online background is not evidence of missing local records. Independent slope ratings stay separate from the project hierarchy.

3. Stage and review edits. Double-click an editable cell or focus it and press Enter. Choose Review & save edits, check the changed values, then Save reviewed edits. Staged drafts are not committed observations. Save or discard them before file export or structural analysis; retain a backup using Protocol 7.2.

7.2C Review structural populations on a larger screen

Use the saved population deliberately. Choose Stereonet analysis after resolving table drafts. Desktop opens with the stereonet at left and tools at right. Measurements holds the searchable list. Kinematics has live slope inputs, and Slope stability is a persistent shortcut above the tools. Source & filters holds the original dataset/project/filter and import controls; Sets & analysis holds interpretation and follow-up tools; Files & exports and Full table retain their original scope controls. Reload field data refreshes the saved field copy, not a captured portable snapshot. Phone layout and section shortcuts remain unchanged.



Actual desktop layout with three synthetic observations: Bedding 35/120, J1 65/240 and J2 55/20 on the Wulff net. Cases & tools now opens beside the same plot. Click, Circle, Freehand and Clear selection stay above the plot; Measurements holds the searchable list and pole-query details. Live overlays have their own clearly labeled input basis. The view is for checking the stated population and interpretation; color or clustering does not establish joint continuity or slope safety.

1. Confirm inclusion. Read the active data source, outcrop filters, selected rows, exclusions and north reference. The main field table and an imported analysis dataset are different record sources. See Protocols 2.4B-2.4C for CSV/paste columns, original Joint set and separate interpreted groups.

2. Compare evidence with interpretation. Inspect unexpected poles against the original readings. Review set means/statistics and sampling limits; do not delete legitimate variation merely to make a cluster tighter. Retain observations separately from edited interpretations.

3. Preserve the handoff. Open Files & exports. Export analysis file retains the portable analysis; Rows and statistics scope controls the two CSV downloads. Figure SVG/PNG always include all plotted rows with the accepted interpretation. Engineering input scope is separate: a pole selection does not restrict its default All plotted measurements. Slope stability keeps its selected-plotted-if-selected source rule. Field GIS export, an analysis file and a calculation package serve different purposes. Phone observation methods, physical input units and calculation equations are unchanged by this desktop layout.

7.2C.1 Find the analysis tools and preserve the right output

Work from the visible population. Stereonet analysis now opens with the plot in view. Use Source & filters, Stereonet, Full table, Sets & analysis and Files & exports on desktop; use the existing Filters / Plot / Rows / Sets shortcuts on a phone. On desktop, Source & filters and Sets & analysis open the original controls in the right panel; The stereonet stays visible while the right-hand tools are used. A narrow window puts the plot first; the same controls remain below it. Field logging, the complete RMR/Barton-Bandis/GSI protocols and independent hazard scoring are unchanged.

Task	Find the controls and check the scope
Bring in evidence	Desktop Source & filters → Import CSV / paste rows; Reload field data is in the source strip. Phone Data & filters retains its original controls. Keep original Joint set, outcrop, north reference and source cells. Filtering does not delete observations.
Read and select poles	Projection, Color by and Plot layers surround the stereonet. Match the legend shape plus group name/count. Click a measurement to query its stored dip/direction; circle/freehand and row selection remain available.
Review selected readings	Measurement selection → Selection & review actions. Include/exclude retains source records. Delete opens the existing reviewed deletion flow. Set assignment and field adoption remain separate decisions.
Interpret groups	Sets → assign/copy observed labels, or open Suggest joint sets. Review settings and statistics before accepting. Review angular outliers places the threshold beside that action and checks all plotted interpreted rows.
Run engineering	Cases & tools and its explicit Engineering input scope. Default All plotted measurements does not shrink when you click one pole. Slope stability continues using selected plotted rows if selected, otherwise all plotted.
Preserve the analysis	Files & exports → Export analysis file for portable datasets/views/provenance. Open analysis file restores that format. The two CSVs use Rows and statistics scope; figure SVG/PNG always use all plotted accepted interpretation. These are separate from field GIS and cloud backup.

Inside Slope stability: open Case settings & actions in any step to name the current case or inspect its Common north reference. The New, Example, Restore and Save as new actions are grouped there. The model selector remains in Geometry. Missing-input links open the appropriate group rather than requiring you to hunt for the field.

Reports: open Reports in the workflow tools; its choices are brought into view. Calculation report is the standard package; Detailed calculation report includes the discrete calculation steps and exact implementation. Enter report metadata, Generate report, then read before saving. Both freshly calculate the current case. Keep optional studies, result/audit files, saved cases and property-library backups separately as appropriate.

On a phone: the slope tool buttons wrap into labeled rows. Setup step and Calculate/Save remain available; Show model is separate from the input diagrams. Local SVG graphics add no remote image dependency. Save the manuals separately for offline reading, and verify field sensor/GPS readings against independent observations.

7.2C.2 Check a downloaded detailed report

1. Keep the full package. In Slope stability, open Reports, choose Detailed calculation report, then Generate report and Download calculation package ZIP. Preserve the original ZIP with its exact inputs, results, source hashes and method/build identity. A reading PDF alone does not contain the replay files.

2. Recalculate without the app or internet. On a computer with Node.js 22 or later, extract to a writable folder, open a terminal in that folder, and run node reproduce.mjs. It creates a new reproduction directory, verifies source hashes and compares every recorded result. It does not upload data or alter the recorded package.

3. Interpret agreement correctly. Record structure, types, nulls, statuses and text must match exactly. Finite numbers allow only abs(actual-recorded) <= 32 x Number.EPSILON x max(1, the two absolute magnitudes), where Number.EPSILON = 2.220446049250313e-16. This accommodates final-digit math differences between JavaScript engines, not changes in engineering assumptions.

Replay output	Logger / reviewer action
PASS; zero numerical differences	Retain the output with the package. Continue the independent method, geometry and input review.
PASS; bounded roundoff differences	Read the printed count, largest absolute difference and fraction of its bound. For example, 20 versus 19.999999999999996 degrees is a last-bit difference; the synthetic planar FS remains 0.3639702342662023.
Failure at a result path	Preserve the original package. Investigate the named field, inputs, method/version and runtime. Do not edit result.json, round away a difference or relax the script to get PASS.

4. Keep the engineering boundary. Successful replay proves numerical repeatability of the included implementation. It does not validate field observations or approve a design. Continue the independent hand checks in Theory I14/I24, and retain separate study/property files. Measurement, RMR, Barton-Bandis, GSI and independent slope-hazard protocols are unchanged.

7.2C.3 Inspect the desktop stereonet beside its measurements

1. Start with the same data. Desktop view at 1000 pixels or wider places the full stereonet beside Measurements and selected-pole details. Source & filters, Sets & analysis, Files & exports and Full table open the existing tools. The stereonet stays visible while the right-hand tools are used. These layout controls are view-only. The phone layout and collection sequence stay intact: Collapse filters / Collapse sets, Expand stereonet, Restore workspace and Escape retain their existing behavior in narrow analysis layouts.

2. Find and select. Find in this list matches outcrop, set, ID or angle; it changes the list only. The list uses 50-entry pages. Click entries to toggle selection, or focus them and press Enter/Space. Pole clicks and circle/freehand selection use the same measurement identities. Dip, dip direction and north reference appear beside the plot. Full table keeps its own pagination and editing/review controls.

3. Confirm the basis. Read source/filter counts, north warnings and device-save status. Saved field copy means a loaded copy: Reload field data refreshes it. A Captured field snapshot is historical portable data and is not replaced by Reload. Imported rows remain analysis data until explicitly attached. Display/selection does not save a new observation, accept a suggestion, change a strength or broaden an engineering population.

4. Preserve the intended output. Engineering input scope is independent of plot selection. Slope stability uses selected plotted rows if selected, otherwise all plotted. CSV uses its chosen row scope. Figure SVG/PNG includes all plotted accepted interpretation, not an unaccepted cluster suggestion. Retain the portable analysis file and original observations as described in the preceding protocols.

7.2H Use clearer labels without changing observations

In the field: required marks identify the existing record-required inputs. Other observations may be saved incomplete; collect the full protocol required for your project and calculation. Blank means unassessed, except an explicitly documented creation default such as depth to rock 0 ft. Latitude and longitude use decimal degrees; length/elevation use feet. Pressure/strength inputs retain their displayed scientific units.

Next field: in a single-line input, Enter advances to the next visible editable field in that same card and original order. It skips hidden, disabled and read-only controls. Enter in multiline notes remains a newline. The last visible single-line field uses Done; it never saves automatically. Tap the labeled save action when ready. Signed coordinates and elevations use a text-keyboard hint to avoid suggesting a decimal-only keypad; nonnegative numbers suggest a decimal keyboard. Check minus-sign access on the actual device. On-screen keyboard behavior varies by device; the reported iPhone keyboard jump has not been physically verified and no scroll workaround was added.

Backup: Data keeps full device backup and safe merge recovery direct. Online status and last check remain visible; More backup actions & recovery retains restore, diagnostics, conflicts and account actions. Offline cache & browser storage holds technical information. Delete or clear data keeps device-only clearing separate from device-and-cloud deletion. Read the scopes and preserve a checked backup before any destructive choice; do not clear storage to install an update.

All RMR, Barton-Bandis, visual GSI/Hoek-Brown and independent slope-hazard measurement procedures, method references and engineering qualifications remain. Interface checks and numerical replay do not replace instrument checks, site observations or independent engineering judgment.

7.2I Check complete locations after restoring a backup

1. Check the pair. Both latitude and longitude must be present finite numbers in their geographic ranges. Empty strings, whitespace, null or a missing axis are not a location. Numerical 0/0 is valid; do not erase a real equator/prime-meridian observation merely because it is zero.

2. Use the review controls. Outcrop notebook → Missing location or rock type, its count/labels and the end-of-day summary use the same complete-pair rule. Imported blank entries remain available for correction. Maps/GIS do not infer a point from blank axes. Capture GPS or deliberately enter the correct pair; this update does not move or fill observations automatically.

3. Preserve the record. Reopen the corrected outcrop, verify its location and export/backup as in Protocol7.2. Keep raw observations separate from interpretation, and continue the complete RMR, Barton-Bandis and visual GSI/Hoek-Brown protocols. Independent slope hazard remains its own workflow.

7.2J Screen kinematics beside the same stereonet

1. Select the population. Open Stereonet analysis. The desktop plot stays on the left. Source & filters, Sets & analysis, Files & exports, Full table and Measurements open in the right panel. Scroll that panel to keep the plot in view. Slope stability is always available above it. On a phone, the same controls retain a vertical layout.

2. Enter the slope. In Kinematics enter Slope dip, Slope dip direction and Friction angle. The lateral limit starts at 20 degrees; change it for the adopted screening basis. Show live kinematics starts on and valid edits update automatically. All plotted measurements is the default. No joint-set assignment is needed for raw measurements. Selected plotted measurements is an explicit narrower choice.

3. Match the reference and association. Read the automatically detected north reference and enter the slope direction in that frame. Unknown or mixed reference blocks calculation. Pair association starts with hypothetical all pairs; choose a recorded outcrop/survey/domain scope when appropriate. Neither option proves that joints connect or persist far enough to form a block.

4. Read the feedback. Highlight mechanism changes the region and critical marks on the existing net. Black is the slope plane, orange the limits, red rings critical poles and red diamonds critical intersections. Original set colors remain. Counts use the full tested population; displayed intersection marks are sampled. These are possible mechanisms, not factors of safety or failure probabilities.

5. Preserve and proceed. Invalid or changed inputs clear old results; Cancel stops the run and Update now restarts it. Export complete critical CSV includes every critical row and source context; figure exports retain the overlay basis. Slope stability opens the separate block model; Cases & tools retains the detailed cases and other structural tools. Recheck those inputs when opening a separate workspace. Field measurement protocols and the independent slope-hazard workflow are unchanged.

7.2K Keep survey geometry and screening case identity

1. Finish retained pairs. Changing a mapping group method preserves observations. A partially entered face dip/direction or scanline trend/plunge keeps both controls visible in retained geometry. If Save flags a missing companion, its section opens and the control is revealed. Enter the missing value or deliberately clear both. Zero is a valid angle where permitted; do not enter a guessed direction just to save.

2. Reopen the same analysis basis. Cases & tools restores Orientation population and Pair scope with its slope angles. With no saved choices the stated defaults are all included measurements and all pairs. Check the source and scope before Run. Interpreted means and raw measurements have different counts; same-outcrop association must not become hypothetical all-pairs without your choice. Every run checks current source compatibility.

3. Keep names unique. Save slope case accepts at most 120 characters. Re-saving a unique name updates that named case. Overlength names are rejected without changing saved cases. Historical duplicates are numbered in the chooser and cannot be silently overwritten: Load and review them, then deliberately remove unwanted entries or save a distinct name. Loading still requires the original source signature to match.

4. Distinguish workspaces. The live stereonet saves separate screening settings; its automatic raw-measurement run cannot replace the Cases & tools means/pair scope or named cases. Inspect the visible controls in the workspace you are using. None of these actions changes measured orientations, mapping order, field protocols or the independent slope-hazard workflow.

7.2L Select poles and use tools beside the stereonet

1. Select where you look. Click, Circle, Freehand and Clear selection stay above the main net. Click queries a pole; drag a circle from its center or trace a freehand boundary around a group. Hold Shift to add. Clear selection clears highlighting only. Measurements contains list search, pole details and reviewed inclusion/deletion actions.

2. Choose the task. Kinematics provides quick live screening. Cases & tools opens in the same screen: Cases & sensitivity retains named studies and optional interpreted means; Stereonet tools contains density, roses and constructions; Traverses & core includes scanline and orientation conversions; Report & exports retains complete calculation data and reports. Slope stability remains the separate FS workflow.

