H4H

Homes for the Homeless
Bushfires and other emergencies

This is the winning design of the Homeless and Emergency Shelter Competition of the Plateau Group. It is a cheap and simple **full-featured** home that can be constructed by unskilled volunteers and generally fundable from donations.

The original aim was to create a basic home that could be constructed by the Homeless themselves, at a cost level that could be raised from donations.

The main features of this design are:

1. It is constructed primarily from six flat panels which can be stored and transported easily, and assembled by two men at almost any indoor or outdoor location - either single or in clusters.
2. It provides the occupant with a bed, work-table, cooking and heating, hot-water shower, toilet, and clothes washing. Also plenty of storage space.
3. A raised (30cm) ablution area provides easy utility access.
4. It is spacious enough for socialising and general living (TV, computers, etc.)
5. It is strong and secure, and can be pegged down to counter inclement weather. Rain harvesting is possible; Solar panels and battery can be added.
6. It is primarily for single occupancy, but an additional drop-down bunk bed can be added for a child or second adult.
7. Wider small-family versions can be easily made using the same side-panels, ablution system and other general features.
8. The frames are screwed together to retain strength when transported.

The cost savings come from:

a. The small two-room footprint of 3.7x1.8m (2.1m in height).
b. Frames made from 30x30 and 70x30 treated rough timber. Wall strength comes from hinged longitudinal shelving and bed. Lining protection in transport also.
c. Wall linings and cladding from uncut sheets of formwork ply, and/or a variety of other similar panel materials in full sheet sizes.
d. Single length 4.2m corrugated galvanised iron roofing. [plus gutter if needed]
e. The simplest possible flushable Water Closet. Easily cleaned.
f. A simple, safe and effective hot-water heating and shower/basin system.

Safety, health and security features:

i. Lockable two-lite door, plus a chain restraint.
ii. Highly flexible toilet disposal system with U-bends and good flow height.
iii. Easy unclogging, cleaning and clearing and maintenance of toilet unit.
iv. Seperate shower-water disposal (water reuse for gardens)
v. Fresh water provided by garden hose and standard garden fittings. (or harvested)
vi. Electricity supple via a builder's safety cable unit with earth-leak drop-out.

There is no restrictions on the use of this design for non-commercial purpose.

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HOMES FOR THE HOMELESS

Built by the Homeless

I am a retired journalist, newspaper columnist (*The Australian*) and documentary TV maker. For a number of years I was the principle organiser of the Plateau Group of ageing journalists and TV people much like myself who spent considerable time and effort lobbying for, and designing, an ideal form of collective social housing. At this time we were interested in conventional small social housing with an emphasis on developing a vibrant community (not an aged ghetto), so the focus was specifically on creating a pedestrian and garden environment dotted with two story terrace houses -- for the aged and disabled (ground floor), and single parent families (second floor). These groups can be mutually supportive and share similar near-transport/shopping needs.

This was the Plateau Social Housing Engineering proposal. As an offshoot to this, we looked at the extreme case of the the cheapest possible, mass-produced, fully-featured home for the homeless, and this was the wining design (since slightly modified). The competition specified that these should be full-feature homes -- not just shelters. This project developed into the H4H Project (slogan "Homes for the Homeless; Built by the Homeless') with emphasis on a design which could be virtually self-built by volunteers and the homeless themselves, both to cut costs and reduce the 'lazy' stigma attached to homelessness.

Later developments of this idea became also a form of portable demountable temporary home for country people rebuilding their homes and lives after the 2019 bushfires. Obviously the current interest is also in providing some paid work as well as housing the homeless, and so this has considerable merit worth expoiting.

Costs: The cost of any mass-produced small-home can be roughly divided into:

- 25% basic material payments for walls/roof/floor framing, cupboards, shelving, linings and cladding, etc.
- 15% for essential utility fittings (plumbing mainly) and off-the-shelf essentials such as electric power-points, double-hotplate, a mattress, etc.
- 30% labour costs of fabrication (which is here replaced by volunteers and the homeless themselves)
- 30% purchase or rental of site (aim is to borrow - since these are demountable).

