KIMBERLEY™

Live Life's Adventure Today...in out of the way places!

Essential Guide for Off-Road Design of a Camper Trailer

Updated with new information on dust, suspension, solar and length of stay, waterless eco toilets and emergency braking tables

Fourth Edition

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How much of Australia do you want to Experience?

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A Beautiful Quote:

"The birds wake you in the dove-grey light of pre-dawn.
What would seem like punishment at home becomes a privilege in the bush. Every sunrise is a brilliant daily performance, every new campsite a home with a strikingly different view: hills the colour of wild salmon, deserts with soils that range from ochre to black, turquoise oceans, creeks the colour of beaten gold.

This kind of travel, I understand quite quickly, is not about ticking the boxes (been there, done that); it's what you learn about yourself and your partner that's the gift.

What is extraordinary is the shock you feel when you look in the mirror for the first time in weeks....
Regardless of how you look, You feel young again.
And adventurous. And capable.

How you feel becomes, for once, the true measure of your age."

"We travel just 2.5 hours west of Sydney on the freeway, then 20 minutes on a dirt road to where there is a great camping spot on the side of a river. You will find many people here with the same idea. However, crossing the river a little further up requires just 100m of off road travel; then 3-500mm of water crossing; then another 200m off road to the perfect camping spot.... With absolute privacy. So we only use the "off road" camper trailer for less than 5% of our travels; ..... but that 5% makes all the difference to great camping!"

How much of Australia do you want to experience?

Designing for off-road travel to out-of-the-way places is more than an art...it is the structured science of getting so much functionality for so little weight and making it compact and durable.

The core question when investigating your requirements is to ask just how much of Australia do you want to experience?

“Experience” is more than just looking. It is not just soaking up the beauty of Australia, it is also living and sharing experiences.

With the right camper trailer you can stay anywhere and experience all of Australia. When (not “if”), you find your favourite spot, you can stay as long as you like. Its your choice and not dependent on facilities.

That’s great, but the price of an “off-road” camper trailer is higher than an outback or an on-road one. Is it worth it?
The resale vale of a quality off-road camper trailer is generally much better than and outback or on-road one. This is because they are built to a higher quality and hold their age very well. So the real cost of ownership is low.

Instead of talking about our designs, we have structured this ebook around identifying the problems in off road travel first and then offering our design solutions.

Some designs may not suit everyone. Researching **your** personal requirements can take time. Once someone has travelled and gained experience they get better insight into what their requirements are, but the purchase has been made!
The purpose of this eBook is to share off-road camping issues with you so that you are better informed to shape your own requirements.

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1. Price Points and Camper Trailers

During your research, at some stage, you may sit back in astonishment at the wide price differential in camper trailers (or caravans).

Unless you are technical and love all the details, it is very hard for a newcomer to appreciate “fit for purpose” and the costs associated with good design and quality. There is also the reality that we all have a “budget” to work to.

We have broadly classified 2 categories of units:

“Utility” Models - start at $3,000 (yet we have seen $40,000 models)
- Designed to a price
- No Shower or toilet, so need these facilities close by
- Poor insulation, so need good weather
- Poor chassis/suspension, so good for short travel on good roads
- Road vibration affects the welds, bolts, staples and glue that is used
- Canvas quality looks ok but deteriorates quickly in the sun
- Little use of lightweight materials, so weight is high for size
- High on use of gas; low on renewable energy with batteries

“Self Contained” Models - start around $35,000 to $55,000
- Designed for light weight, functional use, without a generator
- Shower and toilet so independent of need for facilities
- Excellent insulation, so can even use in the cold and wind
- Good chassis/suspension so good for any road and more importantly for good speed over poor road
- Canvas quality is excellent, Australian, and comfortable even in high winds and poor weather
- Material quality is high, durable and looks like new 5 years later
- High on renewable energy

Camper Trailers handling off-road conditions

Then there are broadly 3 different “grades” of conditions.
You may not need more than you plan to use. Here is a broad guide:

Type	Chassis	Typical Suspension	Typical Brakes
“On Road” Camper trailer with no frills	mixed materials painted	leaf or torsion bar	Mechanical or electric drum
“Outback” Camper trailer with no frills	e-coated or powder coated	simple independent	Drum brakes electric control
“Off-road” Camper Trailer	Laser cut, Hot dipped galvanized	independent with long term warranty Air-suspension becomingpopular	Drum or newer Disc Brakes with or without electronic control

Will you be needing any of these attributes?