3. Check the source before running. Engineering input scope explicitly chooses all plotted or selected plotted measurements. Opening the tools captures that population. Switching tool pages preserves inputs. If the plot source, interpretation, filter or selected-scope membership changes, old tool results cannot be saved or exported. Use Refresh tools from current plot, and confirm replacement of unfinished tool inputs/results. Saved named cases remain; their source-signature check still applies.

4. Keep bases distinct. The live Kinematics panel and Cases & sensitivity retain separate angles and scope. Read the controls in the tool you are using; a named-case report does not silently take the live overlay settings. Check north reference, means versus raw readings, association and denominators before interpreting a result. None of these layout controls changes field observations or the independent hazard workflow.

7.2M Recognize the refreshed interface

Appearance, not a new workflow. The interface uses Arial, blue controls, charcoal navigation and neutral panels. Settings still offers Daylight and Dark; use the mode that is clearest in the field. Text size, touch targets, keyboard focus and offline operation are retained. No corporate logo is shown.

Read the engineering legend. Joint-set colors, critical poles, water and material overlays, and warning states keep their existing meanings. A blue control indicates an interface action, not a stable slope. Read the label, legend and calculation status; do not infer safety from branding colors.

Follow the same protocols. All outcrop, RMR, Barton-Bandis, GSI, reinforcement and independent slope-hazard procedures remain unchanged. Current desktop figures show the updated shell. Retained method screenshots may use the earlier appearance; their named inputs and calculation steps still apply.

7.2N Use accessible display and controls

Choose a readable display. Open Settings on desktop or Data > Settings on a phone. Select Daylight or Dark and choose 200% text when needed. The enlarged desktop workspaces allow scrolling so that plots and controls remain usable. Use browser zoom as another option. Wide observation tables scroll horizontally.

Work with a keyboard. Use Tab and Shift+Tab to move through controls; Enter or Space activates native buttons and checkboxes. Skip to content bypasses repeated navigation. Escape dismisses ordinary dialogs and returns focus. Use measurement-list controls or table checkboxes for stereonet selections when drawing a circle or freehand outline is inconvenient.

Inspect the slope without dragging. Focus the interactive slope model. Arrow keys rotate; Shift plus arrows pan; plus/minus zoom; Home resets. Named surface buttons, Side elevation, Plan view and Reset view remain available. Manual strike/dip and location entry remain available without phone motion or GPS.

Correct the named input. Read the visible hint and status. In live kinematics, incomplete or out-of-range angle fields are marked and linked to their instructions. Correct the field and review the new result. Color is not a safety conclusion: read the labels, symbols, legends and numerical results.

Scope of this guidance. The app applies the supplied HDR accessibility baseline while preserving public-facing accessibility support. Browser tests do not establish complete WCAG conformance or accessibility with every assistive technology. Report any inaccessible workflow with its device, browser and the control involved. Field collection procedures and engineering equations are unchanged.

Project setup spacing. Geological domains remains optional. Finish domain edits, then choose Save project. Manage this project is a separate expandable section below Save project; opening it reveals Delete project and its existing confirmation process. Expanded field sections leave space below their final control. After choosing rock type, color or texture, the picker returns to the field position where it was opened so the chosen value remains nearby. The Contact orientation panel groups the three live angles with Capture averaged reading, while reference and quality stay visible. Expand Phone position & earlier readings for the retained instructions. Capture confirms saving inline and keeps its screen position through the save refresh. Poor quality requires a fresh inline acknowledgement for each retained reading. Restore opens the recovered fields for review; copies differing only in timestamp no longer reappear as another unfinished draft. Distinct unfinished work remains recoverable. No field measurements or calculation procedures change.

7.2O Review contact branches and concurrent field edits

1. Read the accepted calculation branch. In a detailed wedge report, a released contact shows zero applied effective normal stress, shear stress and resistance. Its strength equation is not evaluated. Do not interpret a fitted intercept or a logarithm at zero stress as available resistance. Loaded contacts retain their recorded effective stress and selected strength law.

2. Check the actual support point. An isolated-block report derives support height from the accepted geometry. A support at one-quarter of a 10 ft block acts 2.5 ft above the base. Check that height and its signed moment against the recorded solution. The solver and support compatibility rules are unchanged.

3. Recognize an independently edited mean. Dips 30 and 50 degrees at RHR strike 0 give a 40-degree mean. If you edit that saved discontinuity to dip 65 degrees in Desktop or phone, the original 40-degree source snapshot stays as provenance, and the record is marked edited independently. Refresh from active set is hidden. Comments and physically equivalent bearings do not detach it. Enter independently explicitly detaches it; choose Default to average again only when you want a fresh snapshot.

4. Inspect stale Cases & tools. After changing the main stereonet source or selection, move among all four tools panels to review retained inputs. The warning stays visible. Cancel calculation and Close remain available. Refresh the tools from the current plot before calculating, converting, saving or exporting; navigation alone does not refresh their source.

5. Review the current recovery list. Restore and Discard apply only to the exact draft revision shown. If another tab changed or removed it, the action is rejected before changing the editable form or active context, and the list refreshes. Review that refreshed item. A successfully accepted Restore keeps displaced unfinished work and later source edits recoverable. Typing during context saving is kept. Restoring is not the same as saving the field record: inspect the values and press its Save action when ready.

Field collection order, prescribed inputs, units, physical protocols and cloud schema remain unchanged. Device-local recovery checks are distinct from live cloud restore and physical-phone acceptance.

7.2P Check orientation, recovery and deliberate field saves

1. Check the physical dip side. For a legacy N70W / 60 SW observation, either conversion mode must retain dip 60 and give dip direction 200 degrees (RHR strike 110). For 60 NE, expect direction 20 and RHR 290. N20E / 45 NW gives direction 290 and RHR 200; 45 SE gives direction 110 and RHR 20. A conflict stops conversion and preserves the legacy input. Recheck the field evidence rather than guessing which side was intended.

2. Resolve contradictory saved orientations deliberately. Review flags identify a strike, dip direction or normal that disagrees. Notes-only edits do not fix or rewrite these values. The record remains in exports/backups; affected mean or analysis output is withheld or unresolved. Compare with the original field observation and deliberately correct orientation only with a defensible basis. An unchanged orientation edit leaves the contradiction for review.

3. Keep manual choices and exact angles. Single-reading and mean copies preserve manually entered feature and tool values; blank or previously auto-filled fields can follow the copied source. Unspecified clears only an auto-filled classification. This supersedes earlier unconditional-clear wording. Six significant digits make a copied mean readable, while an untouched save retains exact angles. Deliberate angle changes detach the link but retain its source snapshot. Live copies also keep exact angles; poor-quality acknowledgement resets after use and context change.

4. Review before saving. An untouched discontinuity asks for inline confirmation; add an observation or explicitly choose to save it empty. Partial observations can be saved without inventing missing strength inputs. The manual Save row is compact and the next focused field is brought into view. Status messages appear in the context header and clear when changing tabs. App dialogs support Cancel and Escape; closing one does not commit its action.

5. Recover, then inspect. A restored cardinal bearing remains text until a valid conversion. Restore preserves displaced work; interrupted recovery removes only redundant claims with an equivalent durable copy. Inspect the form and explicitly Save the field record. Do not equate a restored form with a saved observation.

6. Compare backup content. Record comparison ignores key order and revision-only metadata; the file hash still identifies exact downloaded bytes. An older acknowledged backup remains evidence, but the previous comparison format requires a new saved and acknowledged file for content comparison. Keep prior backups. The data model and exported observation fields remain compatible.

Collect, Map, Analyse and Data now organize the field workflow. These interface changes do not establish physical-phone calibration, Safari behavior, live-cloud recovery or independent field acceptance.

7.2Q Use the engineering-first field interface

Start and navigate. Name and save a project; optional details and the north-reference correction stay in a collapsed group. Collect contains the notebook and outcrop hub. Choose Readings, Joints, Rock mass or Photos for the same outcrop. Map opens saved coordinates and a selectable outcrop list; online tiles remain optional. Analyse contains kinematics, set statistics, geology and the independent slope rating. Data retains exports, backups, sync, settings and help.

Interpret coverage conservatively. The four-category notebook count reports whether readings, joints, basic RMR and photos have been recorded. It does not prove representative sampling or engineering adequacy. A valid RMR entry does not certify a complete outcrop investigation.

Read and capture. Choose the correct set, enable sensors, review the live angles/north basis and quality warning, then deliberately capture. The button is hidden without a valid live orientation. Manual RHR strike/dip or dip direction/dip uses the same conversion rules and saves the existing measurement format. The live stereonet marker is not saved; no automated steadiness, outlier rejection or automatic capture is introduced. Compare poles only within a compatible north basis.

Enter joints deliberately. Use live orientation sits beside the bearings; a copied mean retains its source provenance and exact saved angles. A new RHR 290/60 SW conflicts and is blocked. Only an existing legacy axial strike may resolve its dip side during explicit conversion. Delete and retype a primary bearing normally; the secondary clears rather than refilling it.

Carry forward selected observations. Keep pins initially retain plane type, tool, separation, roughness, infilling, weathering and water, matching previous behavior. Keep for next joint pins selected observations on this device. Review every pinned value against the next surface. Angles, traces, mean snapshots and strength inputs are not pinned. The separate trace-end descriptions still mark hidden ends and lower bounds. No class midpoint is substituted for an exact length or aperture.

Use Strength test. Select joint wall or fresh reference; add individual rebound readings or edit the original raw list. Count/mean/min/max use the existing summary. Undo only reverses the unchanged last keypad edit. No automatic discard or rebound-to-strength conversion occurs. Supply the existing JRC, JCS, friction, contact, scale and stress basis before interpreting the existing Barton-Bandis result.

Keep classifications on their existing basis. Select supported RMR categories from observations; missing inputs withhold the appropriate totals. No Table E snapping, automatic joint-condition suggestion, class-only trace/aperture, I-IX roughness mapping or invented infill classification is added. Existing GSI/Hoek-Brown, RMR and Barton-Bandis equations and restrictions remain authoritative.

Review imported bearings. Choose the CSV convention deliberately. A changed direction updates its derived strike; changing only dip cannot resolve contradictory bearings. Correction notes and applied-rotation fields retain the prior interpretation, including after adoption into field records. They do not certify a later manual edit. Check the actual north reference of the current entered number.

7.2R Use automatic phone north correction

Default procedure. Leave Declination override blank. Select the outcrop and set, enable phone sensors and allow location. Check that the live line reads True north, the applied correction and WMM2025 with phone GPS or saved outcrop as its location source. An explicit project correction, including zero, takes precedence. Check the device date and selected outcrop position; the model is valid only in 2025-2029.

When location is delayed. A usable phone fix is retained through transient GPS errors for up to 30 minutes; saved outcrop coordinates are the fallback. Without either basis the reading stays magnetic. Wait for correction, or explicitly acknowledge the uncorrected warning to save magnetic data. Do not mix that data with true-north readings when computing a set mean. No absent correction is silently replaced by zero.

Understand the display. The applied model angle uses 0.01-degree resolution, not claimed accuracy. Missing or unverified-datum outcrop altitude uses 0 m on the WGS84 ellipsoid as a recorded assumption. Coarse location and polar caution zones require review; polar blackout withholds automatic correction. These checks cannot identify nearby steel, magnetic rock or every phone calibration error.

Preserve the basis. Save captures the raw last-sample magnetic top-edge heading, applied correction, model evaluation date and location basis alongside the averaged plane. The raw heading is not an averaged magnetic strike. A live joint copy retains a historical sensor snapshot even if its editable values later change; Duplicate last clears that snapshot. A conflicting chosen tool must be resolved by explicitly choosing Phone sensor before copying.

Avoid double correction. Manual compass, imported and historical bearings are not automatically changed. Select their actual north reference. The iPhone native Compass setting does not establish the browser sensor reference. Compare phone readings with a calibrated control away from metal; do not treat automatic declination as calibration.

Model source. NOAA/NCEI World Magnetic Model 2025: https://www.ncei.noaa.gov/products/world-magnetic-model . Accuracy, local-anomaly and polar-zone limits: https://www.ncei.noaa.gov/products/world-magnetic-model/accuracy-limitations-error-model . The calculation runs offline in the installed app.

7.2S Switch between Field and Desktop without discarding work

Choose Desktop view beside the app name to open the desktop workspace. In Desktop, the same button reads Field view and returns to the field interface. The switch is outside the collapsed badges and More menu, so it is visible in both layouts. The existing View selector in Desktop still offers Auto, Field and Desktop; choosing the direct button sets an explicit view.

Switching changes presentation without reloading the page, submitting a field form, saving a desktop edit, or discarding work. Unfinished project/outcrop notes, manual readings and joint observations remain in their forms. Desktop cell edits remain drafts, including text being typed when the switch is pressed. The selected field context and desktop scope remain distinct and retained.

Return to the same form or desktop table and review its unfinished values. Use the normal Save action for a field observation, or Review & save edits for desktop changes. A layout switch is not a save, a verified cloud backup or protection from browser storage clearing. Before closing or updating the app, save work and keep an independent device backup using the existing procedure.

Verification used an isolated desktop browser with synthetic records: repeated round trips, active cell typing, unchanged stored records, keyboard Enter/Space, 320/390/740/1280-pixel widths and 200% text. These checks do not establish physical-phone, Safari or assistive-technology acceptance. No measurement equations, units, categories, north correction or record schema changed.

7.2D Edit, export and verify the desktop handoff

1. Edit the authoritative discontinuity bearing for each row; its derived bearing is read-only. Review & save applies the prepared record. Undo regenerates derived ratings: Dry (15) to Wet (7) can undo to Dry (15).