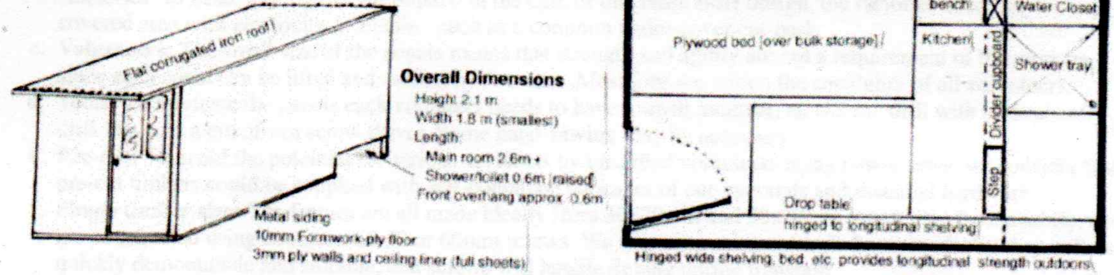
The factors that makes this design exceptional are:

1. **Demountability:** the flat panel approach makes for cheap mass-production, and the ready movability opens many unused sites to temporary utilisation.
2. The **Water-closet** can be fabricated with no expensive plumbing components, and is rugged enough to be thrown onto the back of a truck.
3. The **hot-water tank and shower unit**, is effectively little more than a pop-riveted and soldered galvanised iron box.

Overall, this means that all utility connections can be made by non-tradesmen at the time the home is being erected. There is no need for expensive tradesmen in the factory or on-site.

This design focusses on the basic material for the six shell panels and essential fittings needed to make the unit into a habitable comfortable home. At the time we managed to pare these costs down to about A$3,000 [Now probably A$4,000]. We also designed a couple of width and length variations able to handle small family units, and these add surprisingly little to the basic costs.

Smallest H4h unit for single occupancy



The basic units would be 2.1m in interior height, 1.8m in width, and 3.7m in length. If larger homes were needed for a small family, a wider unit (expanded to 2.1m or 2.4m) could be made, keeping both side panels and all the major utility features essentially the same. The wider units could handle a basic double-bed and two children's bunk beds (at a pinch).

These dimensions were standardised to utilise the full sizes of available plywood liner timbers, since this is an expensive component. Ply is best handled in uncut widths and lengths for maximum cost-benefit, and we didn't want volunteer fabricators using electric saws. The floor, walls and roof liner would be the lowest-grade water-resistant ply (form-work), while the outside skin would be the lightest and cheapest ply, or possibly aluminium or Colorbond metal-profile sheeting.

Shovel-ready

The detailed plans for all main size variations are about 98% complete (they are highly standardised), and this is essential if they are to be churned out in their dozens (or even hundreds). We have always assumed that these units would be sited on 'borrowed land or vacant property' in clusters of, say, six, side-by-side, utilising a common sewerage outfall, and sharing water (via hose) and electricity feeds (via builder's safety extensions).

The H4H venture never advanced passed the conceptual model stage because the members of the collective were also involved in promoting the Plateau small-home developments, and then everyone had virus problems. The potential funder of a H4H prototype also withdrew support. So this development lost momentum, and I am keen to revive it. This could be done today quite easily and quickly through the Mens Shed movement or become a job-creation scheme for local or State governments, with a highly productive purpose. What's more, at these estimated prices, funding for individual units are within the range of business donations and legacy grants for named units.

What is needed is for prototypes to be made to demonstrate the cost and manufacturing advantages. We hope one or more of the Men's Sheds, or other voluntary organisations, will take up the challenge in each state.

This current (Jan 2022) iteration is slightly improved and costs have been even further reduced. We believe the design is as close as possible to the ideal for large numbers to be easily manufactured. We note that with climate change, such housing will also be needed for emergencies, because they can be storage in flat-pack form and be ready for use quickly in any location. The low-level funding needed should also be available given both the State governments' urgent requirements of a way to handle the problem of the homeless evicted from rental/hotel accommodation, and the Federal government's new emphasis on job creation in the building industry. Politically, a rapid increase in the numbers of houses available would also have its attractions and help to keep almost all home rental prices low.

