SPECIFICATION AND DRAWINGS FOR
THE POUNDER RIG

a human-powered drill rig
for constructing shallow small diameter wells
for domestic and agricultural water supply

developed in Uganda and UK
through project funding and support from
Government and People of Uganda, DFID, Danida, Sida, and Unicef

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July 2000
First Edition
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ABSTRACT

Despite all the efforts to date to improve access to safe domestic water supply and sanitation in less developed countries, still between 1 and 3 billion people lack these essential services. The causes of this situation are complex, and are not to be resolved through technology alone. However, it is widely accepted that two broad sets of conditions (among others) need to be in place in order for the situation to improve – technologies which are affordable and manageable by user communities, and the institutional arrangements by which communities can gain access to such technologies.

This document is one contribution from one project in one country (Uganda) within which an attempt is under way to address these issues.

Part 1 describes the background, objectives, and progress to date of the project “Private Sector Participation in Low Cost Water Well Drilling”, which was initiated by Cranfield University (UK) with DFID funding. The aims of the project are: to develop, and transfer to the private sector, technology suitable for affordable shallow well construction; and to research the process of technology transfer and the conditions necessary for its success, in the context of rural water source construction.

Part 2 sets out basic operating instructions for the Pounder Rig, a low-cost, human-powered, drill rig suitable for construction of shallow water wells in a wide range of ground conditions.

Part 3 is the specification of all the components of the Pounder Rig, referenced to the full engineering drawings which follow in Part 4.

ACKNOWLEDGMENTS

The Project is funded by the UK Government Department for International Development (DFID), with supplementary funding from Danish International Development Assistance (DANIDA). Partnership arrangements with Government of Uganda Directorate of Water Development and the local Government of Mpigi District have provided funding through the Water and Environmental Sanitation (WES) Programme, funded jointly by GoU, Swedish International Development Assistance (SIDA), the United Nations Children's Fund (UNICEF), and the Government and People of Uganda. All these funding sources are gratefully acknowledged.

A great many individuals and organisations, too numerous to name, have contributed through ideas, encouragement, and interest. They too receive the grateful thanks of the Project Team.

The Project Team consists of Dr Richard Carter (Project Manager), Eng Kerstin Danert (Team Leader – Uganda), Mr Peter Ball (Drilling Consultant), Mr Ezron Rwamwanja (Community Water Supply Specialist), and Mr Jamil Ssebalu (Small Business Specialist).
PART 1 - PRIVATE SECTOR PARTICIPATION IN LOW COST WATER WELL DRILLING

The last two decades of the twentieth century saw an increasing international determination to end the scandal of extreme poverty. Approximately one fifth of the planet's people experience grossly inadequate services, opportunities, and freedoms. One aspect of this situation is the inadequacy of water supply infrastructure, with corresponding consequences for health, as well as the excessive time and energy which women and children in particular have to devote to water collection. Universal access to safe water, near to the home, together with the practice of safe excreta disposal and changes in hygiene behaviour, are the focus of a new drive toward poverty elimination as the twenty first century begins.

Although much good practice was developed during the International Drinking Water Supply and Sanitation Decade (the 1980s), as well as during the 1990s, the problem remains: how to scale up the good practices implemented in relatively small projects and programmes, to meet the urgent needs of still rapidly growing populations. Previously inaccessible funds and forces need to be released to meet the enormous challenge which still remains.

Arguably the biggest step forward in water and sanitation development in the twentieth century was the realisation that only participative and community-managed approaches would work. Governments and NGOs simply lacked the resources to meet a large and growing need. The implied shift in roles, of former service providers to facilitators, and of target beneficiaries to actively participating managers, is still taking place; such radical change takes at least a generation to become effective.

At the turn of the century, the private sector is increasingly being looked to as a possible means of meeting part or all of the development targets. In the water supply sector there have been many successful, and other more controversial, experiences of private sector activity in the urban environment. The potential and success of the private sector in rural water service provision is far less evident.

It is against this background that the project “Private Sector Participation in Low Cost Water Well Drilling”, initiated by Cranfield University and DFID, was set up. The aims of the project were to investigate the potential of the small scale private sector and to facilitate its success, through development and promotion of a single technology in one country.

Project Starting Points

The project starts from the point of view that private sector providers (implementers) of rural water services, particularly the small business sector, represent a relatively untapped potential. The project sets out on the assumption that if small businesses receive manageable technologies and training in their deployment, training in good business practice, and other forms of support, they can be released to effectively implement water source construction at community level.
The project also assumes that the end users of rural water will be more likely to maintain and sustain their sources if they own them, with real ownership being achieved through the community (or farmer, or school, for example) paying the full cost of source construction.

The logic of this position leads to the need to identify or develop affordable water supply technology – affordable by both small contractors, and by the end-users.

These starting points also raise questions and issues in relation to the entire set of primary and secondary stakeholders involved in the process of private sector service provision. Central and local Governments, their policies, and the incentives (or obstacles) they create for small businesses; local Government and NGOs, and their capacities to manage private sector contractors; and communities themselves, and their adaptability to yet another set of development policies; all take on increasing prominence.

Finally the issue of regulation – encompassing construction quality control, water quality, price regulation, and consumer protection – emerges as a key issue which is crucial to the success of the privatisation of any monopoly.

**Project Aims and Objectives**

The three-year Project (1998-2001) has two overall aims:

- to develop, and transfer to the private sector, technology suitable for affordable shallow well construction
- to research the process of technology transfer and the conditions necessary for its success, in the context of rural water source construction

Put another way, the project is crucially concerned with implementation and uptake, but at the same time we wish to learn as much as possible from the process, in order to apply lessons in future either in or beyond the rural water sector.