2. Paste quoted spreadsheet notes without splitting an embedded line into another observation. Inspect the staged row count before saving. Malformed quoted input is rejected without staging partial edits. Numeric decimals and negative coordinates sort numerically across saved and unsaved values.

3. Set-statistics CSV now has one row per set/outcrop contribution with source ID, readable label and count, plus repeated set statistics. Group by set and sum contribution counts; do not sum the repeated total count. Duplicate names across projects remain distinct.

4. GIS discontinuity angles use numeric properties when they are valid numeric orientations; historical textual strike descriptions stay text. A selected independent slope GIS ZIP includes a valid slope recovery JSON. Keep this workflow separate from outcrop records.

5. Cloud ingestion converts supported legacy metres once to feet. For example 10 m becomes 32.8084 ft and elevation 100 m becomes 328.084 ft. A previously wrong ft-v1 label cannot be diagnosed from the number alone; compare original field evidence. Verify both the saved source record and its exported GIS/CSV value.

6. These data safeguards do not change the full RMR, Barton-Bandis, observed GSI or independent hazard protocols. Removing an RMR override retains category-only RQD/spacing. Barton-Bandis needs an explicit scale-correction choice; blank means incomplete. Save the matching Theory v44 and Field v42 before leaving coverage.

7.2E. Preserve meaning during editing, mapping and recovery

1. Filter numerical counts with ordinary numbers: 0, 0.0 and -0 mean the same value; a blank is not zero. Text outcrop IDs retain their spelling. On the map, equal outcrop names from separate imported datasets remain distinct; date-line neighbors fit as a local group without changing saved longitudes.

2. Copy rows and paste reviewed TSV with quoted cells intact. Embedded tabs, line breaks, literal quotation marks and a final explicit blank cell preserve their row/column positions. Text that could become a spreadsheet formula is protected with an apostrophe; signed numerical columns remain numerical. Paste inside an open Notes editor to keep all lines in that one record. To paste a spreadsheet grid across records, finish or cancel the editor first, focus the table cell itself, then paste. An unrelated save in another tab leaves an open Notes editor, draft and Escape baseline in place; finish or cancel that edit before checking refreshed rows. Check every staged row in Review before saving; Undo remains available after a reviewed save.

3. Use the multiline editor for text, including imported Observer names or source labels containing more than one line. Double-click or press Enter to open a cell. The opening Enter adds no text; later Enter presses within the imported text editor intentionally add lines. Saving an unchanged value preserves its exact line breaks. In the desktop cell editor, Escape cancels the current edit, Enter finishes it, and Shift+Enter adds a line. The imported-value dialog has its own Save button. For coordinates, change either latitude or longitude and leave the other unchanged; review the pair, then Save. Zero is valid. Invalid numeric entries remain open for correction without changing the saved observation. Deliberately clearing Comments keeps the active comment blank while historical notes remain available as provenance. Undo restores the previous visible content.

4. A mapped blank feature remains Unspecified when adopted into the field data. If the feature column is not mapped, the import starts with Joint as its explicit default. Inspect the reviewed feature before adoption. Updating a saved view keeps that view selected; selecting the same file again does not close the workspace.

5. After changing set assignments or filtering, let density recompute for the displayed population before interpreting contours. An older pending calculation is discarded. Confirm the plotted count and density count agree before exporting a figure.

6. Analysis CSVs keep original source headers and cells in numbered header/value column pairs, such as original_1_header and original_1_value. This preserves source labels that differ only by capitalization or punctuation. GIS relationship columns remain present even when their tables have no rows; blank foreign keys are unassigned.

7. Merge full backups when preserving work from multiple files. Recovery-only drafts and sessions from each source are retained in separate source snapshots, including conflicting same-key entries; identical content is deduplicated. They do not automatically replace active forms. The end-of-day changed-since-confirmed-backup count compares actual times across time zones; equal instants are not new changes. Before any confirmed backup, it counts all field records. Keep the original backups. Replace is a different, explicitly destructive field-record workflow. Use Theory v44 for the data contracts and retained engineering equations.

7.2F. Check saved records, scope and downloads

1. Reopen the intended project and outcrop before editing. A retained Field draft is unfinished input, not a saved record. Desktop staged cells remain drafts until Review and Save reviewed edits. Check the named destination and saved-record status; cloud verification and a downloaded backup need separate checks.

2. On Desktop, read the named table, project, outcrop, search and column filter before reviewing rows. Matching rows and selected rows are counts of the current table entity. The linked stereonet uses saved Structure measurements, not staged cell values. CSV/GIS files use saved records at the stated selected, filtered or project scope; Copy may include displayed drafts.

3. In analysis, read filtered rows, plotted rows and selected plotted rows separately. A selected excluded row remains available for Include selected again, but cannot enter an engineering action while excluded. Rows and statistics CSV follow the Rows and statistics scope choice. SVG/PNG figures use every accepted plotted row even when a selected CSV scope is active. Suggested cluster assignments are a preview until accepted; exported figures and data use accepted interpretation.

4. When copying a saved Structure reading into a discontinuity, verify the measurement ID, orientation, north reference and Plane Type. An Unspecified source leaves the destination Plane Type Not recorded instead of carrying a previous classification. Enter a classification deliberately if supported by the outcrop.

5. A historical legacy bearing such as N20E remains text in Legacy orientation mode through a Comments-only edit. Preserve the original field note and resolve the convention deliberately before changing bearings. Do not infer true north or convert a quadrant bearing by merely changing an unrelated comment.

6. Desktop Project Date and Override date should use YYYY-MM-DD. Older ambiguous date text is retained for review rather than interpreted by locale; check it against original notes before correcting. Recent rock-description suggestions use actual timestamp order across time-zone offsets; manual description entry remains available.

7. Independent slope-rating Slope angle can be a descriptive range such as 45-60 degrees. Record the observed range rather than inventing a representative value. It does not directly determine the worksheet score. Reopen the assessment and verify the saved range and other inputs before exporting.

7.2G Follow a paused deletion through to verification

1. Distinguish the two actions. Data > Delete or clear data offers Clear this device only and Delete from this device and cloud. Read the exact target list and account before confirming. Device-only clearing signs out and removes drafts, recovery and pending uploads; it leaves cloud records and downloaded files intact, and destroys any unfinished deletion queue.

2. Read paused status literally. Empty local lists do not mean cloud deletion finished. Review remaining deletion reads active cloud-only records, queued targets and related child blockers without deleting or uploading. Keep the app and queue; resolve listed conflicts or restore cloud-only records for review, then retry sync. Parent-child protections remain active.

3. Check the final readback. Only a verified zero active cloud inventory with no outstanding queue and local saved targets supports completion. Other devices, historical recovery and downloaded copies may remain. Undo last field deletion and Undo assessment deletion are separate limited recovery tools. Do not use local clearing as a workaround for a blocked cloud deletion.

Find help and preferences: Data > Settings changes appearance/text; Data > Help & manuals opens the paired guides. Save both PDFs separately before leaving coverage. Load latest saved records (retain form drafts) appears when saved data changed elsewhere and keeps edited form drafts in recovery; it does not upload.

7.2T Save and recover after an interrupted action

Save deliberately. A Save uses the clicked values. If you continue typing, the newer text stays unfinished under the same record identity; Save again when ready. Adding a structural set preserves a newer typed name and respects a context changed during saving. Restore one draft without resetting unrelated editor identities.

If draft storage fails, keep the page open. Form replacement is blocked until current input is stored. Export a full device backup to rescue the visible forms, resolve storage, then retry. Switching Field/Desktop keeps the forms in place. An empty joint record can be saved only through the explicit confirmation.

Read partial-recovery messages. Field records and independent slope assessments use separate stores. A later failure can leave field records committed while slopes remain incomplete. Saved counts refresh; retain the original backup file and retry after resolving the error. Incoming recovery data is archived before device record import. Recovered project copies may need manual review when a conflicting import is repeated.

Review concurrent changes before deleting. If another tab changed a record or added children since the confirmation was opened, deletion is rejected. Refresh and review again. Undoing an older deletion does not remove a newer deletion’s Undo record. Check the final saved list.

Verify readiness. The offline status checks the complete current worker cache, not just an installed worker. Missing or failed cache is reported; saved records are separate. Keep the current page open, reconnect and verify an actual offline reopen before relying on the app in the field. Browser eviction, physical phone behavior and live cloud delivery remain separate checks.

Find controls and errors. The direct Desktop/Field switch stays visible when text wraps. Large and Extra large also enlarge help and actions. Keyboard Next skips collapsed groups. Errors stay inside Files & recovery; cloud restore keeps its result separate from changing queue status.

7.2U Use geology directly from the Field Map

1. Open Map in Field view. Geologic units and Geology references are directly above the project map. Geologic units starts off on a fresh app load; switch it on to request the published polygon overlay. Adjust Geology opacity to compare it with the topographic background.

2. Tap a colored polygon to read its formation, lithology, age and original map source in Selected geologic units below the map. Descriptions are published interpretations, not surveyed contacts or automatically adopted field observations. Turning the layer off clears the selected-unit panel.

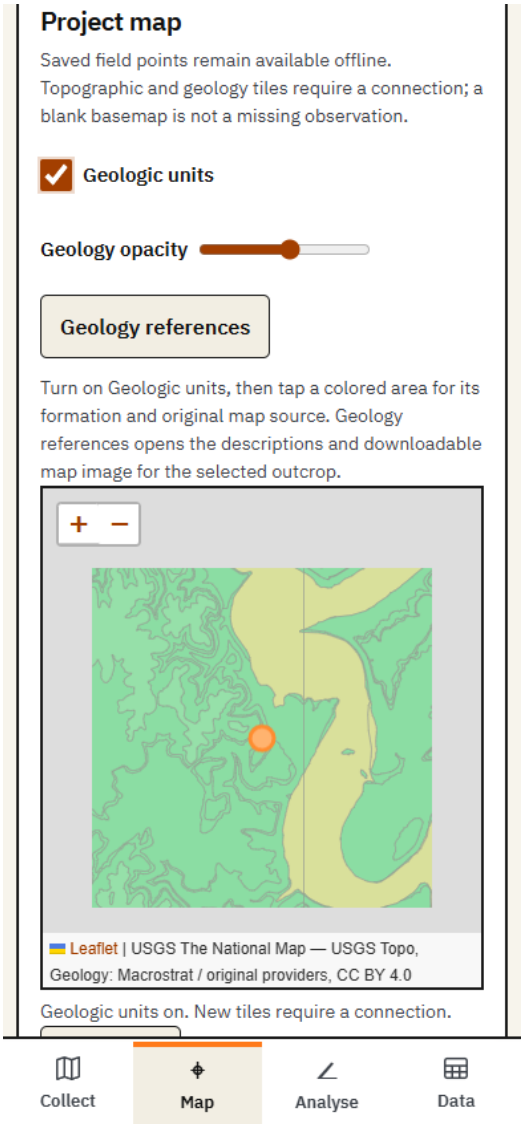
3. Choose Geology references to open the existing formation descriptions and Create / refresh image workflow for the selected outcrop. Confirm the displayed location. Use Map to return. Analyse also retains its Geology references entry.

4. Map controls retain their settings while navigating tabs and switching Field/Desktop during this app session. Desktop has its own Geologic units switch. A fresh reload resets these display choices; they are not geological observations or cloud-backed settings.

5. New tiles need internet and send the displayed area to USGS / Macrostrat. A missing basemap or geology tile does not mean the outcrop was deleted or that a unit is absent. If a request fails, check connectivity and switch Geologic units off and on to retry. Saved outcrop markers remain usable.

6. Keep raw observations separate from map interpretation. Map navigation does not save an unfinished field form: use its normal Save action. Keep a downloaded image and reference CSV for offline reference; they remain separate from field-record and GIS backups.

7.2U.1 Recognize the map controls



The example uses a synthetic outcrop and a recorded published geology tile. Gray areas show unavailable background tiles. Check the selected location and original map source before comparing the reference with field observations.

7.2V Keep appearance stable and inputs readable

In Data, choose Display settings. Choose Sunlight / Daylight or Dark, and a comfortable text size. After a successful save, the same appearance and text size are applied before the app starts on refresh or reopening. The browser toolbar follows the Field appearance.

An older installation may have its choice only in the local database. On its first opening after this update, a neutral light shell waits for that saved choice. If startup fails or takes more than eight seconds, the shell is released so recovery notices and controls are not permanently hidden. Restricted browser storage may require this neutral start on each opening.

Phone layouts keep editable input, selector and note text at least 16 CSS pixels before focus. Larger text settings remain available. Pinch-to-zoom stays enabled; the application does not restrict browser magnification. The keyboard may still move a field into view as part of normal phone behavior.

If a display setting cannot be saved, the app reports the storage error. Its immediate on-screen appearance may differ from the last successfully saved choice. A later reload restores the saved choice. Display preferences do not alter geological observations, units, calculations, record exports or cloud-backed project data.

Browser checks cover delayed startup, preference changes, refresh, close/reopen, legacy and restricted storage, computed input sizes and record preservation using synthetic data. Physical iPhone keyboard, toolbar and focus-zoom behavior still require a device check. Keep a backup of field records before any browser-storage maintenance.

7.2W Frame a geology image on the map

Open Field Map, choose Geology references, then Choose area on map under Geology image. Pan and zoom the square topographic preview to frame the desired area. The outer edge is the generated image boundary. On a keyboard, focus the map and use arrow keys to pan and + / - to zoom.

Read the Image center and approximate width beneath the preview. Panning chooses an image center; it does not move the saved outcrop, GPS preview or formation-description lookup. A preset image width changes the size around the chosen center. Return to selected location restores the outcrop or GPS-preview center.

