How to build a borehole well in northern Ghana

A practical guide for charities

A field-tested guide from the team at Savannah Water Project for organizations starting out in clean-water work.

If you're reading this, you're probably standing somewhere between a good intention and a finished water point — and looking for someone who has already made the mistakes so you don't have to. This guide is for you. It walks through what we've learned building deep borehole wells in northern Ghana: how to choose a community, why this kind of well is the right answer for this region, how to site and drill it, how to choose between a hand pump and an electric pump, how the surface infrastructure comes together, what you have to test before anyone takes a drink, and what it should actually cost.

This is not a substitute for a hydrogeologist and a licensed drilling contractor. It's the orientation we wish we'd had on day one.

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1. The water situation in northern Ghana

Northern Ghana — the Northern, Savannah, North East, Upper East, and Upper West Regions — is geographically and hydrologically distinct from the rest of the country. It's classified as Sudan and Guinea savanna, with a single rainy season (roughly May to October) and a long, severe dry season the rest of the year. Surface water is abundant for a few months, then largely gone. The rural population has historically relied on three things:

1. **Surface water** — streams, rivers, dugouts, and seasonal ponds. Reliable in the rainy season, contaminated and often dry the rest of the year.
2. **Hand-dug wells** — shallow pits, often unlined, that tap the topmost water table. These are highly vulnerable to seasonal drop, surface contamination from livestock and runoff, and total failure during prolonged dry spells.
3. **Boreholes** — drilled wells that reach deeper, more stable aquifers. This is what we'll focus on.

The scale of need is large. Reliable access to an improved water source in rural northern Ghana remains well below the national average, and even where boreholes exist, a significant fraction are non-functional at any given time because of maintenance gaps. The communities Savannah Water Project serves are often several kilometers from the nearest working water point, and water collection — almost always done by women and girls — eats hours out of every day.

2. Why deep boreholes?

The geology of northern Ghana is what makes deep boreholes the right tool. The region is underlain by **Basement Complex crystalline rocks** — granites, gneisses, migmatites — and in places by the **Voltaian sedimentary basin**. Neither of these rock types is naturally porous the way a sandstone aquifer would be. **The water in this region lives in fractures**: cracks, joints, and weathering zones in otherwise solid rock. Those fractures can hold remarkable amounts of water, and because they sit well below the surface, that water is:

- **Year-round.** It doesn't disappear in the dry season the way a hand-dug well does.
- **Cleaner.** It's filtered by tens of meters of overlying material and isolated from surface contamination if the wellhead is properly constructed.
- **Reliable.** A well-sited borehole can serve a community for decades.

The trade-off is that you can't just dig anywhere. You have to find the fracture — and before you do that, you have to choose where you're working and why.

3. Step one: community selection

This is the decision most charities don't think hard enough about, and it shapes everything else.

At Savannah Water Project, our policy is to go to the most remote communities first — the villages other organizations skip because the roads are bad, the logistics are painful, and there's no easy story to tell donors about getting there. These are the people with the worst options and the longest walks to water. They're also the people most likely to be missed by larger agencies that prefer easier deployments.

That choice comes with real complications. You're not just working in a community when you build a borehole. You're working in a web of communities, often with longstanding relationships, rivalries, and obligations to each other. A borehole in one village will be noticed by every village within a day's walk, and you should expect that to produce friction. We've seen all of the following:

- A neighboring village resents the placement, sometimes accusing the local guide or partner who recommended the recipient community of bias toward his own kin.
- A guide who tries to act fairly by directing the project to a community *other than his own* gets shunned by his own people for failing to bring the benefit home.
- Communities several kilometers away begin walking to the new water point in such numbers that local users feel displaced, and the pump and slab come under stress no one planned for.
- Someone — sometimes a chief, sometimes an opportunistic individual — moves to control access to the water point and begins charging outside users.

It's tempting to read that last one and immediately label it exploitation. Sometimes it is. But sometimes it isn't. A borehole in a very remote area can attract users from miles around, and the resulting strain — on the pump, on the slab, on the wait time for residents — has to be managed somehow. Some kind of governance is required, and the community has to figure out what that looks like. That might mean a small contribution from outside users for maintenance. It might mean priority hours for resident families. It might mean a more formal agreement between villages.