**Technology Transfer and Uptake**

The first aim of the project is addressed through three main objectives or outputs:

- the design, field testing, and evaluation of a new manual drilling rig (the “Pounder Rig”)
- the uptake of the technology by a small number of contractors, and their use of the rig in commercial contracts
- the establishment of a sustainable means by which the rig and subsequent spare parts will be made available in country

This aim is achieved through a flexible and evolving process of participation with project partners and stakeholders. This is explicitly a learning project, not driven according to a blueprint, but initiating discussion and research of key issues and responding to the resulting findings.

**Research**

The research aim of the project uses the technology transfer and uptake process as a gateway to action research. The process of developing the technology and introducing it
into the private sector, and the concurrent investigation and learning process, are intertwined in such a way that the project informs the research, and the research informs the project. Both benefit.

The overall research question is

“what enabling conditions and external actions are necessary to stimulate and strengthen effective rural water supply service delivery by the private sector?”

In addressing this question, the research is analysing a set of key sub-sectoral aspects, as well as an equally important set of cross-cutting issues. The intention is to draw all these together in an integrated framework which can provide future guidance to projects or programmes in this or other development sectors.

The sub-sectoral aspects and cross-cutting issues being addressed at the present time are as follows:

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Project Progress

The project commenced in July 1998. After an initial period of planning and field visits, the focus country was selected in November of that year, and the Cranfield University team commenced work in Uganda. The initial project team consisted of Dr Richard Carter (Project Manager), Eng Kerstin Danert (Team Leader Uganda), and Mr Peter Ball (Drilling Consultant). The key determinants resulting in the selection of Uganda included:

- the policy environment, stressing decentralisation and privatisation
- the extensive and genuine interest and political will to make the project succeed
- the Ugandan recognition and acceptance of the inherent risks in the project

One of the first major activities was the commissioning of four individual Ugandan consultants to undertake baseline/information-gathering studies in the areas of hydrogeology, community water supply, small scale irrigation, and the small business sector. The consultants worked independently, and did not meet one another until the presentation workshop for their findings. The studies were completed in March 1999. These studies moved the foundations of the project from a basis of anecdotal evidence and professional instinct to one of (a limited amount of) hard data and wider independent professional evaluation.
During the first half of 1999, two main activities predominated: (a) design, fabrication and limited UK-based trials of the drilling technology, and (b) building up the partner base in Uganda.

The low-cost drilling technology is based on the traditional Asian manual method known as ‘sludging’. This uses a lever to reciprocate a steel pipe vertically in the water-filled borehole, and the palm of the hand of one of the operators to act as a valve, so causing the fluid in the hole to circulate up the pipe, carrying cuttings to the surface. The technology is highly effective in soft ground, and extensively used in the sedimentary alluvial basins of India, Nepal and Bangladesh. We have modified the technology to deal with conditions in African Basement regolith (i.e. the weathered mantle overlying hard crystalline rocks). Here there is the necessity to penetrate partially weathered rock fragments and hard laterite, as well as softer materials.

By the middle of 1999 equipment was ready to be air-freighted for field trials, and an agreement had been drawn up with National and Local Government for initial partnership arrangements. The centre of gravity of the project shifted from UK to Uganda.

Both up to mid 1999, and more particularly since that time, great emphasis has been placed on building relationships with a large range of stakeholders and interested parties. Although difficult to quantify and evaluate, we believe that the quality of partnerships and participation is crucial to success; lip service to these ideas is not enough.

In the second half of 1999 the prototype rig was field trialled in Mpigi District, with a total of 12 exploratory holes and 5 community water supply wells being completed, logged, and reported. At the same time during this period, a series of studies of the policy environment; small business strengths, weaknesses, and training/support needs; comparative studies of other businesses; and of community perceptions of shallow groundwater; were undertaken, preparatory to future project phases. These studies were undertaken by project consultants and Cranfield University Masters students. At the end of the year a National Forum and Workshop was held to present and receive comment on the progress and direction of the project. This was attended by 80 individuals from a wide range of organisations.

As a consequence of consultants Ronnie Rwamwanja’s and Jamil Ssebalu’s increasing involvement in, and commitment to, the project goals, they have been drawn into the project team, and now take part fully in project planning and team decisions. Furthermore, they have established an indigenous NGO, TEMBA (Technology, Mobilisation and Business Access) the explicit mission of which is to pursue the project objectives over the longer term, and provide a national base for continuing initiatives in this area.

During the first half of 2000 the project has focused on the strengthening of private contractors, through whom well construction contracts will be implemented over the mid to late part of the year. Memoranda of understanding are being developed with the District and Central Governments, to enable small Pounder Rig drilling contracts to be set up with selected contractors.

A design review of the Pounder Rig was undertaken in late 1999, and the new machine is being fabricated in early 2000. This will be air freighted to Uganda in the second half of 2000.
Before and during the process of contract implementation, there will be a focus on capacity building of both the contractors and the client organisations. In addition, work will take place with the communities which will receive the wells drilled during this period. Monitoring of all new wells drilled will continue throughout the remaining duration of the project.

In tandem with drilling and monitoring, and in conjunction with other consultants and organisations, a methodology for the siting of Pounder Rig wells has been drafted.

Partnerships and Linkages

The progress and success of the project to date has depended to a very high degree on the extent and quality of the partnerships and linkages built up within and beyond the project team. This has been brought about by a combination of mutual willingness and trust, and the investment of considerable time to build and maintain these attributes.

The team itself has been immeasurably strengthened by the addition of two National members, as described above. The establishment of TEMBA is taken as a sign of genuine local ownership of the project and its purpose, and a potentially exciting means of ensuring the sustainability of the outputs.