Choose Create / refresh image. The raster background and geologic polygons use the same square Web Mercator extent. Widths from 200 to 528,000 feet are supported; the width and scale bar describe approximate ground distance at the center latitude. Areas crossing a projection limit or the date line are rejected. Pan to one side or zoom in before retrying.

The output red target marks the image center, which may differ from the outcrop. Review the image, unit legend, original source citations and retrieval date. Preview and output may contain different source detail; a blank tile is not evidence that geology is absent. The preview uses USGS topography; the generated PNG adds the published geology polygons.

Moving the frame while generation is in progress cancels that request so its old extent cannot replace the new selection. Resizing the map changes its view; recheck the center and width before generating. Map tiles and new images require internet.

Download the PNG for a separate copy. A successfully cached custom image reopens for the same selected source location on this device. Unsaved panning is a session choice; the last generated area is retained with its cached image. The bounded image cache can evict older images, is separate from field/cloud/GIS backups, and is cleared by the existing device-data deletion controls.

Validation used real pointer drag, keyboard pan/zoom, recorded geology tiles and simulated raster responses; tests checked matching raster/vector extents, stale-request rejection, download, reload, reset, responsive layout and unchanged synthetic field records. Independent projected-coordinate checks support the extent calculation. Physical-phone gestures and live external-service coverage remain separate checks.

7.3 Record what remains to be done

List deferred tests, missing coverage, uncertain measurements and unsatisfied calculation inputs under the relevant outcrop or discontinuity ID. Include who will obtain/review each item. A missing score can correctly reflect a completed field observation of insufficient evidence.

Confirm that photo references resolve to the external photo archive, samples to the sample log, profiles to their traces, and test values to their reports. Separate observed notes from interpretation.

A separate workflow: slope hazard rating



Photo P08. A large fallen boulder near Zion Lodge. Document consequences to structures and occupied areas as well as the rock source. People provide context, not a surveyed measurement scale. NPS / M. Reed. Source; Public domain (NPS credit).

Start a new named assessment in Analyse > Independent slope rating. The project/outcrop selectors, Structure readings and discontinuity descriptions do not fill this form. Save assessment is independent of Save outcrop.

Carry a separate evidence log keyed to the assessment name: photographs, sketches, raw dimensions, maintenance records and reasons for the chosen categories. The current form has no dedicated general-notes or photo-evidence field.

This is a rating workflow, not the Slope stability factor-of-safety calculator. A complete or low score does not certify safe conditions.

8.1A Use definitions within the independent hazard workflow

Treat this as a separate assessment. Its identity, GPS, slope observations and worksheet score remain independent of outcrop RMR and of an engineering FS. Use its ordered procedure, then open nearby definitions for any unclear field.

Do not interchange lengths. Rock-slope height is a vertical dimension; landslide axial length follows the slide. Road width is transverse to travel; exposure length follows the affected road. An individual rock-block dimension is not event volume. Annual rainfall depth in feet is not storm duration or intensity.

Retain the worksheet variant. FHWA USMP references explain field concepts, but this app follows the supplied categorical/roadway worksheet variant and its stated caps. It does not claim every federal scoring alternative. Unknown values remain distinct from an explicit Not applicable/zero where that option is allowed.

Check before saving. Confirm route, north/coordinates, units, traffic and evidence date; inspect required categories and incomplete mechanisms. The help does not change a category or complete a missing observation. Save, reopen and export the independent assessment after the protocol is complete.

H1. Start a slope assessment, not an outcrop

The **Slope rating** tool records an independent assessment of an unstable slope beside a transportation route. It does not read the selected project, outcrop, bedding, joint sets, RMR or GSI. Selecting an outcrop elsewhere in the app does not fill this form. A shared name can help you cross-reference your records, but it does not create a link between them. This is also separate from **Slope stability**, the engineering calculator that reports factors of safety.

Use the rating to organize a corridor inspection and describe its observed hazards and consequences consistently. A larger score indicates poorer assessed conditions under this worksheet. A “Good” category does not establish that a slope is safe, and a score is neither a failure probability nor a factor of safety. If rocks are falling, a fresh crack is opening, traffic is endangered or movement is apparent, follow the project emergency procedure; do not wait to finish scoring.

Before leaving the office, obtain the route map, latest traffic estimate and year, annual precipitation source, maintenance/event history, right-of-way information and known environmental/cultural constraints. Ask the route owner what they regard as one slope asset and how assessments should be named. An assessment should represent a defined reach with reasonably consistent conditions; do not conceal a particularly hazardous short reach inside an unnecessarily long average.

1. Open **Analyse > Independent slope rating**. On a wider screen the same tool may be directly available in navigation.

2. Select **New assessment**. If there is an unfinished form, save it or consciously resolve the discard prompt first.

3. Enter **Assessment name**, for example *TRAINING-SH-001 - County Road 12 east cut*. This example is invented; it is not a real site assessment.

4. Complete **Rater**, **Date**, **Weather** and **Road designation**. Check the date displayed by the device rather than assuming the default is the intended inspection date. Include recent rain, freeze/thaw or snowmelt context in the weather entry when known.

5. Put the same assessment ID on the external field notebook/sketch and georeferenced photographs. The current slope form has no dedicated general-notes, evidence-source or photo-upload field. Preserve those supporting records outside the form.

Further reading: [H-USMP], Chapter 4, printed pp. 27-31, and Appendix A, pp. 57-65, for trained-rater preparation, inventory boundaries and field organization.

H2. Locate the reach and keep the three lengths straight

At the defined beginning, stand in a safe position with the best practical sky view. Tap **Use current GPS location**. It fills only **Begin latitude** and **Begin longitude**, in decimal degrees. It does not capture the ending location, elevation or a displayed accuracy estimate, and it does not calculate any length. If you must stand away from the feature, record the offset and actual point represented in the external notebook. Seven displayed decimal places do not mean survey accuracy.

Enter **Ending latitude** and **Ending longitude** manually from a GNSS receiver or an independently recorded location. On a phone, the GPS button will overwrite the beginning coordinates if you press it again at the end. Do not mistake that action for capturing the ending point. Confirm longitude has the correct sign; U.S. locations commonly have negative longitude. Use WGS84 geographic coordinates, not projected eastings/northings or degrees-minutes-seconds in these boxes.

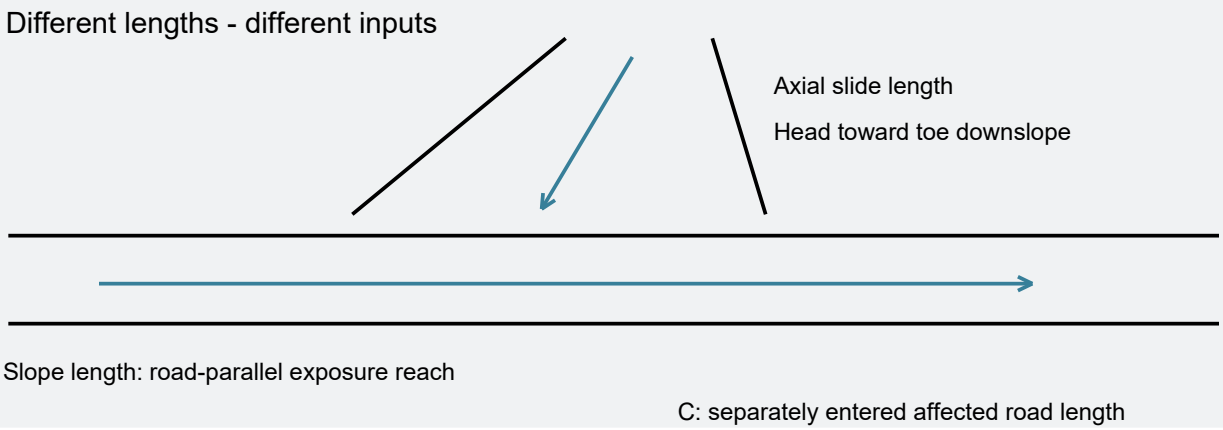
Slope length (ft) is the route-parallel length through the hazard used for human exposure. Measure along the actual road alignment with a wheel, survey or reliable stationing; a straight line between GPS endpoints can cut across curves. Describe the entire rockfall-producing reach and its potential impact extent, not just the freshest pile.

C. Roadway length affected (ft) is the length of roadway affected or reasonably exposed to the assessed landslide/erosion feature. It feeds the landslide length score. It may equal Slope length for a simple common reach, but the two are separate app inputs and do not copy to one another. Do not enter the height of the slope here.

Axial slide length (ft) runs downslope along the landslide's principal axis from head/scarp toward toe; it is a slope distance, not the road-parallel affected length. For debris flow, the relevant source-to-road channel reach may be long. Use surveyed terrain or reliable mapping when direct access is unsafe, and record the measurement basis. For a purely rockfall asset with no assessed slide, do not invent an axial length just to make the landslide output complete.

Further reading: [H-USMP], Appendix A, printed pp. 60-62 and 78-79.

Visual method: distinguish the three lengths

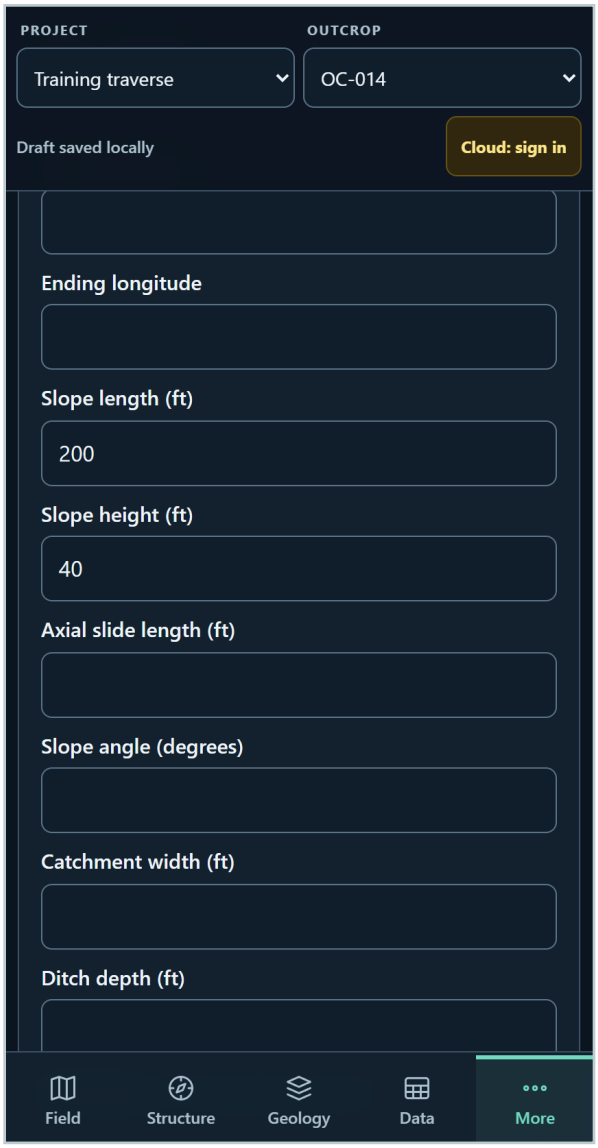


Use route-parallel length for roadway exposure; use downslope axial length for the slide. Neither is the vertical rockfall-source height. Keep a field sketch with the actual measurement endpoints.

Visual method: distinguish the three lengths

(continued)

Retained earlier-interface training illustration; engineering inputs and procedure remain applicable. Open independent slope rating through Analyse.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

H3. Measure height, angle and catchment without climbing the hazard

Slope height (ft) is the vertical difference from the relevant base to the highest credible rockfall source. It is not the inclined distance up the face. A natural cliff above an excavated cut may be the source and may need to be included. Use a survey, a suitable laser rangefinder with verified height mode, or a clinometer with a measured horizontal baseline. Do not stand below a loose block to improve the measurement.

For a simple vertical section with a common horizontal distance D from the observer to the upper and lower target, measure signed sight angles to the top and bottom. Height is *H = D[tan(top angle) - tan(bottom angle)]*. Example: D = 60 ft, top = +30°, bottom = -5° gives H = 39.9 ft. This works only when both targets fit that common-distance geometry. A rangefinder's sloping range is not D; stepped terrain and targets at different plan positions require surveyed coordinates or separate horizontal distances. Keep the raw angles and distances in the notebook.

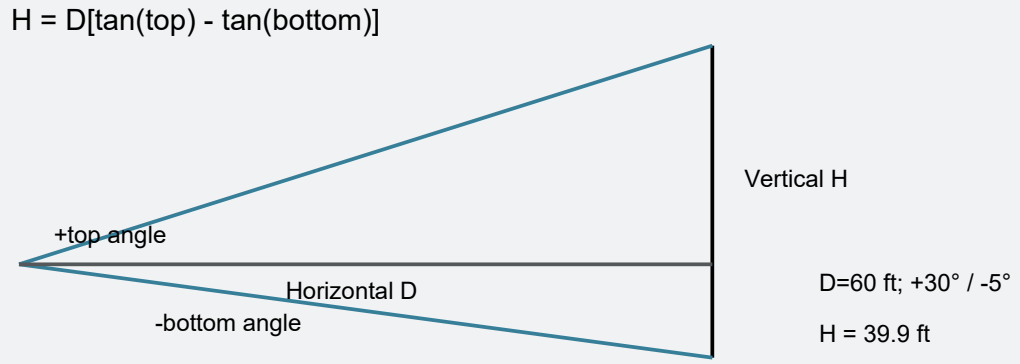
Slope angle (degrees) describes a representative inclination from horizontal. Sight parallel to the steepest descent of the face, or obtain rise/run from a surveyed section: *angle = atan(vertical rise / horizontal run)*. A 40 ft rise over a 30 ft horizontal run gives 53.1°. Record distinct benches, overhangs or compound faces in the sketch rather than forcing them to be a single exact plane. This field records context; it does not directly change the worksheet score.