These are not decisions outsiders should make. Our job as an external partner is not to impose a governance model. It's to learn the local norms well enough to recognize whether what the community is deciding is reasonable, fair, and free of real exploitation. There is a meaningful difference between a community asking outside users for a token contribution toward a spare-parts fund and a powerful individual capturing the water point for personal benefit. The first is sustainable community management; the second is something we'd push back against. Knowing the difference requires local relationships, patience, and a willingness to ask questions instead of assuming.

A few practical principles we've landed on:

- **Work through a trusted local partner**, ideally someone with deep ties to the area but with the integrity to recommend communities outside their own when the need is greater. This person's judgment is one of the most important hires you will ever make.
- **Visit before committing**, more than once if possible. Watch how decisions are made. Notice who speaks, who doesn't, and who is consulted behind closed doors.
- **Confirm broad community buy-in** for the project — including agreement on the site, the governance arrangement, and the contribution the community will make to ongoing maintenance.
- **Be willing to walk away** from a community where the dynamics suggest the project will be captured by one faction.
- **Resist the urge to over-engineer the social structure.** People in these communities have been managing scarce resources together for generations. Your job is to make sure the arrangement is reasonable, not to invent it.

The wells that last are the ones built into a community that already knows how to take care of them. The wells that fail are usually the ones imposed on a community that didn't choose them, or contested between communities that never agreed on who they were for.

4. Step two: site selection with electrical resistivity surveys

Once the community is settled, the geology takes over. You don't pick a borehole site because it's near the school or convenient for the women fetching water — you pick it because the geology says there is water there, and then you negotiate placement within that envelope.

The standard tool is an **electrical resistivity survey**, typically using one or both of:

- **VES (Vertical Electrical Sounding)** — measures how electrical resistivity changes with depth at a single point. Good for understanding the layering beneath a candidate site.
- **ERT / 2D Electrical Resistivity Imaging** — runs a longer transect with multiple electrodes to produce a cross-sectional image of the subsurface. Good for spotting lateral fracture zones.

Both methods work by injecting a current into the ground through two electrodes and measuring the voltage drop across two more. Different materials conduct electricity differently — solid bedrock is highly resistive, weathered rock is moderate, and water-saturated fractures and clays are low resistivity. The resulting profile typically reveals three to five layers in northern Ghana: topsoil, weathered basement, partly weathered and fractured basement, the fractured aquifer itself, and finally fresh (unfractured) bedrock.

What you're looking for:

- A **low-resistivity anomaly** at depth that suggests a fracture zone — not a clay lens.
- Adequate **overburden thickness** (the weathered layer above the fracture) — this contributes to storage and yield.
- A **decreasing resistivity trend** from overburden to bedrock, which in our experience correlates with productive boreholes in this region.

A good geophysicist will produce a short report identifying candidate drilling points ranked by probability of success. Hire one. The cost of the survey is small relative to the cost of a dry hole, and **dry holes are the single most expensive mistake in this work**. Quality siting meaningfully improves your success rate — in our experience, it's the difference between most holes hitting water and a coin flip.

Feasibility: sometimes the answer is “not yet”

The resistivity survey doesn't just tell you where to drill. It tells you whether you can drill there at all, given the constraints you're working with.

In very remote communities — exactly the ones we prioritize — there is often no electrical grid within kilometers. If the survey shows a productive fracture sitting deep, that's unreachable with a hand pump. A solar-powered submersible system can do it, but it adds significant cost and creates an ongoing maintenance dependency that's hard to support in a community with no grid power, no nearby technicians, and no spare-parts supply chain.

In those situations we've had to make hard calls:

- **Wait for grid extension.** In some areas, the Ghana government is gradually extending electricity to underserved communities. If a borehole here needs an electric pump and the grid is expected within a reasonable horizon, sometimes the right call is to commit to the community but delay drilling until power arrives.
- **Shift the site closer to existing infrastructure** — a main road, a market town, an electrified neighboring village — at the cost of asking the community to walk further to fetch water. This is a real trade-off and the community should be part of the conversation.
- **Postpone.** If neither hand pump nor solar can work here, and the grid isn't coming, the honest answer is to allocate the project elsewhere and come back when the situation changes. A charity that can't say “not now” will eventually spend donor money on water points that don't function.

A good resistivity report, combined with an honest read on the local infrastructure, is what makes that decision possible.