Features of the Design

These homes are very basic, but they are vastly superior to most conventional 'shelters'. At the time of the first design during Australia's 2019 bushfires, it was commonly being proposed that second-hand shipping containers (costing A$3,000) be provided to shelter those needing to rebuild their burned-down homes. However local councils are almost unanimous in their rejection of this rust-belt solution for the city homeless. H4H is a valid alternative, offering much more in the way of essential features and costing about the same. The factors we considered to be essential are these:

1. **Fully featured:**

    a. These are not just shelters, but homes offering the dignity of flush-toilet, washing facilities, hot shower, and food cooking. They have a built-in table able to seat three, plenty of shelving, under-bed storage space, electric safety power-points (4 of) and a light.
    b. They are just large enough for the occupant to have visitors to coffee or a meal. A lift-up second bunk could be suspended over the built-in bed. The wider family versions would probably need a separate table and chairs.
    c. The H4H unit would also offer the homeless a semi-permanent address (by reference if they are moved), so as to provide reliable mail delivery which is essential if they are to access government welfare and job-creation services.

2. **Mass produced:**

    The number of houses needed for the homeless in Australia seems to be quoted at anywhere between 10,000 and 150,000, depending on the definition of homelessness being used.

    a. **Local volunteers:** Unless the Australian Federal government gets into the social housing business (highly unlikely) it is obvious that the solution to homelessness will likely be local, and depend on volunteer groups.
    b. **Factories:** Obviously, at any of the possible levels of actual need, it will be necessary to have numerous "factories" to make any significant impact. In the case of this basic H4H design, the factories need only be any covered area with electricity available - such as a common under-cover car-park.
    c. **Volunteers:** The small size of the panels means that strength and agility are not a requirement of the workers since each panel can be lifted and carried by two men. Most jobs are within the capability of all volunteers.
    d. **Tools:** To fabricate the panels each volunteer needs to have a small hammer, an electric drill with a couple of drill-bits, and a cruciform screw-driver. Some hand-sawing may be necessary.
    e. **Pre-cut:** To avoid the potential for serious accidents by unskilled volunteers using power saws, we consider that pre-cut timbers could be supplied with self-contained packages of cut-materials and essential hardware.
    f. **Single timber size:** The frames are all made ideally from 30x70mm and 30x30mm rough pine (sustainable), and are constructed using countersunk 50 or 60mm screws. We suggest screws not nails because ideally they will be quickly demountable and storable, and screws will handle flexing during transport.
    g. **Frame Strength:** Frames are braced internally by tacked and glued plywood (formwork low-grade) lining. The weakest of the panels will be the front panel with its door opening. We believe this needs flat gal strapping as cross-braceing
    h. **Weather proofing:** Externally, they are weather-proofed by cheap waterproof ply or lightweight metal siding and corrugated roofing iron. We assume the units will be required both for indoors (car parks, old warehouses) and outside in weather.
    i. **Rain Harvesting:** The gal iron on the flat roof should be able to handle any heavy rain because of its short length. However if rain harvesting is needed the whole unit can be given a slight backwards slope, to run rain into a guttering and down-pipe

j. **Insulation:** The ideal wall-cavity insulation we suggest is second-hand polystyrene fruit and food crates, perhaps cut and glued in place. Other insulation materials will tend to hold water. These houses are small, but they should remain warm in winter despite not having perfect air-seals at panel joints.
k. **Panel erection:** Side panels fit OUTSIDE the two end panels and should need three 60mm screws per corner. Roof panels are held down via roll-over of the gal iron "eaves" which can be held in place with a few screws. Floor and side-wall panels should have short flat-gal straps, and the floor panel can be pinned down to the earth using four or more star-pickets and fencing wire.

Pre-cut/Pre-marked: All materials would ideally be pre-cut and packaged for delivery to the 'factories'. Side panel timbers would also be pre-marked for drilling and stud positioning by using a standard template. Close adherence to sizes and positions in the side panel frames can be achieved by this pre-cutting and template process, and parts should be interchangeable. The water-closet and water-tank stud spacing should be carefully checked since these components will probably be fabricated off-site.

This whole system of mass production of panels by unskilled workers (with a volunteer supervisor) depends on standardisation of components (not necessarily of the whole units). Insurance risks alone would preclude any use of power saws at the fabrication sites.