Catchment width (ft) and **Ditch depth (ft)** describe the rock-catching space between slope and roadway. Establish a representative cross-section; measure the usable horizontal width and vertical depression relative to the adjacent road edge, and record a sketch showing those reference points. Sediment or debris filling the ditch reduces the effective current depth. Check the narrow or shallow portions, barriers, drainage structures and launch ledges; one wide cross-section is not proof of good catchment.

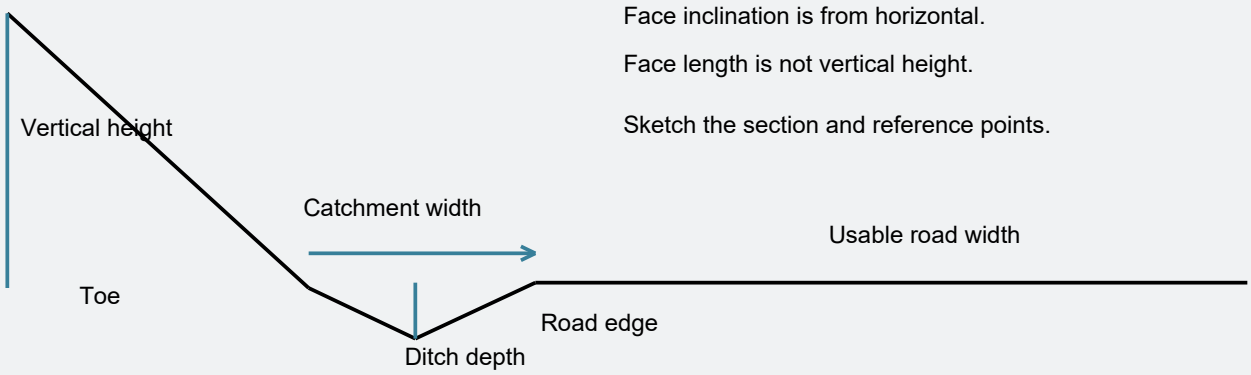
These numeric catchment dimensions do not automatically select **D. Ditch effectiveness**. Select D from observed performance and history: how much falling material actually reaches the roadway, considering the ditch in its current condition.

Further reading: [H-USMP], Appendix A, printed pp. 61-63, 69-70 and 78-79.

Visual method: height and catchment



Only valid when both targets share this horizontal distance in the section.



Original diagrams; no dimensions are inferred from a photograph. Height example assumes upper and lower targets share one horizontal distance from the observer. When that assumption fails, use separate surveyed target coordinates.

H4. Road width, traffic and sight distance are different measurements

For **Road width (ft)**, measure the usable paved width including paved shoulders, or the usable driven width on an unpaved road. Use the narrowest relevant section in the rated reach. Record whether debris or damage already reduces it. The app applies the roadway width equation; this is not the separate trail-width procedure in the federal manual.

For **AADT**, obtain the route owner's annual average daily traffic estimate in vehicles/day. Record its location, year and source in your companion notebook. AADT summarizes annual traffic; it is not a five-minute count extrapolated without seasonal/day-of-week adjustment. If unavailable, leave it blank and flag follow-up. The current app has no qualitative route-importance substitute for missing AADT. Zero means actual zero reported traffic, not unknown traffic. [H-TRAFFIC]

For **Speed limit (mph)**, use the applicable posted limit or lower advisory speed governing the hazard reach, consistent with the assessment method. The dropdown supports 25-65 mph in 5 mph increments. Do not round an unsupported speed to a convenient value. Obtain a separate documented sight-distance assessment for that condition; this app does not implement a general design-speed solver.

For **Sight distance (ft)**, measure the available distance to see the specified target, considering both approaches and use the more restricted direction. The referenced USMP method uses a 2 ft target and a 3.5 ft viewing height. A trained crew must use an approved traffic-control arrangement or a suitable survey method; never put a person or target in a live lane solely to fill this form. Curves, crests, vegetation and the slope face can obstruct the sight line. Record observer/target positions, heights, direction and method. [H-USMP, pp. 90-91]

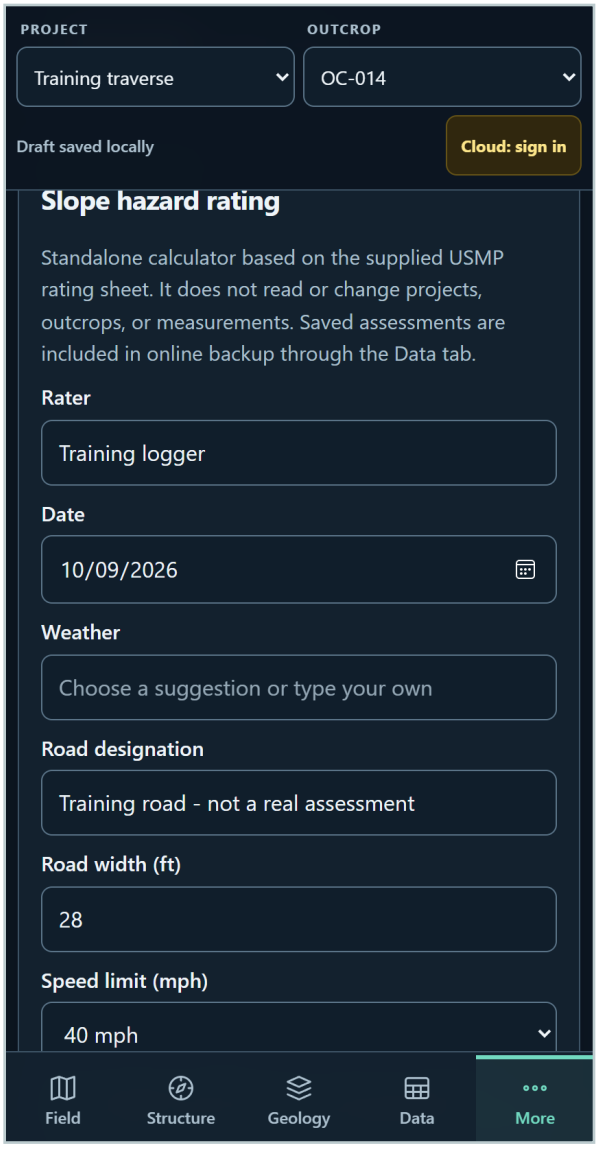
The displayed **Decision sight distance** is a worksheet lookup, not a field measurement. At 35 mph it is 525 ft. If measured sight distance is 315 ft, the available fraction is 315/525 = 60%, and the app's X score is 27. Enter **315**, not 60 or 525, in Sight distance. Do not substitute stopping sight distance from a different design standard without an approved method change.

The roadway inputs on screen

Retained earlier-interface training illustration; engineering inputs and procedure remain applicable. Open independent slope rating through Analyse.

The screenshot shows where to enter the road and traffic inputs. These are separate from the worked score later in the guide: the earlier screen uses 40 mph and 480 ft as a draft demonstration; the worked assessment uses 35 mph and 315 ft.

Copy a supported traffic figure with its year and route segment into your evidence notebook. Do not substitute an unadjusted short count for AADT. A survey or approved traffic procedure is needed for sight distance.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

H5. Read landslide and erosion evidence: A, B, C, L, M and N

Walk the safe perimeter or inspect from a stand-off. Look for scarps, displaced pavement, tension cracks, bulging, tilted vegetation, erosion at the toe, buried drainage and accumulated material. Separate what is visible today from what a dated photograph, survey or maintenance record shows. Photograph a crack with a scale and location reference; a crack width alone is not a movement rate.

A. Roadway width affected uses the affected fraction of the roadway: 0-5% (3 points), 6-25% (9), 26-50% (27), or 51-100% (81). Measure the affected and reference widths at the critical section and record the basis. For example, 6 ft of a 24 ft road is 25%, matching the 6-25% choice. The app asks for a band, not the measured percentage. When observations straddle a category or multiple narratives apply, document the interpretation and use a consistent project rule reviewed by the responsible assessor.

B. Slide/erosion effects evaluates consequences of deformation or deposits. Use a ruler/level at a safely accessible pavement discontinuity, or measure debris thickness at a representative exposed edge. Photograph both the scale and overall context. App landmarks are a visible crack/slight deposit (3), 1/12 ft offset or 0.5 ft deposit (9), 2/12 ft offset or 1 ft deposit (27), and 4/12 ft offset or 2 ft deposit (81), with accompanying erosion/traffic descriptions. Horizontal and vertical displacement can matter; state which you measured. Do not mistake a 1 ft-wide open crack for 1 ft of vertical offset.

C is the route-parallel affected length described earlier. **L. Thaw stability** applies to thaw-related instability, particularly ice-bearing ground; choose the observed/established level of thaw response. A cold morning is not evidence of permafrost instability. Use geological information, seasonal performance and maintenance history; use N/A only when the process truly does not apply.

M. Instability maintenance frequency refers to instability-related work, not routine mowing or every crew visit: the offered recurrence choices are every 10, 5, 2 or 1 years (3, 9, 27, 81). **N. Movement history** requires dated comparison: sporadic/minor creep (3); up to 1/12 ft annually/steady creep (9); up to 0.25 ft per event, one event/year (27); or more than 0.25 ft per event, more than 0.5 ft annually, or multiple events/year (81). Keep actual monitoring data and dates. One visit cannot establish an annual rate.

H6. Inspect rockfall evidence: ditch, history and blocks

D. Ditch effectiveness is about containment. Use observations plus maintenance experience: good = essentially retained (3); moderate = occasional road encroachment (9); limited = frequent encroachment (27); no effective catchment = little containment (81). A full ditch, bounce marks beyond it, rocks on the shoulder and damage to barriers are evidence worth documenting. A wide ditch can still perform poorly beneath a launching ledge. Do not translate ditch width directly into a D score.

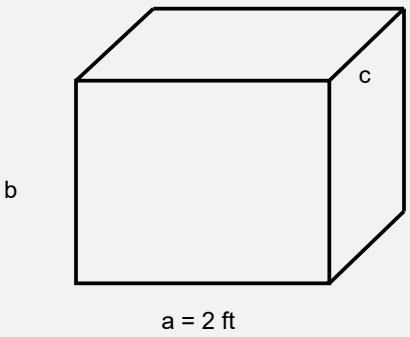
E. Rockfall history distinguishes a few events (3), occasional recurring events (9), many seasonal events (27) and frequent year-round events (81). Interview the maintenance contact and record the time period and event definition. Fresh debris supports activity but its quantity does not reveal how many events produced it. The lowest app choice includes “No Rockfall History Available”; selecting it is not evidence that the hazard has been monitored and found low. Keep that limitation explicit in the companion record and follow up where the decision depends on it.

For **Block length / characteristic size (ft)**, measure representative accessible fallen blocks with a tape or scaled photograph. Record three dimensions and describe which characteristic dimension you enter. Distinguish typical blocks from the largest credible block. Do not touch or climb under unstable material. For **Block / event volume (ft³)**, estimate the volume of one relevant event from mapped extent/thickness, surveyed debris or documented cleanup quantities, and identify the method. A single 2 × 1 × 1 ft rectangular block has a bounding-box volume of 2 ft³; it is not a 162 ft³ event merely because one dimension is 2 ft. Irregular-shape and bulking assumptions belong in the supporting notes.

Then select **F. Block size or volume per event**. The current worksheet uses paired choices of 1 ft / 81 ft³ (3), 2 ft / 162 ft³ (9), 3 ft / 243 ft³ (27) and 4 ft / 324 ft³ (81). It does not automatically score the numeric size/volume boxes and does not interpolate an exact F value between choices. Apply the approved rating interpretation consistently; when both event types are relevant, document the controlling assessment. Do not interpret the slash as an equation equating a block dimension to a volume.

O. Rockfall maintenance frequency separately describes normal scheduled maintenance (3), storm-triggered patrols (9), seasonal patrols (27) or year-round patrols (81). Select it from work orders or the responsible crew's history. It is not automatically copied from E.

Visual method: block versus event



a × b × c = bounding-box volume

2 ft × 1 ft × 1 ft = 2 ft³

An irregular block may occupy less.

An event can include many blocks.

Do not equate a single length with an event volume.



Photo P07. Sedimentary rock fragments collected from rockfall events. Record fragment dimensions and provenance; the size of a collected fragment may differ from the original falling block. NPS / M. Reed. Source; Public domain (NPS credit).

Measure source-representative blocks and document the event definition. A fragment collected after impact can be smaller than the falling block. The photograph is not assigned an F score.

H7. Describe why rock can release: two geologic cases

These ratings describe rockfall controls. They do not request a numerical friction angle, RQD, GSI or Barton-Bandis parameter and do not import those values from an outcrop. Keep detailed bedding/joint measurements in the outcrop workflow if needed; cross-reference the IDs in your separate notebook.

For **Case 1**, inspect discontinuities and the blocks they form. **P. Structural condition** offers favorable (3), random (9), adverse/discontinuous (27), or adverse/continuous (81). Sketch the slope face, bedding and major joints; note whether a block could move out of the face, topple or slide along a release surface. Trace visible discontinuities to their ends and record whether an end is genuine or disappears behind soil/vegetation. A trace cut off by the photograph is not a proven rock bridge. The federal explanation uses about 10 ft continuous trace length to distinguish the adverse categories; where your observations are borderline or obscured, document the uncertainty and obtain review rather than claiming exact continuity.