5. Step three: drilling

Once you have a target, you contract a drilling company. In northern Ghana, this almost always means a truck-mounted air rotary or DTH (down-the-hole) hammer rig capable of cutting through crystalline basement. There are reputable contractors based in Tamale and Wa; vet them carefully and ask for references on previous boreholes — including ones that failed.

A few principles on depth:

- **Don't stop short.** A borehole that's only 10–12 meters deep is essentially an expensive hand-dug well. It will be vulnerable to seasonal water table drop and surface contamination. The minimum useful depth in this region is roughly **15–20 meters**, and that's only if you've genuinely hit the fracture aquifer. In practice, productive boreholes in northern Ghana commonly land between **40 and 80 meters**, and in some areas considerably deeper.

- **Don't drill blind past the target.** Once you've intercepted a productive fracture and the yield is good, going deeper doesn't help — and can compromise water quality if you cross into a zone with higher mineralization.

- **Trust the driller's read on the cuttings.** A good driller can tell you in real time what they're cutting through, how much water is coming up the hole, and whether you've hit a fracture or just a wet zone with low yield. Their judgment in the field, combined with the geophysics report, is what determines final depth.

Striking a fracture does not guarantee water. A low-resistivity anomaly might be a fracture filled with clay rather than water, or a fracture with poor connectivity to recharge. You can do everything right on the siting and still come up dry. Budget accordingly: assume some holes will need to be re-sited, and never commit to a community with a single attempt.

After drilling, the borehole is **cased** (typically PVC) and **gravel-packed** in the screened section to prevent collapse and filter sediment. A **test pump** is run for several hours to measure sustainable yield. The yield threshold for a community water point depends on population, but you generally want enough sustained flow to support continuous community use without drawing the well down — your driller and a hydrogeologist can advise on the specific number for your site.

A note on timing. Roads to remote communities in northern Ghana become impassable for heavy drilling rigs during the peak of the rainy season, especially July through September. In practice you have a working window from roughly November through May. If you commit to a project in June, expect to be drilling in November. Plan accordingly, because community trust erodes fast when promises slip.

6. Step four: hand pump vs. electric pump

This is one of the most consequential decisions you'll make, and it should be driven by depth, community size, and maintenance capacity — in that order.

Our default: wired-in electric, with hand pumps where electric isn't viable

Our preference, where it's possible, is a wired-in electric pump connected to grid power. Throughput is higher, users don't have to work a hand pump for every container of water, and the maintenance picture — while more technical than a hand pump — is more predictable than solar in the long run.

That said, the grid does not reach many of the communities we work in, and may not for years. So the real-world hierarchy of choices for us is:

4. **Wired-in electric pump** where the grid is present or imminent.
5. **Hand pump** where the depth and population allow it and grid power isn't coming.
6. **Solar-powered electric pump** as the engineered fallback when the depth or population rules out a hand pump and grid power isn't available.

That last option is sometimes the only one that works. When it is, it's worth doing — but it's a more expensive system to keep running, and that has to be planned for from day one.

Hand pumps

The two dominant models in Ghana are:

- **Afridev** — the workhorse for shallow-to-moderate depth installations. Designed for **VLOM (Village-Level Operation and Maintenance)** — most repairs can be done by trained community members with basic tools. Manufacturer ratings cover deeper installations, but in our experience the effective ceiling for sustained community use without exhausting pumpers is shallower than the spec sheet suggests.

- **India Mark II** (and the Ghana-Modified India Mark II, which addresses corrosion issues in local water) — heavier-duty, used at greater depths. Maintenance is more centralized than the Afridev.

For each model, talk to the manufacturer and to local technicians about the real-world depth ceiling for your specific community — particularly how many people will be using the pump and how often. Pump effort that's manageable for a small village can be punishing in a larger one.

Advantages of hand pumps:

- Lowest capital cost.
- No electricity or fuel dependency.
- Repairable at the community level, especially the Afridev.
- Highly resilient. A well-maintained hand pump can run for many years.

Disadvantages:

- Throughput is limited — you can only move so much water through one pump in a day, which constrains how many households one borehole can serve.
- Effective depth ceiling.
- Maintenance still requires a functioning community structure (a WASH committee, a pump caretaker, and a small ongoing fund for spare parts). Without that, even the most reliable pump will eventually fail and stay failed. Non-functionality rates on hand pumps across rural Africa are high, and almost always trace back to maintenance, not the pump itself.