3. **Demountability:**

a. **Storage:** The main reason why we settled on this quickly-demountable design was to allow flat-packing and storage for emergency use in the future. This also made the units easy to transport and erect.
b. **Homeless sites:** This approach also allows us to "borrow" unused inner-city construction and infrastructure development sites; these are often available for long periods of time before construction begins. Suburban residents understandably object to the homeless being sheltered in piles of second-hand shipping containers in their immediate vicinity, but they can't really object to vacant construction sites being used temporarily by the homeless in small houses with sewerage disposal.
c. **Quick erection:** The units are designed with a simple air-tight panel-joining system using only three screws in each corner. A unit can be quickly erected or disassembled on site by two men in about two hrs + sewerage connections.
d. **Flow-height:** The toilet-shower area is raised about 30cms to provide sewerage flow-heights for up to six adjacent units, even if they are sited on a concrete surface. This flexibility means that they can connect to a wide range of sewer-disposal systems (sewerage access drops, septic tanks, or even pump-out bladders). These can be located in any direction from the erection site without the need for trenching or even pipe-gluing.
e. **Safe fabrication:** An important secondary consequence of flat-pack designs is that all panel fabrication can be done at waist-height on a flat timber 'bench' supported by four standard trestles. Panels can therefore be safely handled by unskilled workers; there is no scaffold-climbing, and at these modest dimensions everything is within easy reach. These physical limitations of volunteers have been an important consideration.

Homeless self-build: Ideally the homeless should be involved as volunteers in the fabrication process.

Stock-piled: Cheap flat-packed houses can also be stock-piled by governments for potential later catastrophes or events (bush-fire emergency accommodation). They could also be sold to regional authorities as seasonal homes for back-packer fruit-picking squads moving between districts. [We hoped that the out-of-work homeless could expand this into a cooperative business.]

4. **Heating and cooling:**

a. Side walls and ceiling would be insulated in the main room area by standard glass-wool in the cavity between the inner ply liner and external metal siding and corrugated roofing. Better still would be reclaimed polystyrene. The end panels are subject to wetting (shower, etc), so they could be best insulated with polyurethane foam (discarded fruit boxes) in the cavities.
b. The double-plate electric hot-plate used for cooking and shower-heating would warm the small unit size (11-16 cubic metres) on the coldest of nights in a few minutes. The hot-water tank, with its high thermal mass, would radiate heat for a considerable time in mid-winter.
c. Controlled ventilation air-escape would be provided in a couple of areas. In hot weather we would rely on door-opening (with a security chain) for cooling,
d. The front roof overhang of 0.3 metres is to provide some front-panel shade and rain cover allowing the door to be left partly open on hot nights. Guttering can collect water at the rear in some applications. Solar panels can also be installed, obviously.

5. **Site flexibility:**

a. These demountables can be assembled on any site ranging from a disused city warehouse to an open wind-exposed field: in the city or the country. They are designed to be easily "pegged-down" to handle heavy wind or storms.
b. In regions without piped water or mains electricity they can harvest roof water (with an additional tank) and carry solar panels and a battery storage unit.
c. Waste shower water remains isolated from sewerage solids, and so can be reclaimed for garden watering.
d. The utilities cavity provides enough flow-height for about six units side-by side without needing trenching, however twelve or so could be handled by raising half of the units on railway sleepers, etc. Access to a sewerage drop point is likely to be a limitation to the use of some sites, but with both the above and pipe-direct flexibility,

probably up to 50 units could share a single dump point.

e. The units do not have any intrinsic roof slope. This simplifies construction, cuts costs, and has other benefits. If necessary the floors of the units can be angled with wood-chocks to achieve a flow, but with roof areas of only a few square metres, we calculate that the corrugation heights can handle heavy rain anyway.

6. **Security:**

- We intend to use a solid wooden door with two fracture-proof plexiglass lites (the only windows in the unit). Two lites with solid timber between is a security measure. The door would have a standard Yale key-lock (and need to be easily changed); alternately the door itself would be on slip hinges to be easily exchanged after a unit has been vacated.
- Ideally the door would also have a bolt and/or slip-chain unit so it can be left partly open on hot nights. The door is one of the most expensive components because it requires good carpentry skills, and we need to see whether bulk purchase makes local manufacture unnecessary.
- A solid door could be made from a single sheet of heavy ply. A small air-gap above the door is probably an advantage. These units could easily be too air-tight.
- We settled on a door-width of only 600mm as adequate. The front-panel beside the door will need cross-bracing using flat gal iron strapping. A strap crossing the door-stoop gap (for transport reason, mainly) will probably also be needed. It could become a trip-hazard: may need to be flat steel bar.
- The two studs alongside the door should be DRESSED 70x30 to provide space for locks and surrounding door-seal battens. It is probably best not to use rebated timber; doors may need to be occasionally removed from the outside, so nailed-on battens are probably preferable. The door should always open inwards for security reasons.