Relationships with National (Directorate of Water Development) and District (Mpigi) Government have been formalised through a Memorandum of Understanding, but once again the quality of these partnerships would not have been possible without the mutual desire on both sides to make a success of the project.

Capacity Building and Regulation

The key aspect of implementation over the remainder of the project is capacity building. The abilities of small contractors to function as effective, profitable businesses; of local Government clients to manage and facilitate the work of contractors; and of communities to play their part in the process; all require support and training.

Consumer protection – in relation to price, construction quality, and water quality – will be important as Government discovers its regulatory function in relation to the private sector.

Quality control of rigs and well designs will be pursued through the Uganda National Bureau of Standards.

Funding

Core funding for the period July 1998 to June 2001 has been provided through the UK Department for International Development (DFID); funding is allocated through the Knowledge and Research (KAR) programme of the Infrastructure and urban Development Division (IUDD) of DFID.
The Memorandum of Understanding linking the project to DWD and Mpigi District allows for financial and in-kind contributions by both organisations, and these have been forthcoming over the course of the project to date.

Supporting funding was agreed at the end of 1999 by DANIDA through its partnership with DWD. This fund is specifically for monitoring and training activities in relation to the new technology and private sector uptake.

Beyond the Project

The project will complete its three year DFID funding period in June 2001. At this time the research element of the project will also end, and the findings will be written up over the following months as a Doctoral thesis.

It will be important to build on the project experience and apply the research findings over the following years after 2001. It is believed that the potential for rural water supply implementation by the private sector is significant, but the enabling and nurturing of this means of up-scaling service coverage will require a longer period than the three years of the project period.
PART 2 - POUNDER DRILLING - BASIC OPERATING INSTRUCTIONS

[Note: in Parts 2 and 3, page numbers in Arabic numerals refer to the drawings in Part 4]

The Pounder Principle

To dig a hole, the most important requirement is to be able to remove spoil from the bottom of the hole and lift it to the surface. If the ground is hard, it may also be necessary to use a cutting edge and sufficient force to loosen the material at the bottom of the hole. If the ground is soft and likely to collapse, the walls of the hole may need support during construction.

The Pounder technique borrows its spoil removal method from a long practised Asian technique referred to as ‘Sludging’. It involves continuous removal of debris by filling the constructed hole with water fed from a small surface pit and inserting steel drill tube to the bottom of the hole. The pipe is then oscillated up and down by hand with the aid of a lever. On the up stroke the palm of a hand seals the pipe top and the water in the pipe is drawn upwards. The pipe is then thrust downwards with the palm lifted and water is ejected from the top of the pipe. When the pipe reaches the bottom of the hole the palm covers the pipe to seal it once more, and the pipe is lifted again. This draws water and debris from the borehole bottom into the pipe to be ejected on the next downstroke.

How does Sludging work? On the upstroke the palm of the hand creates a seal, and the water in the pipe is lifted roughly the height of the stroke. On the downstroke the steel pipe moves faster than the dropping column of water, which is held up by friction and the presence of water in the borehole. The faster speed of descent of the pipe compared to the water column results in water and debris overflowing the open end of the drillpipe.

In soft sands, clays and silts that need little cutting action holes can be ‘sludged’ simply and quickly with plain galvanized steel water pipe, simple cutting shoes and the practised hand of the driller.

The Pounder technique extends basic sludging by extending the range of soil types which it is possible to penetrate. Pounder drilling has been designed to penetrate limited thicknesses of harder, more consolidated, material which are typical of the weathered zone (regolith) over hard basement rocks. To do so it has had to develop a number of extra attributes.

- Harder ground takes more energy to break and this energy needs to be directed through hard cutting tools. The Pounder rig uses tungsten carbide buttons (tungsten carbide is the second hardest material known to mankind) set in hardened steel drillbits to enable hard formations to be efficiently cut or broken.

- When dissipating energy against a hard layer at depth in a borehole, a very strong drill string (or column of drill pipe) is needed to contain the forces and pressures developed. This means using carbon steel drillpipe which is three times stronger than conventional galvanised steel water pipe.
When penetration through harder materials is slow, it is impossible to sustain the palm of a hand to work as the suction valve for water and spoil removal. The drillpipe has to oscillate for long periods of time, and as it jars against harder material this makes the hand valve untenable. The Pounder rig replaces the hand with a robust flap valve.

Because the Pounder combines the basic sludging technique with ground cutting the drillpipe oscillation must be as energy efficient as possible. A system of counterbalancing the drill pipe weight is adopted to achieve this.

The Set Up of the Pounder Rig

Transport

The Pounder Equipment 70-001 (pp1&2) is transported on a special Trolley Frame 40-037 (p22). This frame allows the major components of the Pounder to be stored and transported. The angled trolley frame allows the Pounder to be wheeled up a pair of stout wooden planks into the body of a typical light pick-up truck 800/1200Kg capacity and simply tied down for safe transport. Close to site the Pounder can be manually wheeled about and manoeuvred into position.

Setting Up

The main components are unloaded and the Trolley Frame 40-037 unpinned from the Chassis 40-025 (p9). The site is roughly levelled and a robust timber plank (1m long by 200mm wide by 40-50mm thick) is placed on firm soil 0.5m from the intended borehole centre, and levelled along its length. This is the main foundation for the set-up. The centre of the chassis is positioned on this timber and two other timbers are set, one under each end, to allow the corner jacks to level the chassis. The chassis should firmly rest on the central timber and then be levelled along its length to prevent bending or overloading the chassis steelwork when drilling. With the chassis properly level, drilling water will drain off the frame to the settling pit.

At the borehole end (the end with the steel tray) the main settling pit is dug 800 x 800mm square by 300-400mm deep, and a 150mm deep by 150mm wide channel dug down the side of the chassis to the borehole.