Electric (submersible) pumps

If your borehole exceeds the practical depth for a hand pump, or your community is large enough that hand-pump throughput becomes a bottleneck, you're looking at a submersible electric pump — wired into the grid where possible, solar where it isn't, often with a small elevated tank and a few tap stands.

Advantages:

- No effective depth limit (within reason).
- Much higher throughput; supports larger populations and multiple distribution points.
- Easier on users (turn a tap, fill a container).

Disadvantages:

- Significantly higher capital cost.
- Maintenance is more technical. A blown controller or a failed pump motor is not a village-level repair.
- For solar systems, theft of solar panels is a real risk and has to be designed against.
- Long supply chains for replacement components, especially for solar-specific parts.

Our rule of thumb: wired-in electric where the grid will support it, hand pump as the next-best default, solar only when neither of the above is workable. Some of the saddest sites we've visited are abandoned solar systems where one component failed and no one had the budget or expertise to fix it. A working Afridev beats a broken solar pump every day of the week.

7. Step five: slab and apron construction

Once the borehole is drilled, cased, and tested, the surface infrastructure goes in. This is the **sanitary slab and apron** — the concrete platform that surrounds the wellhead, channels water away, and prevents surface contamination from re-entering the borehole.

A proper slab includes:

- A **concrete platform** (typically 2–3 meters in diameter) sealed to the well casing.
- A **drainage channel** carrying spilled water at least 5–10 meters away from the wellhead to a soakaway pit.
- A **cattle trough** offset from the platform, fed by the drainage — this matters in pastoral communities and reduces the temptation to bring livestock onto the slab itself.
- A **fence** around the immediate area, typically chain link or local materials, to keep animals off the platform.

Don't skimp here. A poorly constructed apron will crack, allowing surface water — and whatever's in it — back down along the casing. We've seen functional boreholes effectively poisoned by a bad slab.

8. Step six: water quality testing

Do not commission the well for drinking until the water has been tested. This is non-negotiable, and “the driller said it tastes fine” is not a substitute for laboratory analysis.

At minimum, test for:

- **Bacteriological contamination** — total coliforms and E. coli. Should be zero in a properly sealed borehole; if they're present, you have a casing or apron problem.
- **Salinity and TDS (Total Dissolved Solids)** — should be well within the WHO drinking-water guideline. Shale formations and certain weathered zones can produce brackish water that's technically “available” but unhealthy to drink long-term.
- **Fluoride** — this is a real issue in parts of northern Ghana. Parts of the Upper East have documented fluoride concentrations above the WHO limit, which causes dental and skeletal fluorosis with chronic exposure. Test for it.
- **Iron** — high iron isn't acutely dangerous, but it discolors water, stains laundry, and tastes bad. Communities will often abandon a high-iron borehole and go back to surface water, which is a worse outcome.
- **Arsenic** — particularly important in or near mining communities and the Birimian geological belt.
- **pH** — should sit in the WHO drinking-water range. Low pH water is corrosive to pump components, especially galvanized steel.

A basic field kit can check pH, conductivity, TDS, and turbidity on-site. The rest needs a proper lab — the **Council for Scientific and Industrial Research – Water Research Institute (CSIR-WRI)** has facilities in

Accra and Tamale, and **Community Water and Sanitation Agency (CWSA)** regional offices can usually point you to accredited labs. Budget for this in every project.

If a parameter comes back out of range, you have decisions to make. Mild fluoride or iron can sometimes be addressed with treatment at the point of use. Severe contamination usually means the borehole is unsuitable for drinking and should be repurposed for livestock or irrigation, with a fresh hole drilled elsewhere. This is painful but necessary. We've seen communities continue to use known-contaminated boreholes simply because the alternative was the river, and the long-term health consequences are real.

9. What it should actually cost

A question we get often from new charities is “how much should this all cost?”

The honest answer depends on depth, geology, remoteness, and how much infrastructure has to be brought to the site. But as a working baseline, **a complete deep borehole project in northern Ghana with a hand pump can be delivered for roughly $3,500 to $6,000 end-to-end** — geophysics survey, drilling, casing and gravel pack, pump and installation, slab and apron construction, water quality testing, and community handover all included.

