Limitations of Ground Penetrating Radar (GPR)

As part of our ongoing commitment to quality, safety, and transparency, this memo outlines the known limitations of Ground Penetrating Radar (GPR) based on industry best practices and real-world experience. This information must be understood, documented, and communicated clearly during site walks, pre-scan assessments, and client discussions.

Material and Environmental Limitations

- **High Conductivity Materials:** Clay-rich soils, wet concrete, moist, and mineral-heavy soils absorb radar signals, reducing penetration and making features undetectable.
- **Metal Interference:** Metal objects (e.g., rebar, pan decking, post-tension cables) reflect or overpower the signal, masking nearby or deeper targets.
- **Low Dielectric Contrast:** GPR requires a dielectric contrast to generate reflections. Similar materials (e.g., concrete and stone base) may not reflect radar signals, making boundaries difficult to identify.
- **Voids and Hollow Structures:** Voids in hollow-core slabs or air gaps may alter signal behavior, making depth or object interpretation challenging.

Structural Challenges and Reinforcement Complexities

- **Wire Mesh Confusion:** Closely spaced mesh may appear as rebar or mask conduits beneath. Misidentification leads to over- or under-marking.
- **Mesh Overlap:** Overlapped mesh sheets can create false positives resembling conduits unless confirmed with multiple verification steps (spacing, depth, cross-

polarization).

- **Indistinguishable Reinforcing Layers:** Failure to identify both mats of rebar can cause incorrect slab diagnosis. Seeing one layer doesn't guarantee you're seeing the bottom of the slab.

Depth Accuracy Limitations

- **Dielectric Uncertainty:** Depth calculations are dependent on the dielectric constant, which must be estimated or manually adjusted. Inaccurate dielectric input leads to incorrect depth readings.
- **Time Zero Errors:** Automatic surface (time zero) calibration can be set incorrectly, especially when the antenna is initialized over shallow metal. This causes depth miscalculations or clipped data.
- **Object Marking Errors:** Marking at incorrect points (e.g., peak amplitude vs. actual center of reflection) results in depth inaccuracies of up to several inches.

Conduit Detection Limitations

- **Plastic Conduits and Smurf Tubing:** Smurf tubing and plastic conduits are harder to detect and often only visible with cross-polarized scans.
- **Low Current Conduits:** Passive locating may fail to detect low-voltage or inactive electrical lines. Power mode is not guaranteed to find all conduits.
- **Conduits Below Mesh:** Wire mesh often masks conduits lying directly beneath it.
- **Depth Positioning:** Conduits may blend in with the bottom slab reflections, making their exact location ambiguous.

Structural Types and Configuration Limitations

- **Topping Slabs:** Thin topping slabs over structural layers can mask the true bottom, leading to false assumptions about slab thickness and missed deeper targets.
- **Ribbed/Waffle Slabs:** Thin slabs between beams and joists may show little to no reinforcing, and joists must be identified to avoid drilling into structural elements.
- **Decking Slabs:** Conduits in the valleys may not be visible due to the pan decking's geometry and material interference.

- **Hollow-Core Slabs:** GPR cannot penetrate the full depth of hollow-core slabs. Prestressed cables cannot be seen, must be inferred, and marked based on hollow locations.

Operational and Client-Related Constraints

- **Limited Access:** Lack of access to utility rooms, panels, or slab bottoms prevents proper scanning and interpretation.
- **Environmental Obstruction:** Wet surfaces, muddy terrain, dust, debris, uneven surfaces, or fresh concrete pours may interfere with antenna contact and signal return.
- **Incomplete Site Information:** When as-built drawings or utility records are unavailable, assumptions must be clearly communicated, and limitations documented.
- **Client Non-Cooperation:** Lack of access to vaults, electrical rooms, or utility plans severely limits comprehensive locating.
- **Time and Surface Limitations:** Thick or complex slabs may require multiple passes and advanced data interpretation, increasing scanning time and reducing field efficiency.

Equipment Limitations

- **Single Dielectric Entry:** GPR systems accept only one dielectric per scan. Variations within the slab or soil cannot be simultaneously accounted for.
- **Impenetrable Metal Barriers:** GPR cannot see through metal objects. Anything beneath dense rebar mats, decking, or steel plates may be entirely obscured.

Interpretation and Data Quality

- **Hyperbola Misinterpretation:** Misreading or failing to match hyperbolas correctly results in marking errors and incorrect object classification.
- **Cross Polarization Dependency:** Plastic and mesh elements often require cross-polarized scans to confirm their identity. Lack of these scans leads to incomplete or inaccurate findings.

- **Surface Initialization Errors:** Improper initialization (e.g., over mesh or metal) skews the data display and may clip objects from view.

Field Protocol Reminder

- Always document any limitation encountered during scanning (e.g., attenuation, unknown depth, no bottom visible).
- Communicate all limitations clearly to the client, both verbally and in the job summary report.
- Never assume a client understands the constraints of GPR unless they are explicitly stated in writing.
- When in doubt, get a second opinion, perform a cross-polarized scan, or escalate for further analysis.

This memo should be reviewed regularly and discussed during technician training and project kickoff meetings. Miscommunication or omission of limitations can result in costly errors or unsafe work conditions.