The Pivot Tube 40-009 (p33) is then placed vertically in the socket in the centre of the chassis, the Lever 40-020 (p3) positioned in the yoke at the top of the pivot tube, and pivot bolt 10-077 is fitted. The 4 support cables 40-010 (p34) are then hooked into the 4 eyes on the chassis and evenly tensioned. The Sludging valve 50-027 (pp37&38) fitted with 1m length of BP drillpipe 20-024B (pp76&77) is hung on the Pivot tube over the BP Table Bush (p56). The support cables can be adjusted to perfectly align the drillpipe with the bush. Once again, note that the chassis must be level both along its length and width to allow water to flow correctly – the support cables must not be used to adjust a chassis which is not initially set level.
Setting Conductor Casing

Assemble the **Conductor Casing 20-027** (p66) by screwing on a **Casing Shoe 20-015** (p67) and the **Casing Top 20-011** (p57). Align the slot in the casing with the feed trench from the settling pit.

In most cases the conductor casing is intended to be driven into place to ensure it is both vertical and firm in the top soil. To produce an acceptably straight and plumb hole requires that the conductor casing is set correctly. Depending on the soil, this can be achieved in a number of ways.

- In soft soils the conductor casing can be simply driven without pre-drilling.
- Alternatively, a hole can be sludged to a nominal depth of 1m and then the conductor casing driven into this hole taking care it is driven both central to the chassis table hole and kept vertical.
- Harder ground might require the hole for the conductor casing to be dug or drilled before the chassis is erected.

Casing can be hammered lightly by connecting the **BP Casing Driver 20-023** (p54) and oscillating the lever bar. This can be done whilst simultaneously drilling with a bit fitted to a piece of BP Drillpipe of same length as the casing.

Additional 1 metre lengths of **Casing 20-022** can be used to deal with particularly soft or water-logged soil close to the surface. A pumped supply of water (eg from a treadle pump) can be introduced into the annulus between the casing and drillpipe to allow sludging to commence.

**Commencement of drilling**

In most cases drilling should commence at the minimum diameter of 80mm to allow logging of the formation and to establish the depth and likely yield of groundwater. Samples of the formation should be taken every metre and anything relevant to the hole construction should be recorded on the driller's log. This initially might just be an exercise book – the essential requirement is to record everything in writing. Type of soil, its relative hardness, any water loss into it, and time taken to drill, are all items that are useful to record.

Having drilled an exploratory hole to the specified depth it is relatively easy to ream out the hole (ie enlarge the hole diameter) to a diameter suitable for pump installation.

The lever is operated by a pair of pull ropes, **10-063**, fitted one to each end and led under the rollers on the chassis. The ropes can be tied at different points on the lever. Drillcrew can comfortably pull these ropes to induce the required oscillation. The positioning of the ropes and the choice as to whether to use the counterbalance barrel, **40-050 p36**, are varied as required, in order to keep the drilling action comfortable on the drillcrew and the drilling action working efficiently.
The Sludging Valve 50-027 (pp37&38) requires the leather covered valve to sit and seal perfectly on the valve seat. The valve needs periodic cleaning with the finger if the sludging action falters.

When drilling harder material the drillstring needs to be rotated slowly on the up stroke by gently pulling an Endless Rope Sling 40-008 wrapped around the drillpipe. This is to ensure that the 69mm Button Drilling Bit 30-007, 60mm 30-008, 82mm 30-009 or 100mm 30-010 (pp68,69,70&71) is constantly drilling new ground and that the drillpipe remains threaded tightly. Rotation must always be clockwise – ie in the direction required to tighten the threads.

Two long Aluminium Handles 50-042 (p53) can be threaded into the Sludging Valve 50-027 (pp37&38) to facilitate driving the pipe downwards. This improves the sludging stroke, so allowing a greater volume of water to be pushed up through the pipe, and imparts more energy into the cutting action. The key to efficient operation is to use the handles to induce speed on the downstroke only while not expending excessive energy driving the pipe hard into the rock. This is tough work on the drillcrew’s hands as well as the Pounder equipment.

The Effect of Water Level in the Hole

The most efficient sludging water flow is seen when the sludging valve is close to the water level. This is why drilling is progressed by use of 1metre lengths of BP drillpipe 20-024B (pp76&77). Add each individual 1m pipe (2 supplied) then remove both and replace with a 3 metre length 20-024A (pp76&77).

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**Head of water prevents collapse of hole**

The flooded hole also serves to support the borehole walls from collapse. This works if the water level in the borehole is constantly maintained at least 3m higher than the groundwater rest level in the formation. The pressure induced by 3m head of water is considered the minimum necessary to support unconsolidated borehole walls from collapse. This is an important feature of the Pounder and influences site selection.

In the event of a high water table (ie shallower than 3m) in unconsolidated ground steel or plastic casing needs to be set to support the borehole walls.

Water addition is best done by keeping a 200 litre open topped steel drum at least half full adjacent to the settling pit. This acts as storage, allowing a bucket to be used to quickly top up the settling pit. The larger the settling pit, the less topping up will be needed, but a large pit will require more water at the initial filling. Additions of water must equal the volume of losses – tanks and pits are only buffers.

**Preventing undue water loss into the formation.**

It seems strange to have to carry water to construct a borehole at the very place that water is needed. However, water is available in most places in the quantities needed for drilling.
Drilling requires a steady regular supply particularly when drilling unconsolidated ground, in order to guarantee borehole wall support.

As the ground formation is drilled above the water rest level it is likely that some water loss will occur and a few bucketfuls will need to be added to the settling pit to keep the hole flooded. When drilling into permeable water bearing formations water will flow out of the settling pit into this formation. The best action is simply to make up all losses by adding water to the settling pit, so keeping the borehole flooded. However this may not always be feasible – for instance where water is being hand carried to site and water carrying capacity cannot keep up with demand.