7. **Unconventional design features:**

a. There are no noggins in the walls. These generally require careful on-site cutting and nailing, neither of which is desirable. We maintain that noggins are not essential when the internal height of the unit is only 2.1 metres - however battens may be needed to join ply sheets..

b. There are no eaves protecting the sides of the roof panel. We propose to simply roll the corrugated iron over the edge and pin it to the frame sides so it overlaps the vertical siding. The gal will then act as a roof strap-down. In areas with really cold weather the roof-wall joints may require some sort of sealing material (foam strip) between walls and roof.

c. Lightning may be a potential problem outdoors in exposed locations. The roof panel can be strapped down to the walls at each corner, and these straps extended to establish a metal-to-metal link via the corner-angle to the base (star-picket). This metal 'chain' would link the roof electrically to the earth (if deemed necessary).

d. When the space needed for erection has access limitations, the units can be entirely assembled and locked together from the inside by using angle-gal in each of the four corners. The sewerage and utilities can also be entirely run and connected from inside the units. [This is important for site flexibility.]

e. Both the bed and shelving are hinge to the wall studs and these provide protection for the lining panels during transport. The bed forms a storage compartment with two hinged-down sides. Shelf hinging is important: it strengthens the structure and allows smaller, lighter, and cheaper stud timbers, and provides protection for linings and fittings during transport.

Utilities

Plumbing with its need for tradesmen, can be a most expensive component of any house trying to offer toilet, showers and washing facilities. Also the space wasted by the rarely-used ablution area is considerable. We think this latest plan with a hinged-divider cupboard is a major achievement in overcoming this problem.

Also space is recovered by using the water-closet's toilet area for showering. This means that the Water Closet area will be regularly washed down (maybe an advantage) but also that a toilet-paper roll will need to be protected. A length of broom-stick on the inside of the dry cupboard (above toilet) is probably the best solution. The hinged Divider-cupboard seals off the Water-closet area while allow a narrow wet-drying hanging area behind. ing

1. **Water tank/shower unit:**

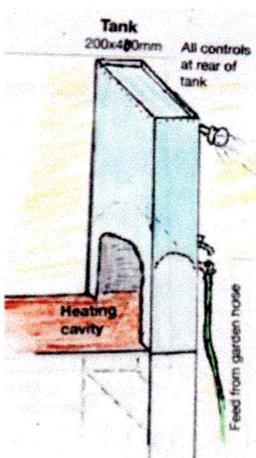
Made from standard galvanised flat iron, pop-riveted and soldered (brazed if possible). The cavity would be formed by a curved base (it can be curved either way), which would be riveted from the outside, and soldered from the inside to seal.

The lid/cap of the tank would best be screwed to the sides so it can be removed and cleaned. The cap probably doesn't need to be a perfect seal (But we are not in agreement on this!!) , however the lips of the cap might need to be bent UP, and then rolled OVER and DOWN the outside of the tank sides to seal (creating three layers). This tank cap would be fixed using metal screws. If the water pressure is high it may leak and need sealing.

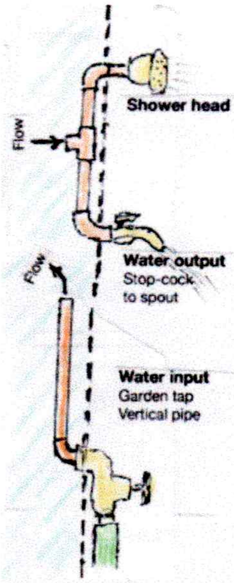
The water is heated using the double (600 and 1000 watt) hot plate slid below into the cavity. The water feed would be a standard garden hose with a solid metal clip-fitting to the pipe and tap unit (not a plastic unit obviously).

If the water enters the tank via a single brass garden tap, the shower-user can feel the temperature of the water before turning the shower on. This replaces the need for expensive water temperature control systems.

The output could be handled in a couple of ways:



Stop Cock: A stop-cock on the basin spout. When the cock is OFF, the water will flows up to the top show-rose.
Diverter: Alternately, a brass garden-hose diverter could select ONE output OR the other.



Note: It is obviously important that water pressure can't accidentally build up in the tank during heating (the user might go to sleep). Therefor one outlet or the other must always be open. For this reason, if a diverter is used to determine whether the hot water flows out to the basin or up to the shower rose, then it must not have a half-way OFF position -- or if it does, some form of safety valve may be needed on the tank to ensure heat expansion can't rupture the tank.