Q. Rock friction is a surface-condition category: rough/irregular (3), undulating (9), planar (27), or clay-infilled/slickensided (81). Inspect an accessible surface in the potential movement direction. Photograph close up with a scale, look for polished striations or clay seams, and distinguish a freshly broken rock face from the actual pre-existing joint. Do not strip the infill before documenting it. These words are not measured friction angles, and the number of points is not a strength value.

For **Case 2**, look for weaker material eroding beneath stronger material, protruding blocks and developing overhangs. **R. Structural condition** moves from few localized features (3), through occasional widely distributed features (9) and many large features (27), to severe overhangs/oversteepened features (81). Sketch the undercut and identify what appears to be losing support.

S. Differential erosion concerns the contrast and rate of erosion: small/near equilibrium (3), features developing over a few years (9), noticeable annual change (27), or rapid/continuous change (81). Material contrast can be observed on one visit; a timescale needs repeat photographs, monitoring or credible history. Avoid inventing annual behavior from a single image.

The app uses the larger of P + Q and R + S. If one whole case does not apply, both of its fields may be explicitly set N/A where justified. A blank case remains unassessed and leaves the rockfall result incomplete. N/A is not a convenient way to skip unknown geology.

Observe source, path and deposit separately



Photo P04. Rockfall blocks at the base of Devils Tower. Map the source, travel path, and deposition area separately. An old talus deposit establishes past activity but does not by itself establish current rockfall frequency. NPS. Source; Public domain (NPS credit).



Photo P09. Large angular sandstone blocks at the foot of a canyon wall in Glen Canyon. Assess safely from an appropriate viewpoint; do not enter unstable piles or overhangs to fill a field. NPS / Jack Wood. Source; Public domain (NPS credit).

These deposits show rockfall products at two different sites. Their presence alone does not give event frequency, a current source-block volume or a maintenance rate. Inspect from a safe position, link the dated photographs, and obtain history before selecting those categories.

H8. Water, rainfall and consequences need different evidence

I. Slope drainage ranges from dry/well-controlled runoff (3), intermittent water/moderate drainage (9), water usually present/poor drainage (27), to water always present/very poor drainage (81). Observe seepage, ponding, staining, blocked outlets, wet seams and runoff paths. Describe weather and recent storms so that a dry-day observation is not mistaken for year-round dryness. Seek repeat or maintenance evidence before saying “usually” or “always.”

Annual rainfall (ft) is long-term climate information, not rain measured during this visit. Use a suitable regional/local source and save its station/location and reference period. NOAA provides U.S. climate normals; ensure the selected precipitation measure is appropriate to the rating method and identify whether it includes liquid-equivalent snowfall. Do not type annual snowfall depth as rainfall. Convert inches to feet by dividing by 12: 24 in/year becomes **2 ft/year**. [H-CLIMATE]

A numeric rainfall entry automatically sets **J. Annual rainfall** and disables its dropdown. Clear the number to choose a band manually. The app assigns 3 points through 10/12 ft, 9 above 10/12 through 2.5 ft, 27 above 2.5 through 5 ft, and 81 above 5 ft. Exact shared boundaries use the lower band. An invalid nonblank number does not count as an assessed rainfall input.

G. Impact on use asks how the route can function through the relevant event: minor delays/full use (3), partial use/short detour (9), blocked with long detour or shorter closure (27), or blocked without detour/long closure (81). Check the actual detour and likely restoration sequence with the route owner; a map line is not proof a detour is passable or suitable.

Y. Right-of-way impacts progresses from no outside implication through minor impacts and affected private land to affected structures, other routes, railways, utilities or parks. Use boundary and asset records plus a defensible impact footprint. **Z. Environmental/cultural impacts** requires the appropriate resource specialist's information when potentially relevant. The logger can record a sediment pathway or threatened feature; choosing a dropdown is not a regulatory finding.

AA. Maintenance complexity distinguishes routine in-house work, an in-house special project, specialized equipment/contractor work and complex or dangerous work. **BB. Event cost** offers $0-2,000, $2,000-25,000, $25,000-100,000 and over $100,000. Obtain a documented maintenance/repair estimate or event record and state its date and scope. Do not confuse an event cleanup estimate with a complete mitigation design cost.

H9. Read the result, and understand incomplete records

Results update while you type; there is no separate Calculate button in this workflow. The app displays landslide and rockfall preliminary scores, hazard totals, a common risk total, decision sight distance and two final totals. **Highest hazard** compares the two hazard totals, not a measured rate of movement and not an engineering factor of safety.

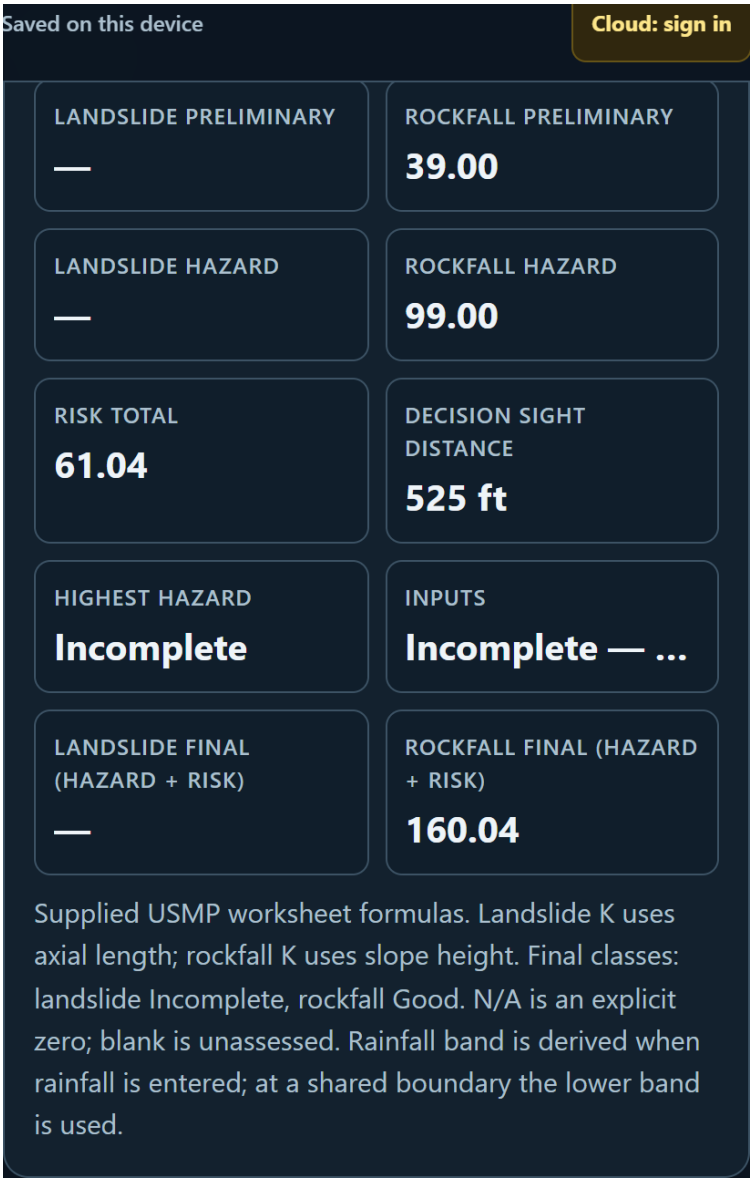
The final class is **Good** below 200, **Fair** from 200 through 400, and **Poor** above 400. The app implements the user's supplied spreadsheet variant, not every option in the federal program: calculated category values cap at 81; F is a dropdown; traffic requires AADT; and roadway width/sight equations are used. The federal manual includes additional options and some different equation caps. Identify this worksheet/version whenever a score is handed to someone else.

Not assessed means there is no assessment for that category. A numeric blank means no number was provided. **N/A**, where offered, is an affirmative statement of nonapplicability and contributes zero; it is not the same as unknown. An entered zero is an actual numerical value and can produce a nonzero calculated score. For example, the current exponential C expression gives 1 point at 0 ft, not N/A. Never fill blanks with zero simply to remove Incomplete.

The app's overall Inputs status requires both hazard totals and the risk total. A defensible rockfall total may exist while the unassessed landslide workflow is incomplete, or vice versa. Keep the unassessed side explicit instead of fabricating data. A save can preserve an incomplete assessment; saved does not mean complete, reviewed or approved.

Training calculation (invented numbers): road width 28 ft; speed 35 mph; AADT 200 vehicles/day; slope length 100 ft; sight distance 315 ft. This gives V = 9, H = 9 and X = 27. With G/Y/Z/AA/BB each 3, and W approximately 1.0404, risk = 61.0404. For a hypothetical rockfall, D = 9, E = 9, F = 9, I = 9, rainfall = 2 ft (J = 9), slope height = 50 ft (K = 9), O = 9, P = 27, Q = 9, R = 0 and S = 0. Rockfall hazard is 99; final total is **160.04 (Good)**. These numbers demonstrate data entry and arithmetic only; they do not describe the photographs or establish safety at a real site.

The worked rating on screen



Actual calculator, synthetic TRAINING-SH-001: rockfall total 160.04. Overall Incomplete remains because landslide-specific inputs were intentionally unassessed. Read the worked values on the preceding lesson; this is not a rating of a photographed site.

H10. Save, verify and deliver the assessment

1. Check the name, location signs, actual units, ratings and evidence sources. Compare numeric block/ditch entries with the categorical choices because the app does not link them automatically.

2. Tap **Save assessment**. Read the status; the successful message distinguishes local saving from the queue for online backup. Reopen it using **Open [assessment name]** from **Saved slope assessments** and verify key values.

3. If online backup is enabled, go to **Data** → **Check cloud data** and verify that the saved slope assessment is present. Waiting in a queue, being online or seeing a local draft is not evidence of upload. Unfinished slope drafts stay local and are not uploaded as saved assessments.

4. Use **Download assessment backup** for a slope-assessments JSON file, or the Data tab's full-device backup for the combined app records. On iPhone, use the generated download link or **Share / Save to Files** when available, then confirm the file exists in Files. Keep an independent copy outside browser storage.

5. For analysis, Data offers slope CSV/GIS exports. The slope CSV includes saved records and unfinished drafts with a record-status column; filter deliberately. An exported draft is not an approved rating. Confirm coordinates before expecting a map feature; ending coordinates do not fill themselves.

Refresh saved list refreshes the list while retaining the form. **Recover draft: [name]** reopens unfinished local work; you still need **Save assessment** to make it a saved assessment eligible for online backup. A recovered draft can be saved as a distinct record. **Restore assessment backup (merges by ID)** restores a JSON backup; it is not CSV import.

For a new inspection date or a changed slope condition, select **New assessment** and give the record a date/version suffix so the prior inspection remains available. Opening an existing assessment and saving normally edits that assessment. Cross-tab concurrent edits may be preserved as separate copies, which should be reviewed deliberately rather than assumed to be duplicates.

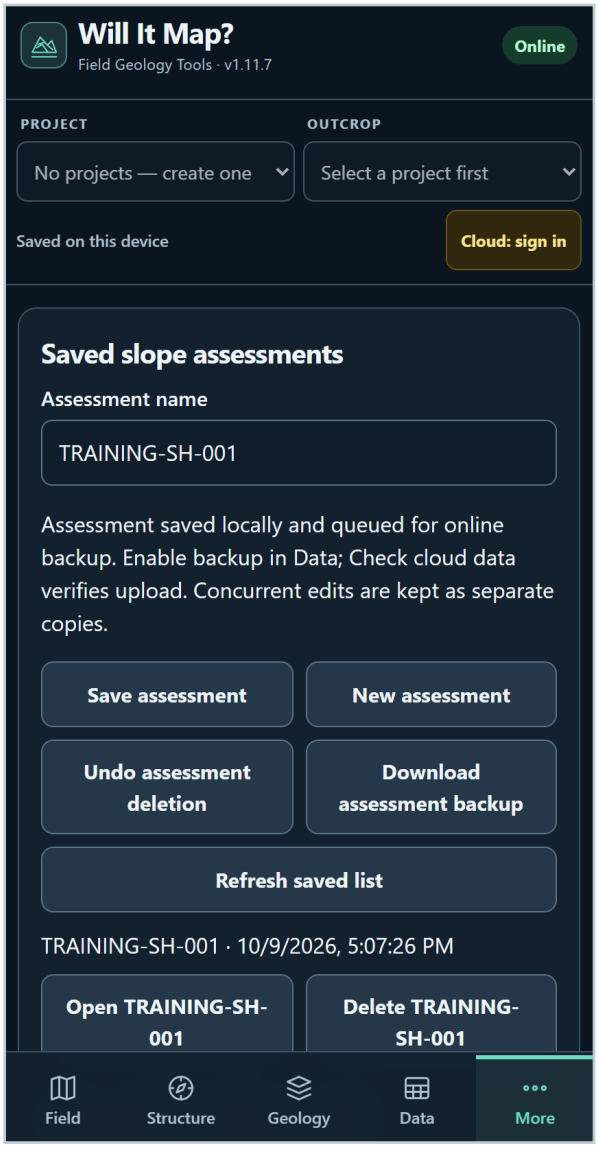
Delete [name] removes that saved assessment, and **Undo assessment deletion** is available for the last such deletion. Do not test deletion with your only field record. Avoid clearing browser/site data as an update or troubleshooting shortcut.

Save the independent assessment

Retained earlier-interface training illustration; engineering inputs and procedure remain applicable. Open independent slope rating through Analyse.

Actual local save of TRAINING-SH-001. The message says saved locally and queued for backup. This test session is signed out, so the screenshot does not demonstrate a cloud upload.

Reopen the saved assessment and check the values. Later, when signed in and backup is enabled, use Data > Check cloud data. Keep a separate JSON export and the linked evidence notebook/photos.



Actual app screen; synthetic training data. Scroll to reach controls outside this view.