Where it is known that the borehole has not yet reached the water table it is possible to add fibre such as saw dust, milled grain husks or cow manure to the water flowing into the borehole. This fibre will effectively be drawn to the area of loss, bridging the permeable layer, and so limiting water loss. A few handfuls to several bucketfuls might be required for this to have an effect. These materials should not be used in the portion of the hole where screen will be set, as the fibre will be very effective in blocking the screen slots and prevent water entering this part of the well.

If the formation below the water table is unstable and soft to drill (eg sand or gravel) then the choice is to case the hole with temporary casing or to use a drill mud additive. The best type of additive is a polymer, mixed with water at 0.5-1.0% dilution and given at least 30 minutes to thicken – a good use of the 200 litre storage barrel. This mixture is then added to the settling pit. Depending on how viscous or thick the polymer mix becomes it might be necessary to extend the settling pit to ensure any clean settled fluid flows back down the borehole.

The rule about supporting a hole with 3m head of water applies throughout the drilling operation. This might require using polymer to keep a hole full overnight. Polymers are particularly good for this use as their viscous effects break down effectively between 24 and 72 hours after mixing.

Other additives are used in the drilling industry, the most popular being the natural clay, bentonite. This requires 12-24 hours to build viscosity fully and will not break down in the same way as the polymer, making it unsuitable for practical use and difficult to remove from a hole after well screen is positioned.

With the Pounder the best water producing well will be created by making up all the losses with clean water – keeping the water producing formation largely unblocked. The best approach therefore is to ensure a good supply of clean water for drilling. To achieve this, consideration could be given to drilling when rainwater is lying in sufficient quantities. For example a well prepared village or client might dam a convenient depression near the potential drill site weeks in advance of the drilling operation in order to conserve energy which would otherwise be spent in water carrying. A treadle pump could be used to move water efficiently and steadily.

Drilling Consolidated Ground with Water Losses

Drilling into weathered rock or through and around hard layers can result in water losses. Those above the water table can be plugged with fibre, or alternatively cement grout (50kg
sack mixed with 27 litres of water) can be used to permanently plug a fissure that is
taking a high volume of water away. This should be left for 12 hours to set and then drilled
out.

If a fissure or permeable layer is met below the water table, use of blocking or cementing
materials should be avoided. Once more these will permanently block off the water supply
flowing through the well screen when it is set. The best strategy in this case is to let the
natural water table take over – no head of water is required to support the hole from
collapse in this consolidated ground.

The Pounder rig can be fitted with one or a series of Clack Valves 50-012, 50-013 & 50-014
p61 to suit pipe BP, NP & HP. At least one needs to be fitted at the bottom of the pipe or
below the water table, and this will allow the water to be lifted up and through the sludging
valve if the supply is prolific enough and the strata being drilled become well mixed in the
water. In low yielding holes the drillpipe might need to be tripped out (ie removed from the
hole) to clean out an accumulation of drilling debris held behind the clack valve. For this
reason a short length of NP pipe or HP pipe 20-004, 20-005 & 20-006, p77, of larger
diameter and so having a large storage volume, can be used directly behind the drillbit.
This is a most effective drilling method as no debris is smeared against the borehole walls,
inducing the cleanest, least contaminated, method of well construction.

In-Situ Yield Testing

To check well yield an adapted hand pump piston, Test Pump Arrangement 50-047 (p58),
can be inserted inside the BP drillpipe on standard 12mm hand pump rod and the
oscillating drill stroke can be used to pump the well. There is a choice of footvalve that can
be used with the Test Pump piston 50-044 (p78). If a clack valve is already fitted into the
drill string this will work. If no clack valve is being used the Footvalve Receiver 50-045
(p79) can be fitted inside a drillpipe below the water rest level the Footvalve 50-046 (p80)
can then be dropped into place and then after pumping can be removed by coupling the
recovery threads on the test pump piston and footvalve. The water flow away from the
borehole can be channelled and its flow measured in a bucket. This will enable a well
yield to be estimated whilst drilling to determine when drilling has reached sufficient depth
or whether more water is becoming available.

Handling Drillpipe

The Pounder drillpipes are high quality carbon steel pipes with fine threaded couplings.
They should be carefully stored to prevent damage to ends and kept straight. They should
never be used as lever bars or misused for tasks such as loading the Pounder trolley into
the back of the pick-up truck.

Threads should be wiped clean before threading up with a little grease applied to prevent
abrasive wear.

Pipes are added in 1metre lengths, then the two 1m lengths are removed to allow a 3m
length to be added. The pipe can be held at the table with BP Lifting Spanner 20-010
(p74) held firmly in place. Two Stillsons 10-018 are required to break the drillpipe – one to
hold the lower joint and the other to work the pipe above the ground. Good quality pipe wrenches are required with hard and sharp jaws to grip the carbon steel drillpipe bodies.