	Dust ingress	Handles Corrugations and gullies	Independence on solar
“On Road” Camper trailer with no frills	Generally Yes	No	No
“Outback” Camper trailer with no frills	Less Dust but Some	weak point	Maybe but rare
“Off-road” Camper Trailer	Absolutely not	Absolutely	Absolutely with long battery life

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1. Weight of different Camper Trailers

Typical Weights	Tare Weight	Water, Gas and Fuel Carried on Board	Accessories and Personal Goods	Total ATM Weight
“On Road” Camper trailer with no frills	700 kgs	100 kgs	220 kgs	1,020 kgs
“Outback” Camper trailer with no frills	800 kgs	150 kgs	220 kgs	1,170 kgs
“Off-road” Camper Trailer	1,000 kgs	240 kgs	220 kgs	1.460 kgs

Experienced travelers will tell you that “weight” is one of the critical parameters in your decision choices.

For more comfort and to carry more personal goods, you therefore want as low a tare weight as possible.

The use of alloy construction and integrated designs significantly reduce weight for the same camper trailer strength.

Some published tare weights by top of the line camper trailer manufacturers now go past 1,000kg. With some as heavy as 1,250 kgs.

That additional 250 kgs has a big impact to a long journey!

The “Off Road” type of Camper Trailer

Chassis and Suspension

Being the most critical component, it has to be strong but flexible. It is very hard to describe a “right” or “wrong” way to build these. Rather, the proof of the manufacturer’ confidence in their product is the strength of the warranty for their Chassis and Suspension. For example, most cars are at least 3 years and this is the minimum period to look for. Some manufacturers like Kimberley offer 5 years. Ensure that the warranty on the chassis and suspension can transfer to a future buyer, as this will significantly increase your re-sale value.

One of the important elements to a chassis is whether or not it is hot dipped galvanized. The benefit of hot dipping is not only on the exterior of the chassis but on the inside of the box sections. If rust starts on the inside sections and you cant see it, you have a poor product.

“e-coatings” and “powder coating” look great when new but after a couple of years start to deteriorate on any sharp edge. They are fine for “outback” grade camper trailers but risky for anyone on the coast.

The advantages of independent suspension is:

- greater ground clearance as there is no “beam” axle
- adjustable wheel alignment
- superior spring and dampening tuning
- more even ride
- generally lighter and stronger

Look at a camper trailer 5+ years old and after 30,000 kms to get a good idea of how the suspension holds up. It will reflect in the resale price as well.

Off Road type of Camper Trailer

One other reason why the chassis is important is in “recovery “ of your vehicle and camper trailer.

The photo on the right is of a Landcruiser and a Kimberley Kamper stuck in a creek crossing.

The only way to safely recover the two units was to pull the vehicle and camper trailer out from the crossing in reverse using a strap. The estimated total weight was 3.3 tonne for vehicle and 1.0 tonne for the camper trailer giving 4.3 tonne.

The unit was pulled out safely on the Kimberley chassis rear recovery lugs. The vehicle was in a gentle drive mode.

The other reason for a strong chassis is to travel through that “one” tough spot on an otherwise easy trip.

In the photo on the bottom left, the camper trailer “slid” down gunshot on it’s water tank protection plate. In the one on the lower right, the current while crossing the Daintree is an easy exercise.

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Section 2:
Camper Trailers are compact when traveling.

What setting up and packing up time do you want?

2. Understanding setting up time is essential

You have to start with a short “set up” and “pack up” time:

Just imagine a trip for 6 weeks with 20 stops every 2-3 days.

In twenty stops, allowing 30 minutes to setup and 1 hour to pack up: you will have spent 1,800 minutes = 30 hours x 2 people = 60 hours!

This is a lot of time for 2 people, and becomes increasingly stressful.

	Opening up and tent ready Chairs out	Completing Awning	Kitchen and dining table	Bathroom and Second Bed-room
Soft Floor Camper with pull out tent	Typically 45 mins for big unit	15 mins for attaching and pegging out	10 mins to swing out, assemble	If available may taken another 30 minutes
Traps	Allow 5 minutes per pole and peg. In bad weather 3 x times as long. Level ground key. Ground Prep needed.	May need 2 people. May take more time to get level.	If swing out kitchen then this can be quick but storage boxes have to be lifted out and placed.	Bathroom floor doesnt connect directly to camper floor. second bed-room is an “insert”
Hard Floor Kimberley Kamper is used as example	Less than 1 minute. No difference in bad weather	Less than 5 minute (Kwik awning always zipped on)	Less than 1 min	Less than 5 minutes for either. Second Bedroom can stay zipped on all the time.