A few things will move that number up:

- **Inflation and supply-chain volatility.** Cement, fuel, steel, and pump components have all moved meaningfully in recent years, and the cedi adds another layer of variability. Treat the range above as a current baseline, not a permanent one.
- **Extreme remoteness.** Communities far off the paved road cost more in fuel, equipment mobilization, and time. The most remote sites can sit well above the range.
- **Engineered redundancy.** Building in backup systems — for power, pumping, or storage — adds cost up front but reduces failure risk later.
- **Solar systems.** A solar-powered submersible setup is meaningfully more expensive than a hand-pump installation, typically two to three times the baseline depending on the tank, distribution network, and panel array.
- **Maintenance budgeting.** A capitalized maintenance fund — and the spare-parts and training pipeline behind it — is part of what makes a well last. We strongly recommend including it in the project budget rather than treating it as an afterthought.

If you're being quoted significantly more than this for the same kind of project in the same region, ask where the difference is going. Some of it can be legitimate — overhead, monitoring and evaluation, larger pumps, additional community infrastructure. But a lot of it is organizational bloat: layers of administration, expat salaries, branded vehicles, conference travel, marketing budgets. Donors deserve to know where their money goes, and a useful test is the ratio of dollars donated to wells in the ground.

At Savannah Water Project our model is that every donated dollar reaches the field. Members of the team pay their own travel costs out of pocket. We keep our operational footprint as light as we can. None of this is meant as a criticism of organizations that operate differently — there's good work being done at every scale, and large agencies can do things small ones cannot. But for a charity starting out, we'd encourage you to ask hard questions about your cost structure from day one, because the answers get harder to change later.

10. Longevity and ongoing care

A well-sited, properly drilled, well-maintained borehole in northern Ghana can serve a community for decades. The fracture aquifer is recharged annually by the rainy season, and unless the regional water table drops dramatically — which can happen if overuse outstrips recharge across a catchment, or if upstream development changes the recharge dynamics — the supply is durable.

The most common failure modes are not the geology but the human systems around it:

- **Pump failure from lack of maintenance.** This is the dominant cause of non-functional water points across rural Africa. Build a WASH committee, train caretakers, and capitalize a spare-parts fund before you leave.
- **Wellhead contamination from a degraded apron.** Inspect and repair the slab annually.
- **Yield decline** from siltation of the screened section or from regional drawdown. Periodic re-development by a contractor can recover yield in many cases.
- **Salinity or contamination changes over time.** Rare, but worth re-testing every few years.

Before you leave a site, make sure the community knows where to source spare parts — there are dealers in the regional capitals who carry Afridev components, and the link between the village caretaker and the nearest dealer is one of the most important things you can establish at handover. Record GPS coordinates of the borehole, document the depth and water quality test results, and keep a copy for your own records and one with the community.

A well is not a one-time gift. It's the start of a relationship with a community, and the projects that last are the ones that treat it that way.

A short checklist

If you're starting your first project, here's the sequence in a single view:

7. Identify a community through a trusted local partner. Prioritize remoteness and need. Visit more than once before committing.
8. Confirm community buy-in, agreement on governance, and a maintenance contribution.
9. Commission an electrical resistivity survey (VES and/or ERT) by a qualified geophysicist.
10. Use the survey, together with an honest read on local infrastructure (grid access, road conditions), to decide whether the site is feasible — or whether to wait, shift, or move on.
11. Contract a reputable drilling company with experience in northern Ghana basement rock.
12. Drill, case, gravel-pack, and test-pump the borehole during the dry-season working window.
13. Decide on pump type based on grid access, depth, population, and maintenance capacity. Default to wired-in electric where the grid will support it, hand pump where it won't, solar only as a last resort.
14. Install the pump and construct the sanitary slab, apron, drainage, and fencing.
15. Test water quality at an accredited lab before commissioning.

16. Train a WASH committee and pump caretakers; establish a spare-parts supply chain; capitalize a maintenance fund.
17. Hand over the water point with documentation — GPS coordinates, test results, parts supplier contacts — and a follow-up schedule.

Savannah Water Project is a 501(c)(3) nonprofit (Tax ID 85-2030151) bringing clean water to villages in northern Ghana. If you're starting a similar project and want to talk through any of this in more detail, get in touch — we'd rather help you succeed than watch another well go dry.