To remove 3 metre long drillpipes the lever bar can be swung sideways (see 70-001 Pounder Rig Assembly, p2) and the BP lifting spanner used to lift the drillpipe out of the ground. Do not lift more than 3metres length above the chassis floor.
## PART 3 - POUNDER RIG SPECIFICATION

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<td>6/10 metre rope - large &amp; comfortable diameter for hand pulling</td>
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PART 4 – THE POUNDER RIG DRAWINGS

Please note that the scale drawings which follow will not automatically reproduce to correct scale when printed. However, all individual parts drawings are dimensioned. Only assembly drawings are not dimensioned. When printed to correct scale the outer box around an A4 drawing is 190mm by 277mm and the outer box around an A3 drawing is 400mm by 277mm. Each drawing clearly has A4 or A3 shown in the top right hand corner.
40-025 Chassis Complete

50-027 Sludging Valve

40-020 Lever Complete

40-020 Lever swung & pinned off centre to allow 3m drillpipe to clear

40-049 Counterbalance Barrel (empty steel barrel not supplied)
MATERIAL: 5 x 25 x 3mm RHS 43C

General Tolerances:
Sawn & Sheared + or - 1mm
Machined + or - .1mm
Unless Specified Different

NOTES

DRAWN BY: Peter Ball
DATE: 26.4.2000
TITLE: Lever Spokes
SCALES: Full
DRG No.: 40-019

19 JUN 2000

SHT. 1
OF. 1
General Tolerances:
Sawn & Sheared + or - 1mm
Machined + or - .1mm
Unless Specified Different

MATERIAL: 50 x 50 x 3mm RHS 43C

NOTES
DRAWN BY
Peter Ball
DATE
26.4.2000
SCALE:
Full
DRG No.
19 JUN 2000

TITLE
End Bars
Pounder Rig

DRAFT

SHR. 1
OF 1
General Tolerances:
Sawn & Sheared + or - 1mm
Machined + or - .1mm
Unless Specified Different

MATERIAL: 50 x 50 x 3mm RHS 43C
Turn in Lathe - facing both ends square to bore

3mm x 45° Chamfer

NOTES
From 80 Square Mild Steel Square

DRAWN BY: Peter Ball
DATE: 8.1.2000
SCALE: Full
DRG No. 40-026

TITLE
Pivot Socket
Pounder Rig

19 JUN 2000
NOTES
From Mild Steel Tube
168Ø Stock

DRAWN BY: Peter Ball

DATE: 19.2.2000

SCALE: 1:2

TITLE: Table Tube

Pounder Rig

19 JUN 2000

DRG No. 40-027

DRAFT

SHR. 1
OF. 1
### Notes
From 60 x 10mm Mild Steel Flat Bar

### Drawn By
Peter Ball

### Date
19 Jun 2000

### Title
Roller Supports
Pounder Rig

### DrG No.
40-031

---

**DIAGRAM:**

- Dimensions: 200mm x 200mm
- Round hole diameter: 12.4 mm

---

**SCALE:**
NTS

---

**DRAFT**
Notes:
Base material 30AF Hexagon mild Steel Bar

Drawn by: Peter Ball
Date: 19 JUN 2000

Title: Bearing Pin
Pounder Rig

Scale: 1:5
Drg No.: 40-032
Material: 3mm Mild steel plate

NOTES

DRAWN BY: Peter Ball
DATE: 26.4.2000
SCALE: Full
DRG No. 40-034

TITLE

Gusset
Pounder Rig

19 JUN 2000
SHT. 1
OF. 1
MATERIAL: 50 x 25 BMS Flat
50 x 10 BMS Flat

NOTES

DRAWN BY: Peter Ball

DATE: 19 JUN 2000

SCALE: Full

DRG No.

TITLE: Table Bush Clamp

Pounder Rig

40-048 & 049

SHT. 1

OF 1
Material: M30 x 200 long Studding
25 x 5 x 200 long Studding
160 x 100 BMS

NOTES
General Tolerances:
Sawn & Sheared + or - 1mm
Machined + or - .1mm
Unless Specified Different

DRAWN BY: Peter Ball
DATE: 26.4.2000
SCALE: Full
DRG No. 40-035

TITLE
Jack Screw
Pounder Rig

DRAFT
Material: 60 x 10 BMS Flat

NOTES

DRAWN BY: Peter Ball

DATE: 26.4.2000

SCALE: 1:2

DRG No. 40-047

19 JUN 2000

TITLE
Jockey Wheel Mount
Pounder Rig

SHT. 1
of. 1
Weld 10-035 M30 Nut to 10-033 dia washer

3mm x 45° chamfer

NOTES
From M30 x 50 High Tensile Studding

DRAWN BY: Peter Ball
DATE: 19 JUN 2000
TITLE: Wheel axle
Pounder Rig

19 JUN 2000
40-033
Material: 40 x 40 x 3mm RHS 43C

NOTES

DRAWN BY: Peter Ball
DATE: 26.4.2000
SCALE: Full
DRG No. 40-039

TITLE
Angle Brace
Pounder Rig

19 JUN 2000
Material: 40 x 10 x 120 BMS flat

NOTE

DRAWN BY: Peter Ball
DATE: 26.4.2000
SCALE: Full
DRG No.: 40-040

TITLE
Brace Mounts
Pounder Rig

SHT. 1 OF 1
Material: 40 x 10 x 200 BMS flat

NOTES

DRAWN BY: Peter Ball
DATE: 26.4.2000
SCALE: Full
DRG No. 40-041

TITLE
Brace Locators
Pounder Rig

19 JUN 2000

SHT. 1
OF. 1
Material: 60 x 10 x 200 BMS Flat Bar

NOTES

DRAWN BY: Peter Ball

DATE: 26.4.2000

SCALE: 1:2

TITLE Long Prop Mount

Pounder Rig

40-042

19 JUN 2000

DRG No.

sh. 1 or. 1
Material: 60 x 10 x 136 BMS Flat Bar

DRAFT

NOTES

DRAWN BY: Peter Ball

DATE: 26.4.2000

SCALE: Full

DRG No.: 40-043

19 JUN 2000

TITLE

Short Prop Mounts

Pounder Rig

SHT. 1

OF. 1
390 OD Rolled ring from 122.2 long 80 x 10 Flat - 3mm gap for weld

1.63 long 40 x 10 Flat.