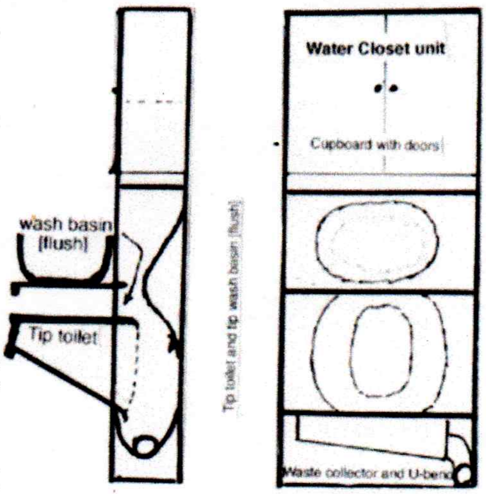
Safe hot shower: The ability to provide a reasonable hot shower in a safe (non-scalding) way without costly and elaborate hot-water units with temperature regulators is a major achievement of this design.

- We recommend using a standard outdoor brass tap for water input to the tank. Such a tap will always be as hot as the water, so the temperature will always be tested by the user before the shower is turned on.
- This tap will be fitted *'the wrong way around'*. The normal screw output of the tap is insert into the tank (soldered to seal) and the normal pipe-entry end fits to the hose and water feed.
- Inside the tank, the water should enter into a brass screw-fitting 'L' bend with a short length of pipe taking the cold water immediately to the top of the tank. Since hot water rises, this is a simple way of averaging -- of mixing the cold and hot, so as to prolong the shower beyond just the storage value of the tank itself.
- A diagonal baffle across the tank may prove to be beneficial in forcing the mixing of water being heated from below and the output to the shower rose higher in the tank.
- **Stop-cock:** If a stop-cock is used to control the output, then it would block the low-level output spout to the basin. Within the tank, therefore, would be vertical pipe made from two 'L' bends, with a 'T' (the hot water entry) half way between. The shower-rose would be obviously at the highest point.
- **Diverter:** If a diverter is used to control the output then all fittings will need to be outside the tank. One pipe would go down to the basin level, and the other up to the shower-rose.

In general we believe the stop-cock method is the better and safer, and it creates a unit with the fittings within the tank rather than outside.

Shower water disposal: The shower falls into a 600 x 600 shower-tray. This could be a flat gal pop-riveted tray with a single drain pipe, or it could be constructed entirely from water-proof ply with a timber surround. The square tray can be rotated to handle various exit point requirements. The tray water drops into a down-pipe and then to a clipped-on loop of flexible hose. This can then be hitched up to the tray to form a natural U-bend. Shower disposal is best kept separate from toilet waste -- for reasons of potential back-pressure from sewerage solids, and also for differing flow-heights needs, and for water preservation in dry conditions.

2. **Water closet:**



This unit requires reasonable carpentry skills, so we assume that it will be mass-produced to fairly fine size tolerances (600mm width).

Made entirely from plank-timber and waterproof ply with stiff plastic sheet (replaceable) liners. The wash basin would be a conventional plastic carry-basin, bolted down to its own drop-door. It has been suggested that dog choke-chains are probably ideal supports for both toilet and basin drop-downs.

Note that the WC unit is made to fit between two studs (no wall liner) so that it can carry the weight by having a single solid screw on either side at a high level within the cupboard

The toilet is emptied by tipping. It is then flushed with water from the plastic basin attached to the tip-panel directly above. The flush output may need to be deflected by a replaceable back liner through the toilet tray (try without first).

The flush water eventually enters a sloping "collector" which is probably best made from either a roof guttering/gulley (storm-water fittings) -- or by splitting a large plastic pipe (100mm) lengthwise, heating it, and widening it into a "U". The flush then enters into a conventional U-bend, before entering the general disposal pipeline system of the cluster.

The output pipe system can use light-weight PVC rain-water fitting (since it is not underground or designed to last a 100 years). It only need builders-tape and a screw to link pipe-sections together.

The main characteristic of this WC is that it is easy to keep clean, has no parts needing maintenance, can be demounted easily, and can be transportable without the risks attached to porcelain.

The toilet and wash-bowl drop-down doors will need rust-proof chains in support.