2. Understanding packing up time (cont.)

We all know packing up takes longer that setting up.

At Kimberley we did a “time and motion” study to find out *exactly* where the bottlenecks were with camper trailers.
Although the answer is not so surprising, we changed our designs to keep the squence right. Some people will close up the main body of the camper trailer first in a few minutes, then load the storage areas.

Whichever way you do it, The secret is to simplify the “Putting Away” phase. There is a simple rule: Have a place for everything and everything has its place. The trap is that large open spaces take so much more time to organize to put things away neatly, safely and securely.

Examples of designs for fast “putting away” and “packing up” are:

Cooker	Lock down lid/grill in seconds. No concern about smells inside other areas of camper trailer
Dining Table	Slide in is quicker than a foldup table.
Kitchen Pantry	Slide in with multiple sections, many separate pantry areas and drawers have everything in its place. Messy oils and bottles in stainless vertical pantries
Chairs	Fold and place in front storage area, keep away from bed
Bedroom	Leave bedding on bed. Underbed storage easy access. Best if items can still be added or retreived after camper is closed up.
Second Bedroom	beds stay in bedroom area so easily deployed
Plates, utensils	in Multiple Drawers for quick access
Poles and Pegs	If you have to use them, alloy poles essential and pegs in 24 hr access area
Solar panels	Store in front box out of sight.
Awning and Tent	Always do last. gives protection in bad weather

Section 3:
There is only canvas between you and the stars.

What you need to know
about the features and pitfalls of canvas.

3. What you need to know about canvas

Camper trailers would not be as popular were it not for Australian made canvas. The best is a poly/cotton blend of tough “Japara” material that breathes. Special impregnation of oil based treatments render it water and mildew proof. There are some traps though:

Trap No 1
People think the “heavier” the canvas, the better the quality and the stronger the construction. This is not the case.
The quality is more determined by the tightness of weave and the uniformity of the weaving.
The strength of the completed “tent” is determined more by the quality of the sewing and the design of the panels.
Lightweight 275g/sq.m multi-treated Australian canvas with 40 thread ends per cm approx. is the just the best!

Trap No 2
It is a trap to think that “rip stop” canvas is better for camper trailers. All those small ridges in “rip stop” slowly wear as the canvas opens and closes in the folding action. They also trap dust. Dust creates more wear. There is no advantage and only disadvantages in using “rip stop” canvas for folding camper trailers.

Trap no 3
The waterproofness of canvas is measured by the height of a column of water above the canvas without a drop coming through in a certain period of time. It should be 750mm. Yet this alone is not enough.
The workmanship of the sewing using undersized needles with no retracing is the secret. The seams are sealed by either “thread tape”, a clear material adhered to the canvas after sewing or by using special thread that expands with “wicking” and closes out the sewing holes. At Kimberley we use the latter.
The sealing tape can crack over time with UV and once cracked, the tent leaks like a sieve!

3. Canvas Features

Australian made canvas is easy to look after and will dry out after being drenched very quickly. Thats because it is oil impregnated and it is only the small amount of surface fibres that actually get “drenched”. The thread gets wet of course as does the velcro.

There is no problem with “wet canvas” on the bed when folding up. Generally most manufacturers have a small sheet to be placed on top of the bed which prevents water soaking through. However, because of the tropical roof, there are 2 layers of canvas and it is the top roof layer which is wet and the second dry layer is the one in contact with the bed.

Tropical Roof	Important for some people who want that extra coolness in the tropics because the heat is reflected and the air gap between the 2 “rooves” creates a cooler layer of air.
Inverted (Rear) Walls	This avoids rubbing up against “wet walls” when seated on inside floor area. It ceates a greater air space inside for better airflow
Window Flaps on the inside	This allows zipping up in bad weather from inside with no reason to set foot outside
Zips and Velcro	Both Zips and Velcro work well with canvas. Zips are stronger and more precise, velcro more forgiving and easier to use. Generally awnings, doors and windows use zips, annex walls can use velcro
All weather windows	These are clever windows that open automatically with the camper and let air flow even in a torrential down pour. This means you can leave it open during the day while hiking and let airflow through the camper to keep cool.
Midge Proof Windows	These are a must and not available in chinese made tents. The hole size needs to be 0.6mm x 0.6mm. What’s more is that you want to see through them so the colour of the midge screen is important. A special dark charcoal grey gives you near perfect visibility.
Clear Windows	Adding clear windows instead of canvas is great to use in windy conditions (as in WA) You dont feel you are in a cave and can enjoy the great views!