1"Ø Drilled Hole

3mm x 45° Chamfer

Centralise in jig 41.001 - and weld in spokes all around

80

70.0

40.0

10.0

DRAFT

NOTES

DRAWN BY: Peter Ball

DATE: 20.5.2000

SCALE: 1:5

DRG No. 40-044

19 JUN 2000

TITLE: Steel Wheel

Pounder Rig

shrt. 1

of. 1
Material: 40 x 40 x 3mm RHS 43C

NOTES

DRAWN BY: Peter Ball

DATE: 26.4.2000

SCALE: full

DRG No. 40-045

19 JUN 2000

TITLE

Cross Brace
Pounder Rig

sh. 1
of 1

32
NOTE: Locate lock nuts in single plane and weld to assemble. Align fork with location arm!

BQ wireline - 55.6 OD x 2090 long

10-066 2" BSP Lock Nuts
40-010 Support Cables
40-015 Stabiliser Tube
10-066 2" BSP Lock Nut

DRAWN BY: Peter Ball
DATE: 27.4.2000
TITLE: Pivot Tube Complete
Pounder Rig
DRO NO.: 40-009
Weld 3mm wings on outside only - locate in jig.

MATERIAL: 3mm MS plate & 2" BSP Pipe Iron Coupling

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NOTES
From 25 x 5 Bright Mild Steel

DRAWN BY
Peter Ball

DATE:
17.2.2000

SCALE:
Full

TITLE
Spacers
Pounder Rig

DRG No.
50-031

19 JUN 2000
NOTES
From 25 x 5 Bright Mild Steel

DRAWN BY: Peter Ball

DATE: 17.2.2000

SCALE: Full

TITLE Valve Support
Pounder Rig

19 JUN 2000

DRG No. 50-032

SHT. 1
OF 1

5.0

25.0

100.0
NOTES
From 2mm Mild Steel Plate

DRAWN BY:
Peter Ball

DATE:
17.2.2000

SCALE:
Full

DRG No.

TITLE
Hinge Cover
Pounder Rig

19 JUN 2000

50-034
NOTES

From 2mm Mild Steel Plate

DRAWN BY:
Peter Ball

DATE:
17.2.2000

SCALE:
Full

TITLE
Valve Cover
Pounder Rig

DRG No.
50-035
NOTES
Flame profiled from 10mm mild steel plate

DRAWN BY:
Peter Ball

DATE:
16.2.2000

SCALE:
1:2

TITLE
Valve Top
Pounder Rig

19 JUN 2000

DRG No.
50-036

DRAFT
NOTES
Sheared 3mm
Mild steel Plate

DRAWN BY:
Peter Ball

DATE:
16.2.2000

SCALE:
1:2

TITLE
Valve Sides
Pounder Rig

19 JUN 2000

DRAFT

50-037
NOTES
From 35+ BMS stock - Fully Machined and then case hardened

DRAWN BY:
Peter Ball

DATE: 16.2.2000
SCALE: 1:5

TITLE
Inner Bush
Pounder Rig

19 JUN 2000

50-038
25.05 - 25.10

45° x 1mm chamfer all corners

30.05 interference fit in reamed hole rel part no 50-036

NOTES
From BMS stock - Fully Machined and then case hardened

DRAWN BY:
Peter Ball

19 JUN 2000

DATE:
16.2.2000

SCALE:
1:5

TITLE
Outer Bush
Pounder Rig

DRG No.
50-039
NOTES
Machined from part 10-050
1.1/2" BSP Black Steel Socket

DRAWN BY: Peter Ball
DATE: 19 JUN 2000

TITLE: Handle Bush
Pounder Rig

SCALE: Full
Drg No.: 50-041
NOTES
Machined from 1.1/2"
Aluminium Scaffold Tube

DRAWN BY:
Peter Ball

DATE:
16.2.2000

SCALE:
Full

DRG No.

TITLE
Handles
Pounder Rig

50-042
<table>
<thead>
<tr>
<th>Bore of Tube</th>
<th>Part No.</th>
<th>Width</th>
<th>Groove Dia</th>
<th>Dist between Grooves</th>
<th>Ring Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP</td>
<td>46</td>
<td>1.41</td>
<td>47.6</td>
<td>10-040</td>
<td>10-041</td>
</tr>
<tr>
<td>NP</td>
<td>60.3</td>
<td>1.41</td>
<td>64.0</td>
<td>10-045</td>
<td>10-041</td>
</tr>
<tr>
<td>HP</td>
<td>77.8</td>
<td>1.73</td>
<td>80.2</td>
<td>10-047</td>
<td>10-042</td>
</tr>
</tbody>
</table>

Tolerances - All Dims +0.07 -0.00

DRAFT

NOTES

DRAWN BY: Peter Ball

DATE: 27.4.2000

SCALE: NTS

TITLE: Drillpipe Grooves

Pounder Rig

19 JUN 2000

DRG No: 20-004, 5&6

SHT 1

OF 1

59
TIG Weld Valve hinge and seat hinges both sides - clean off excess weld to allow fit.

<table>
<thead>
<tr>
<th>Size of Bore</th>
<th>Part No</th>
<th>Valve Seat Part No</th>
<th>Valve Roll Pin</th>
<th>Pin Diam</th>
<th>Roll Pin Pin No</th>
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<tbody>
<tr>
<td>HP</td>
<td>NP</td>
<td>BP 46</td>
<td>50-012</td>
<td>4mm</td>
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<td></td>
<td>50-018</td>
<td>8mm</td>
<td>50-019</td>
<td>3mm</td>
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<td>50-020</td>
<td>18mm</td>
<td>50-016</td>
<td>2mm</td>
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<tr>
<td></td>
<td></td>
<td>50-021</td>
<td>25mm</td>
<td>50-022</td>
<td>4mm</td>
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<tr>
<td></td>
<td></td>
<td>50-023</td>
<td>30mm</td>
<td>50-024</td>
<td>6mm</td>
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</tbody>
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NOTES
Fabricate and weld from SS Grade 304