3. **Electric Power supply:**

We propose to use an off-the-shelf builder's cable reel (at a price of about $50) as the main feed. These come with four power-points and a standard earth-leak trip/safety switch. This distribution and safety-switch unit would sit below the step (a dry area) and so be easily accessible to the occupant.

Electricity would normally flow via the four three-pin plugs and their cable links from the Utilities Cavity or the Step Box. One plug should lead the current directly to the hot-plate (requires 1000 watts); another one would run to a standard hanging builder's light fitting, and another to a cheap multipoint distributor for mobile charging, etc.

4. **Cold Box:**

Below the large hinged divider cupboard we suggest a polystyrene-lined cool-box.
Alternately: a bar-fridge ($100) could be provided and take a direct feed from the cable and safety-switch reel.

Supervision and skills needed

a. **Supervising:** We planned to use as supervisors, volunteer handymen from men's workshops. They would be given one day of training, and they should be able to handle a dozen or so complete novices fabricating the main shell panels. Obviously the Water Closet, water tank and the divider cupboard require some higher-level skills, but these are skill that anyone can't quickly acquire. Our main concern was the need for electric saws. We feel it is best for main timber frames to be cut to length at one central site using a draw-saw which can be set up to cut-to-size hundreds of studs, bearers, rafters, etc in a day.
b. **Pre-cut frame timbers:** Timbers and metal siding for the panel frames would ideally be delivered to the 'factories' in packages.
   Volunteers with just basic skills can fabricate the floor, roof, and both front-and-back panels with an absolute minimum of supervision after the timber marking has been explained. All frame panels can then be fabricated by drilling and screwing (not nailing) and all the work can take place at desk height. The volunteers would be using nothing more complex than an electric drill (most will bring their own), with some glue, hammer and brads for fixing the ply lining.
c. **Insulation:** The main side-wall cavities and the roof would be filled with insulation (polystyrene foam pieces or sheets ... or with glass wool). The end wall cavities probably need polystyrene box offcuts because these must be waterproof.
d. There are no separate windows because the front panel needs diagonal strength to withstand high wind pressure. The use of full-size plywood sheets glued and tacked to the frames provide most of the cross-bracing strength.
e. Water-proof ply, weatherboard, sheet aluminium or Colourbond flat-profile siding can be nailed or screwed to the frames. At these small sizes, two adults can easily lift and handle all fitted-out panels.
f. These units should not require a licensed electrician present in either the factories or on the erection site. The special builder's extension reel with safety switch is obviously an important component (They cost about $50) but this solves the problem of having electric cables, plugs and switches within the walls.
g. The main divider cupboard requires slightly more carpentry skills than panel fabrication. However this is essentially little more than an open book-case with a stabilising bar (used as shower-curtain and/or clothes-drying rod) spanning from the top of the unit to rear wall (drop-in) fittings.
h. The water-closet requires more-than-basic cabinet-making skills, but most handymen can learn to make these easily under some initial supervision. For safety reasons they would need some electric bench-saw experience, etc. (which raises questions of insurance and supervision). The toilet can be fitted with a standard fold-up plastic seat. Faeces drop into a sloping plastic tray. This can be made by diagonally slicing a white plastic rubbish bin -- or by using flexible plastic place mats, clipped into the unit (and then easily removed, cleaned or replaced).
i. The hot water-tank is the most complex fabrication. It is essentially a flat-gal box (200x400 x 600 = 48 litres), which is pop-riveted and sealed by soldering. It fits between two main wall struts. It probably needs angle-gal reinforcing in the cavity area because of the water weight. Tank fittings are minimal;
   i. a standard brass garden tap controls the water inlet from a hose (and therefore flow to both outlets);
   ii. a gardening stop-cock (ON-OFF) controls water feed to wash-basin or to the shower-head.
   iii. a standard garden-wand spray head creates the shower.
j. For metal fabrication, obviously metal-sheers and basic soldering skills would be required (brazing would be better, but not essential). This design ensures there's little risk that the tank can run dry over the hot-plate (so no risk of a steam explosion): nor can the user get accidentally scalded.

New features of construction.

1. The panels were originally tied together at all vertical junctions using 75 x 75 mm angle to create both an air seal and a

vertical link to lock the roof-panel down to the floor-panel and on to earth stakes (if necessary) as a lightning conductor. Now we believe that this is not necessary and that three screws would be sufficient to join each panel junction in most cases; however the old system might be used in cramped spaces with side-by-side clusters.