H11. Field card: what must be measured versus researched

Measure or map in the field: beginning/end locations; route-parallel reach lengths; vertical slope height; axial landslide length where applicable; representative slope angle; usable road width; sight distance under an approved procedure; catchment dimensions; block dimensions/event extent; displaced pavement/debris geometry; visible traces and surface conditions; present seepage/runoff.

Obtain or corroborate from records: AADT and year; annual rainfall/precipitation source and period; event frequency; movement rate; maintenance recurrence; detour practicality; right-of-way; environmental/cultural constraints; work complexity and cost. A clean road today does not establish no prior rockfall. A wet slope today does not establish permanent seepage. A large block does not reveal recurrence frequency.

Retain in the companion record: assessment ID and date; photo filenames and view directions; sketches and dimension reference points; instruments and units; raw readings; inaccessible or concealed areas; observed versus inferred features; data-source names/dates; category rationale; pending inputs; reviewer and follow-up. This is particularly important because the current independent slope form has no dedicated notes/source field.

Before leaving: confirm saved status; keep the source photo/notebook files; check missing categories without converting unknowns to zero; identify any immediate issue to the responsible field lead; make a portable backup when practicable. On reconnecting, separately verify cloud backup.

Explicit-value checks. Independent slope assessment rejects latitude outside +/-90 degrees, longitude outside +/-180 degrees, and negative physical lengths, road widths, traffic, speed or rainfall. Valid incomplete assessments may still be retained. Blank means unavailable, not an invented zero; examine Input status and keep the original field evidence. Save captures the clicked assessment while later typing remains a separate unfinished draft.

Protocol 8 completion check

Before moving on:

1. The assessment name, GPS location, route/roadway and evidence log identify the assessed slope independently of any outcrop.

2. Exposure lengths, source height, road geometry, traffic, material/history and applicable mechanism inputs follow the ordered steps in this section.

3. Unknown is not a zero score. Check every required applicable category and identify which mechanism remains incomplete.

4. The worked example is teaching data; the calculated rating is not a factor of safety or a safety certification.

Save and check: Save assessment, reopen it and verify the saved values. Include slope assessments in the full backup and cloud-data check when enabled.

If incomplete: Preserve what you observed, identify missing evidence, and leave unsupported numerical inputs blank. Completing the field visit does not require forcing a calculated result.

Conversion card for all protocols

Instrument / source unit	Enter into field-length inputs
1 inch	0.083333 ft
1 mm	0.00328084 ft
5 mm	0.0164042 ft
10 cm (RQD reference length)	0.328084 ft; 4 inches is only an approximation
1 meter	3.28084 ft
1 cubic yard	27 ft³
24 inches annual precipitation	2 ft
1 MPa	145.038 psi (pressure conversion only)
Dip direction 090 degrees	RHR strike 000 degrees
West longitude in the United States	Negative decimal longitude, e.g. -105.000000

Use the displayed unit, not a remembered convention. Do not round a tiny aperture to zero. Keep the raw instrument reading and unit in notes when conversion affects a rating boundary. Feet for length does not imply every parameter uses U.S. units: the Hoek-Brown panel explicitly uses MPa.

Describing uncertainty

Measured aperture 1 mm with comparator; entered 0.00328 ft. Visible J1 trace >12 ft; ends concealed. Estimated GSI 50-60; selected 55 for the recorded representative value. RQD not assessed. These statements preserve evidence and limits better than extra decimal places.

Field-record limits and supporting evidence

RQD has no dedicated method/source selector. Use outcrop notes for core-versus-scanline basis, raw lengths, direction and run/window ID.

Single Field spacing cannot represent every joint set. Preserve per-set intervals/ranges and the selected assessment basis in discontinuity notes/comments.

Barton-Bandis profile azimuth has no separate north selector. State reference in BB notes and keep it consistent with the discontinuity orientation.

Frequency, aperture and the older Length / Persistence remain text fields. The separate numeric visible-trace length, basis, endpoints and direction retain new structured evidence; they do not infer full persistence.

Legacy Plane Type C/F, C, VW and Tool B/C lack sufficient generic meaning; do not teach a guessed expansion.

A field handbook cannot physically validate iPhone/Android sensor accuracy. The current app warns manual compass entry is authoritative until calibrated.

Do not claim a complete laboratory test method from the guide. Full adopted standards and trained practice are required for rebound, UCS, point-load, triaxial, tilt and direct-shear testing.

Save the raw evidence even when it lives outside a dedicated input: profile traces, scanline sheets, original photographs and test certificates need stable IDs in the appropriate notes.

Reinforcement guidance sources and their scope

FHWA FP-24 (2024). Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects. §260.06, pp.195-196, steel limits; §260.08(a), p.196, rock-bolt/dowel installation; §260.09(b), p.199, proof and lock-off. Applies within this specification context. Primary source

FHWA GEC 4, FHWA-IF-99-015 (1999). Ground Anchors and Anchored Systems. §5.3.6, p.70, installation inclinations; §5.3.8/Tables 9-10, pp.77-78, prestressing steel; §7.5, p.154, lock-off. General ground-anchor ranges are not universal rock-bolt defaults. Primary source

FHWA Context Sensitive Rock Slope Design Solutions (2011), Chapter5. Tensioned/untensioned anchors, design/installation and Figs 41-43. Review geology, water, length and bond; a passive resistance assumption is not a displacement prediction. Primary source

FHWA-FLH-19-002 USMP Field Manual (2019). p.61, source dimensions; pp.71-73, block versus volume; pp.88-91, road/exposure/sight definitions. The app retains the supplied worksheet variant. Primary source

Williams Form Engineering, Grade 75 & Grade 80 All-Thread Rebar. Grade 75 product rows #8/R61-08 and #10/R61-10; net threaded area and Structural Properties. Undated; accessed 10 October 2026. Published values are not a project certificate. Primary source

Williams Form Engineering, 150 KSI All-Thread-Bar. Nominal 1-inch/R71-08 and 1-1/4-inch/R71-10 rows and Structural Properties. Undated; accessed 10 October 2026. Use the accepted project product and certificate. Primary source

Find an input and its protocol

Input / group	Protocol step and page
Project name *	1.2 (p.14)
Date	1.2 (p.14)
County	1.2 (p.14)
Route	1.2 (p.14)
Nearest MP	1.2 (p.14)
Default Slope ID	1.2 (p.14)
Personnel	1.2 (p.14)
Project notes	1.2 (p.14)
Outcrop ID *	1.2 (p.14)
Slope ID	1.2 (p.14)
Station reference (optional)	1.2 (p.14)
Latitude	1.3A (p.17)
Longitude	1.3A (p.17)
Elevation (ft)	1.3A (p.17)
Accuracy (ft)	1.3A (p.17)
Capture GPS	1.3A (p.17)
Photo references	1.3B (p.18)
Sample IDs	1.3B (p.18)
Optional photos / sketches	1.3B (p.18)
Observations / field notes	1.3B (p.18); 3.2A (p.59); 3.2B (p.61); 3.5 (p.72); 5.1 (p.96)
Interpretation	1.3B (p.18)
Hazards / site conditions	1.3B (p.18)
Discontinuity notes	1.3B (p.18); 3.2B (p.61); 3.3 (p.62); 3.4A (p.65); 4.2A (p.78)
Photo #	1.3B (p.18); 4.8 (p.93)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Comments	1.3B (p.18); 3.3 (p.62); 3.4A (p.65); 3.4B (p.67); 3.4C (p.70); 3.5 (p.72); 4.2A (p.78); 4.2B (p.80); 4.2C (p.83); 4.8 (p.93); 4.3A (p.87)
Lithology / Rock Type	1.4 (p.20)
Formation / Unit	1.4 (p.20)
Color	1.4 (p.20)
Texture / Grain	1.4 (p.20)
Joint-wall rock type	1.4 (p.20); 4.8 (p.93)
Depth to rock / regolith thickness (ft)	1.5 (p.23)
Exposure length (ft)	1.5 (p.23)
Exposure height (ft)	1.5 (p.23)
Weathering	1.6 (p.25)
Weathering	1.6 (p.25)
Declination override (°)	2.1 (p.32)
Override date	2.1 (p.32)
North reference	2.1 (p.32); 2.2 (p.33)
North reference	2.1 (p.32)
Active structural set	2.2 (p.33); 2.4 (p.39)
New structural set name	2.2 (p.33); 2.4 (p.39)
RHR Strike (°)	2.2 (p.33)
Dip (°)	2.2 (p.33)
Note	2.2 (p.33); 2.4 (p.39)
Feature type	2.2 (p.33); 2.4 (p.39)
Orientation entry	2.2 (p.33)
Strike (° / quadrant)	2.2 (p.33)
Dip (°)	2.2 (p.33)
Dip Direction (°)	2.2 (p.33)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Measurement tool	2.2 (p.33); 4.8 (p.93)
Copy saved Structure measurement	2.2 (p.33)
Enable phone sensors	2.3 (p.37)
Capture averaged reading	2.3 (p.37)
Live RHR Strike	2.3 (p.37)
Live Dip	2.3 (p.37)
Live Dip Direction	2.3 (p.37)
Sensor quality status	2.3 (p.37)
Sensor north reference	2.3 (p.37)
Compass accuracy	2.3 (p.37)
Measurements shown	2.4 (p.39)
Inspect a measurement	2.4 (p.39)
Show selected plane	2.4 (p.39)
Observed hardness	3.1 (p.55)
Strength rating	3.1 (p.55); 3.6 (p.74)
Strength rating source	3.1 (p.55); 3.6 (p.74)
RQD (%)	3.2A (p.59); 3.2B (p.61); 3.6 (p.74)
RQD rating	3.2A (p.59); 3.2B (p.61); 3.6 (p.74)
Discontinuity spacing (ft)	3.3 (p.62); 3.6 (p.74)
Spacing rating	3.3 (p.62); 3.6 (p.74)
Frequency	3.3 (p.62); 4.8 (p.93)
Length / Persistence (ft)	3.4A (p.65); 4.2A (p.78)
Visible trace length (ft)	3.4A (p.65); 4.2A (p.78); 3.4A.1 (p.66); 4.2A.1 (p.79)
Length basis	3.4A (p.65); 4.2A (p.78); 3.4A.1 (p.66); 4.2A.1 (p.79)
First trace end	3.4A (p.65); 4.2A (p.78); 3.4A.1 (p.66); 4.2A.1 (p.79)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Second trace end	3.4A (p.65); 4.2A (p.78); 3.4A.1 (p.66); 4.2A.1 (p.79)
Trace direction on the plane	3.4A (p.65); 4.2A (p.78); 3.4A.1 (p.66); 4.2A.1 (p.79)
Trace evidence / endpoint notes	3.4A (p.65); 4.2A (p.78); 3.4A.1 (p.66); 4.2A.1 (p.79)
Separation / Aperture (ft)	3.4B (p.67); 4.2B (p.80)
Infilling	3.4B (p.67); 4.2B (p.80)
Infill thickness (ft)	3.4B (p.67); 4.2B (p.80); 4.7 (p.92)
Asperity height (ft)	3.4B (p.67); 4.2B (p.80); 4.7 (p.92)
Roughness	3.4C (p.70); 4.2C (p.83); 4.3A (p.87)
Groundwater	3.5 (p.72); 3.6 (p.74)
Groundwater score (derived)	3.5 (p.72); 3.6 (p.74)
Water	3.5 (p.72)
Discontinuity condition rating	3.6 (p.74)
Orientation adjustment	3.6 (p.74)
Rating override reason (optional)	3.6 (p.74)
JRC observed estimate / range	4.3 (p.84)
Selected JRC (0-20)	4.3 (p.84); 4.3A (p.87)
JRC assessment method	4.3 (p.84)
Profile / intended shear direction (°)	4.3 (p.84); 4.3A (p.87)
Measured profile length L0 (ft)	4.3 (p.84); 4.7 (p.92); 4.3A (p.87)
Test/profile IDs, hammer serial/calibration, correlations, impact angle and assumptions	4.3 (p.84); 4.4 (p.88); 4.5 (p.90); 4.6 (p.91); 4.7 (p.92); 4.3A (p.87)
Joint-wall rebound readings (comma or space separated)	4.4 (p.88)
Fresh reference surface rebound readings	4.4 (p.88)
Rebound hammer type	4.4 (p.88)
Hammer impact direction	4.4 (p.88)
Joint-wall condition during testing	4.4 (p.88)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Joint-wall compressive strength JCS0 (psi)	4.5 (p.90)
JCS determination method	4.5 (p.90)
Friction angle (°)	4.6 (p.91)
Friction basis	4.6 (p.91)
Friction determination method	4.6 (p.91)
Surface applicability	4.6 (p.91); 4.7 (p.92)
Scale correction	4.7 (p.92)
Assessment length Ln (ft)	4.7 (p.92)
Minimum effective normal stress σ′n (psi)	4.7 (p.92)
Maximum effective normal stress σ′n (psi)	4.7 (p.92)
Effective normal-stress basis	4.7 (p.92)
Station reference (optional)	4.8 (p.93)
Plane Type	4.8 (p.93)
Original JCS(R)	4.8 (p.93)
Slope ID	4.8 (p.93)
Observed GSI (0-100; visual estimate)	5.1 (p.96)
Observed GSI carried into Hoek-Brown	5.1 (p.96)
Intact UCS σci (MPa)	5.2 (p.99)
UCS determination method	5.2 (p.99)
HB test IDs, source, orientation and assumptions	5.2 (p.99); 5.3 (p.100); 5.4 (p.101)
Intact rock constant mi	5.3 (p.100)
mi rock-type reference	5.3 (p.100)
mi determination method	5.3 (p.100)
Disturbance factor D (0-1)	5.4 (p.101)
D field scenario	5.4 (p.101)
Rock-mass applicability	5.4 (p.101)
Slope dip (°)	6.1 (p.104)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Slope dip direction (°)	6.1 (p.104)
Joint friction angle (°)	6.1 (p.104)
Lateral limits (±°)	6.1 (p.104)
Automatically detected north reference	6.1 (p.104)
Project geological domains	1.2A (p.16)
Default geological domain	1.2A (p.16)
Default slope reach / segment	1.2A (p.16)
Mapping method & coverage (optional)	2.0 (p.28); 2.0A (p.29)
Structure mapping group (optional)	2.0B (p.30)
Structure geological domain	2.0B (p.30)
Structure slope reach / segment	2.0B (p.30)
Discontinuity mapping group (optional)	2.0B (p.30)
Discontinuity geological domain	2.0B (p.30)
Discontinuity slope reach / segment	2.0B (p.30)
Assign survey / domain	2.0C (p.31)
Batch geological domain	2.0C (p.31)
Batch survey / exposure	2.0C (p.31)
Change slope reach	2.0C (p.31)
Batch slope reach / segment	2.0C (p.31)
Kinematics pair scope	6.1A (p.106)
Strength-law evidence guidance	6.2B (p.119)
Geometry, strength, water and load evidence	6.2B (p.119); 6.2C (p.120)
Additional waviness	6.2C (p.120); 6.2C.1 (p.121)
Additional waviness angle (degrees)	6.2C (p.120); 6.2C.1 (p.121)
Geometry orientation source selection	6.2A.1 (p.115)
Model surfaces & assignments / surface names	6.2A.1 (p.115); 6.2A.3 (p.117)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Live slope geometry, definition sketch and linked values	6.2A.2 (p.116); 6.2A.3 (p.117); 6.2A.4 (p.118)
Protected mechanism drafts and slope copying	6.2A.4 (p.118)
Named contact-property profiles and evidence	6.2C.2 (p.122); 6.2C.3 (p.123); 6.2E (p.127)
Assigned contact snapshot / local overrides	6.2C.2 (p.122); 6.2C.3 (p.123)
Optional water, seismic, support and load summaries	6.2D (p.124); 6.2D.1 (p.125)
Setup readiness and linked corrections	6.2D (p.124); 6.2D.1 (p.125); 6.2D.2 (p.126)
Explicit seismic and derived-water input correction	6.2D.2 (p.126)
Export/import property library and local-save recovery	6.2E (p.127)
Expandable input definitions, methods and references	START (p.10); 8.1A (p.196)
Five-step reinforcement design procedure	6.2F.1 (p.128)
Legacy capacity qualification and support audit	6.2F.1 (p.128); 6.2F.4 (p.131); 6.2F.5 (p.132)
Published bolt products, material properties and steel design procedure	6.2F.2 (p.129); 6.2F.6 (p.134)
Apply or discard product overrides and preserve original source values	6.2F.2 (p.129)
Bolt head-to-tip direction / face-normal starting orientation	6.2F.3 (p.130); 6.2F.7 (p.135)
Total length, full/partial grout and geometric embedment	6.2F.4 (p.131); 6.2F.8 (p.136)
Qualified service limit per bolt and evidence	6.2F.5 (p.132)
Tendon steel and design / lock-off / test loads	6.2F.5A (p.133)
Pending steel-check edits / Save or Discard	6.2F.5A (p.133)
Show bolts, transparency, labels and geometric engagement on the model	6.2F.9 (p.137)
CSV / paste Joint set (optional)	2.4B-2.4C (p.43)
CSV / paste Interpreted set (optional)	2.4B-2.4C (p.43)
CSV / paste Outcrop and original provenance	2.4B-2.4C (p.43)
Desktop layout, scope and record inspector	7.2B (p.168)
Desktop staged edits and review/save	7.2B (p.168)
Desktop structural analysis and imported populations	7.2C (p.169)