DRAWN BY
Peter Ball

DATE: 19 JUN 2000

SCALE: NTS

TITLE: Clack Valve

Pounder Rig

50-012, 13, 14
NOTES
Stainless Steel Grade 304

DRAWN BY: Peter Ball
DATE: 3.2.2000
SCALE: NTS

DRAUGHT

TITLE
Valve

Pounder Rig

50-015, 16, 17

SHT. 1 OF 1
NOTES
Stainless steel Grade 304

DRAWN BY:
Peter Ball

DATE:
3.2.2000

SCALE:
NTS

19 JUN 2000

TITLE:
Valve seat hinge

Pounder Rig

DRAFT

50-021,22,23

sht. 1
of 1
Material: 20-014 114mm x 1m steel casing

Milled slot through one wall only

NOTES

DRAWN BY: Peter Ball

DATE: 15.6.2000

SCALE: 1:2

TITLE
Conductor Casing
Pounder Rig

DRG No. 20-027

19 JUN 2000

srt. 1
of 1
Material: 114mm x 5mm wall seamless steel casing

114

114

ODEX style flush box thread

and temper cutting edge

Frame hardened quenched
NOTES

19 JUN 2000
Peter Ball

DRAWN BY
DATE
21.4.2000
FULL SCALE

30-007

TITLE
69mm Button Bit

DRAFT

Material EN24T (817M40) Fully Machined then heat treated - Dipping the reduced and 22mm long

contoured punch (31-007) only

removing drill holes and filling into hole with reaming back off TC drilling (10-037) - By

into self blind and quenched hardening then

BP Pin

45.0

100.0

6.5 x 45°

69.0

45.0

6.0

3.5

8.3

0.005

Remed 31.25° (5/16") + 0.01" +

19/64" Drilled hole x 8.3mm deep then

5 equal spaced holes 72° offset 5° PCD

30 degree offset on 62°

5 equal spaced holes 72° offset 5° PCD

A4
Material EN24T (8717M40) Fully Machined then heat treated - Dipping the reduced end 12 mm long. Stressed pitch by single point tool (1o, 5o) on outer surface of rig. 30° off-set on 42.8pCD 4 equi-spaced holes 30° of outer 53.2pCD 4 equi-spaced holes 48pCD.

1/6th 4.5 mm drill hole x 8.3 mm deep then reamed 3.125 (±0.167 +0.001) +0.005.

Contoured punch (31-001) only.

Warning: Drill dots and flange into hole with flanging block RT Tooling. (10-031) by using set bolt and gentle hammering then.

B.P. Pin

2 x 45°
Material EN24T (817M40) Fully Machined then heat treated - Dipping the radius end 20mm long into salt bath and quench hardening then tempering back Fit TC buttons(10-031) - by warming bit bodies and fitting into hole with contoured punch (31-001) only.

NOTES
Pound-a-Rig, Low cost Water Well Drilling Project by Cranfield University funded by UK Department for International Development (DFID)

DRAWN BY
Peter Ball

DATE
19 JUN 2000
82mm Button Bit

SCALE
Full

DRG No
30-009
Material EN24T (817M40) Fully Machined then heat treated - Dipping the radiused end 20mm long into salt bath and quench hardening then tempering back Fit TC buttons(10-031) - by warming bit bodies and fitting into hole with contoured punch (31-001) only.

19/64" Drilled hole x 8.3mm deep then reamed .3125"(6/16") ± .0001" ± .0006".

Notes:
- Pound-a-Rig, Low cost Water Well Drilling
- Project by Cranfield University funded by UK Department for International Development (DFID)

Drawn by: Peter Ball
Date: 21.2.2000
Title: 100mm button bit
Scale: Full
Drawing No: 30-010

19 Jun 2000
<table>
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<th>NOTES</th>
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<th>TITLE</th>
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<tr>
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<td>Peter Ball</td>
<td>22.4.2000</td>
<td>BP Lifting Spanner</td>
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<tr>
<td></td>
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<td>1:5</td>
<td>Pounder Rig</td>
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<tr>
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<td>19 JUN 2000</td>
<td>20-010</td>
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</tbody>
</table>

10-059 Deck Plate

750 long - hollow 25.0 Tube or 25x25 RHS or 25.0-1'' Solid bar

Continuous Weld Both Sides
25mm-1" EN8 Steel Plate - Flame Profiled

19 JUN 2000

BP Lifting Piece
Pounder Rig

20-009
<table>
<thead>
<tr>
<th></th>
<th>HP</th>
<th>NP</th>
<th>BP</th>
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<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td></td>
<td>+ or - 1mm</td>
<td>+ or - 1mm</td>
<td>+ or - 1mm</td>
</tr>
<tr>
<td>A</td>
<td>83.33</td>
<td>63.37</td>
<td>64.87</td>
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<tr>
<td>B</td>
<td>84.85</td>
<td>65.37</td>
<td>65.87</td>
</tr>
<tr>
<td>C</td>
<td>81.76</td>
<td>68.37</td>
<td>68.87</td>
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<tr>
<td>D</td>
<td>85.30</td>
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<td>L</td>
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NOTES

DRAWN BY: Peter Ball
DATE: 5.6.2000
SCALE: NTS
TITLE: BP, NP & HP Threads
Pounder Rig
Dwg No. 20-024,25 & 26

19 JUN 2000
Material: machine flange from Skat Part No C2757
Material: machine smaller taper from Skat Part No C2759

NOTES

DRAWN BY: Peter Ball
DATE: 23.6.2000
SCALE: Full
DRG No.

19 JUN 2000

TITLE

Footvalve
Pounder Rig

50-046