2. The original design used 70x35 framing timbers, which appears excessive in such small units. We have now settled on 30x30 for all main studs. The exception is the side-panel corners which need liner attachment and hinges within the interior space. Note these are being used the 'wrong way'.
3. In these smaller units we have utilised full-length hinged shelving along the longer-walls to provide lateral strength to the whole unit, as well as shelf-storage space, and ply protection during transport.
4. A child's bunk bed could be suspended above the main bed (locked to the upper shelf) even in the smallest of the units.
5. In smaller units, the table hinges to the lower shelf so as to allow folding against the wall when not needed. Three people can still sit around the table. (Wider H4H versions would have separate table and chairs.)
6. When transporting; the bed, tables and shelving all fold against the interior panels to protect the ply and any other fixtures and fittings.

Fabrication time-requirements.

Taking into account the possibility of the age and potential infirmity of volunteer workers (say 5 hours/day), we estimate that, once a temporary 'factory' is set up in some vacant car-park, and with pre-cut packaged materials at hand, two experienced average volunteers could construct the six main panels for each unit in two days.

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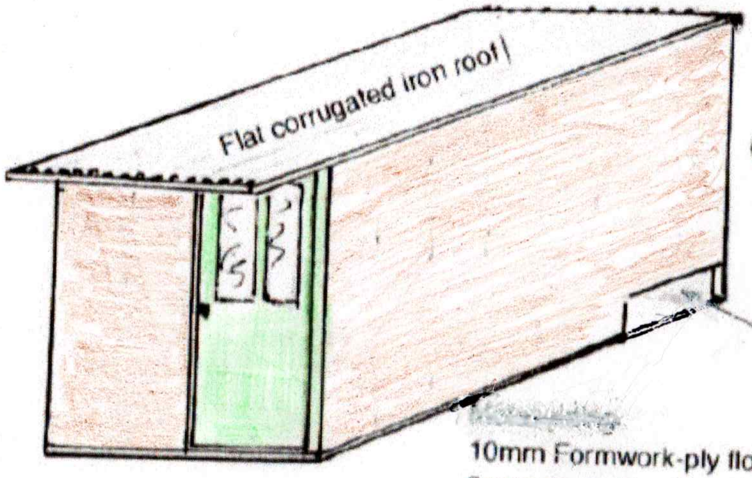
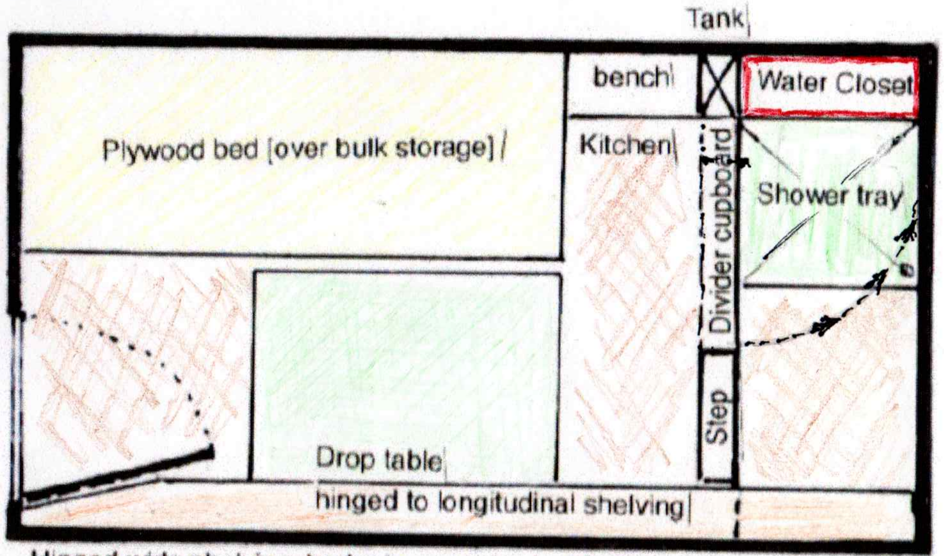
Smallest H4H unit for single occupancy



Overall Dimensions

Height 2.1 m
Width 1.8 m (smallest)
Length:
Main room 2.6m +
Shower/toilet 0.6m [raised]
Front overhang approx. 0.3m

10mm Formwork-ply floor
3mm ply walls and ceiling liner (full sheets)



Hinged wide shelving, bed, etc. provides longitudinal strength outdoors