Find an input and its protocol (continued)

Input / group	Protocol step and page
Desktop slope workflow, current case and live model	6.2G (p.138)
Desktop slope result, study and report review	6.2H (p.139)
Calculation report generation, preview and delivery	6.2I (p.140)
Detailed numerical report and reproducible calculation package	6.2J (p.152)

Slope-rating input index

Slope-rating input	Lesson / how obtained
Assessment name	H1/H10 - Required to save; use stable ID/date and cross-reference external notebook/photos.
Rater	H1 - Observer name or approved initials.
Date	H1 - Actual inspection date; check default.
Weather	H1/H8 - Conditions today and recent rain/snowmelt if known.
Road designation	H1 - Route name/number and reference reach.
Road width (ft)	H4 - Narrowest usable roadway width; include usable paved shoulders or usable unpaved width.
Speed limit (mph)	H4 - Applicable posted/advisory speed; supported 25-65 in 5 mph increments only.
AADT	H4 - Route owner annual traffic estimate with year and station/location.
Sight distance (ft)	H4 - Measured available visibility using defined observer/target heights and restricted direction.
Begin latitude	H2 - Actual beginning location or documented safe offset; GPS button fills this.
Begin longitude	H2 - WGS84 decimal longitude, check sign. GPS button fills this.
Ending latitude	H2 - Manually enter independently recorded endpoint.
Ending longitude	H2 - Manually enter independently recorded endpoint.
Slope length (ft)	H2 - Route-parallel exposure length through the hazard.
Slope height (ft)	H3 - Vertical height to credible source; not face length.
Axial slide length (ft)	H2 - Downslope length along slide axis, head to toe/source-to-road channel as appropriate.
Slope angle (degrees)	H3 - Representative inclination from horizontal; sketch complex slope.
Catchment width (ft)	H3 - Usable current horizontal width of catchment at documented cross-section.
Ditch depth (ft)	H3 - Current effective vertical depth with reference level documented.
Block length / characteristic size (ft)	H6 - Tape/remote measurement; retain three dimensions and basis of characteristic size.
Block / event volume (ft^3)	H6 - One relevant block/event estimate; method and assumptions retained externally.
Legacy size / volume text	H6 - Original combined block-size entry; preserved verbatim, uncertain units not automatically converted. New work uses separate fields.

Slope-rating input index (continued)

Slope-rating input	Lesson / how obtained
Annual rainfall (ft)	H8 - Sourced long-term annual climate depth; divide inches by 12; locks/derives J when nonblank.
C. Roadway length affected (ft)	H2/H5 - Affected route-parallel landslide/erosion length; independent of Slope length.
A. Roadway width affected	H5 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
B. Slide/erosion effects	H5 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
D. Ditch effectiveness	H6 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
E. Rockfall history	H6 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
F. Block size or volume per event	H6 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
G. Impact on use	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
I. Slope drainage	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
J. Annual rainfall	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
L. Thaw stability	H5 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
M. Instability maintenance frequency	H5 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
N. Movement history	H5 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
O. Rockfall maintenance frequency	H6 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
P. Structural condition (case 1)	H7 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
Q. Rock friction (case 1)	H7 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
R. Structural condition (case 2)	H7 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.

Slope-rating input index (continued)

Slope-rating input	Lesson / how obtained
S. Differential erosion (case 2)	H7 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
Y. Right-of-way impacts	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
Z. Environmental/cultural impacts	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
AA. Maintenance complexity	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.
BB. Event cost	H8 - Choose the evidence-supported category; see the cited lesson and preserve the rationale in the companion record.

Where to read more: measurement methods

Start with USBR Chapters 4, 5 and 7 for hands-on rock description and discontinuity surveying. For the strength classifications, use the original author papers and the in-app reference charts. Laboratory or standardized index tests require the complete adopted test method, equipment instructions and trained practice; an app field and this guide are not a laboratory protocol.

R1. U.S. Bureau of Reclamation, Engineering Geology Field Manual, vol. I, Chapter 4: Classification of Rocks and Description of Physical Properties of Rock

Printed pp.65-79: description format, texture/color, weathering and field hardness. Chapter is U.S. government guidance. Open primary source.

R2. U.S. Bureau of Reclamation, Engineering Geology Field Manual, vol. I, Chapter 5: Discontinuities

Printed pp.95-98: RQD/frequency; pp.100-110: orientation, true spacing, trace lengths/end conditions, openness, fill, roughness/waviness and water; Figure 5-1 RQD; Figure 5-2 spacing; Figure 5-3 roughness. Open primary source.

R3. U.S. Bureau of Reclamation, Engineering Geology Field Manual, vol. I, Chapter 7: Discontinuity Surveys

Printed pp.205-208: survey purpose, scanlines, right-hand rule and directional sampling bias. Open primary source.

R4. FHWA-NHI-16-072, GEC 5: Geotechnical Site Characterization (2016)

Section 4.15.2 and Eq.4.18: RQD. Printed pp.9-34-9-35, Tables 9-5 and 9-6: RMR and orientation categories. Open primary source.

R5. Marinos, P. and Hoek, E. (2000). GSI: A Geologically Friendly Tool for Rock Mass Strength Estimation. GeoEng2000, pp.1422-1446

Tables 1, 2 and 3: field intact-strength grades, mi estimates and GSI chart. The app contains selected reference material, not the complete publication. Use this author/title citation to obtain the full original for further study.

R6. Marinos, P., Marinos, V. and Hoek, E. (2007). The Geological Strength Index (GSI): A Characterization Tool for Assessing Engineering Properties for Rock Masses

NIOSH Proceedings, printed pp.87-94. Figure 1 p.88; applicability p.89; weathering/water p.91; precision and ranges p.93. CDC labels record Public Domain. Open primary source.

R7. Barton, N. and Choubey, V. (1977). The shear strength of rock joints in theory and practice. Rock Mechanics 10, 1-54

Primary research paper: JRC, JCS and residual friction, index-test basis and length-scale effects. Open primary source.

R8. Hoek, E., Carranza-Torres, C. and Corkum, B. (2002). Hoek-Brown failure criterion - 2002 edition

Author-hosted paper; Section 7 and Table 1 (PDF pp.5-7): disturbance guidance; equations define sigma_ci, mi, GSI and D. Open primary source.

R9. W3C Geolocation Recommendation

GeolocationCoordinates: decimal WGS 84 latitude/longitude, altitude relative to reference ellipsoid, accuracy semantics. This verifies API semantics, not actual phone calibration. Open primary source.

Where to read more: measurement methods

(continued)

R10. NOAA NCEI: Magnetic Declination (Variation)

Location/date-specific declination and calculator link. Use the applicable date and location; do not hard-code the illustrative +8° example. Open primary source.

R11. FHWA-NHI-10-016, Drilled Shafts: Construction Procedures and LRFD Design Methods (2010)

Printed pp.2-16-2-17 and Figure 2-7: qualifying sound core, core losses and mechanical breaks. Open primary source.

R12. Palmström, A. (1995), RMi - A Rock Mass Characterization System for Rock Engineering Purposes, Appendix 4

Appendix A4 p.10, Section 6.1: limitations of RQD-Jv correlations. Author-hosted primary source. Open primary source.

R13. Hoek, E. Practical Rock Engineering: Shear strength of rock discontinuities

Chapter Shear strength of rock discontinuities, Figure 5 (chapter p.7): Barton-Choubey reference profiles with 0-10 cm scale; accompanying JRC/JCS and scaling discussion. The app contains selected reference material, not the complete publication. Use this author/title citation to obtain the full original for further study.

R14. Aydin, A. (2009). ISRM Suggested method for determination of the Schmidt hammer rebound hardness: Revised version. IJRMMS 46, 627-634

Primary test-method paper; ISRM hosts a 2024 instructional video under Schmidt Hammer Rebound Hardness. Full standard procedure controls calibration, specimens, impacts and reduction, not the app summary. Open primary source.

ISRM instructional material.

Where to read more: slope hazard rating

H-USMP. Beckstrand et al. (2019). Unstable Slope Management Program for Federal Land Management Agencies. FHWA-FLH-19-002.

Chapter 4, pp.27-31; Appendix A, pp.57-95; Appendix B, pp.96-97. Open source.

H-USMP-PORTAL. FHWA Geologic and Geotechnical Services

Official USMP forms and training resources. Open source.

H-TRAFFIC. FHWA (2022). Traffic Monitoring Guide

Glossary and traffic data methodologies: AADT and appropriate annualization. Open source.

H-CLIMATE. NOAA NCEI. U.S. Climate Normals

Identify the station, location, reference period and appropriate precipitation measure. Open source.

H-APP: WillItMap v1.35.4, inspected 9 October 2026. The app implements the supplied USMP_RATING_SHT 2.xlsx worksheet variant. Its displayed categories and formula caps are not identical to every procedure in the federal manual. Use the in-app results and this guide's stated version when reproducing the worked example.

Source numbers in the measurement lessons refer to the preceding reference list. H source codes refer to this list. Page numbers are the printed document pages unless stated otherwise. The field photos have separate provenance in the photograph credits.

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P01. Jointed rock face, Lamar Canyon

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P02. Sedimentary rocks below Devils Tower

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P03. Weathered sandstone surface

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P04. Boulder field below Devils Tower

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P05. Volcanic column surface and interior, Yellowstone

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P06. Polygonal joint pattern, Devils Postpile

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P07. Rockfall fragments used in hazard investigations

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P08. Large rockfall boulder near Zion Lodge

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P09. Sandstone talus at Glen Canyon

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P10. Field geology discussion, Acadia

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P11. Clinometer measurement on a rock surface

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P12. Compass direction measurement

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P13. Schmidt rebound hammer

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P14. Saprolite profile, Aranmore, Ireland

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P15. Drill core boxes, Onkalo, Finland

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P16. Roadcut in Otero County, Colorado

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P17. Tilted sandstone beds, Split Mountain

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P18. Newton Cave Seep, April 2021

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