Section 4:
Keeping out Dust and Midges:
The little things that ruin a good trip

4.Keeping out Dust

One of the fundamental requirements for an off road camper trailer is to travel comfortably in fine bull dust or mud. This means when you break for camp, you can get straight into the cooking or into bed without having to clean up dust and mud that has got in through the seals.

The photo on the left is a Kimberley Kamper Platinum Model after traveling to Cape York in 2014. The Gullwing lid on the kitchen side is opened up and photographed by a happy customer.

Dust comes into a camper trailer when there is a vacuum or lower pressure inside. This is generally caused by the "venturi effect" of slip stream air passing over a hole and sucking the air inside the camper trailer out. A hole the size of a pin head can create a vacuum and cause a camper trailer to fill with dust.

Pay particular attention to how the canvas fixes onto the camper body. A vinyl style "fixing band" sewn carefully to the canvas between the outer body and the interior "liner" gives the best results. If the canvas just "sits over the edge" of the trailer with gaps between the canvas and camper trailer body, there is a high risk of dust and midges entering.

The way seals work for an off-road caravan or camper trailer is that they are semi-pneumatic. In other words, they are a round "tyre" like profile and this presses against a clean and smooth surface. They will also have a pneumatic property as the air inside will be captured with very small controlled drain holes.

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In off-road conditions, when vibration travels through the seal, the seal will flex its profile shape. If the sealing is the correct design, with the correct seal and fitted in the right way, even when flexing the seal will maintain contact with the sealing surface and isolate the inside from the dust and or rain or mud.

The size of the seal used and the type of seal depends on the amount of flexing required. As you may know the secret to off road design is to have a flex in the chassis and the whole suspension system for the extreme off road conditions. The same applies to lids and seals.

At Kimberley we DO NOT USE closed cell or open cell rubber strips as primary seals. These have no “flex’. This type of seal is useless as a primary seal as they have no semi-pneumatic compression. These can be used as secondary seals is some special applications.

We have a famous customer “Phil” who hates bull dust. He claims it is so fine, it will “get into your salt and pepper shakers”; BUT it doesn’t get into his Kimberley. One thing that Phil does though is keep the seals and the surfaces they press on immaculately clean. As you can imagine if there is some “stuff” that falls on the sealing surface whilst in camp and it is not cleaned off, there will not be a perfect seal when the camper or the gullwing lid is closed. This is the most common cause for poor sealing in a Kimberley.

The key to good sealing is:
The design has to have the right type of compression seals on smoothly painted or poly-urethane coated surfaces. You cant seal on a galvanized surface or a rough stainless steel surface. It is difficult

to seal on plastic or polypropylene surfaces for off road use.
The design has to have a sufficient recessed gap between the 2 surfaces to match the seal size. So for large seals, generally, a recessed retainer plate is required for sufficient compression volume because of their size.

The compression latch “travel” has to be precise to match the seal profile.

The type and quality of the seals.
There is a big difference between using EDPM, natural rubber and a rubber mix. Natural rubber wears too easily for camper trailer lids that expose this rubber at the floor when walking in and out. Camper trailer lids need an extremely high quality EDPM seal with a large compression profile.

- The design of the seals may require additional fine rib lines or lips. This is one of the secrets to keeping out bull dust.
- Maintaining clean surfaces for the seal to make 100% clean contact with the painted or highly polished surface.

The reasons a seal may not work assuming it originally DID are:

- Build up of grime and dirt:
- Run a cloth around and make doubly sure the sealing surface and the seal is clean of grime and other material. If it isnt perfectly clean, the seal may not work.
- Paint or surface is chipped where the seal sits on.
- Corrosion of some type on the surface where the seal sits on
- The seal has been closed and tight for a long time and it has “lost its ability to rebound” to normal shape. This occurs commonly while the camper trailer is in storage, so relax all the doors and open the lids to take all the pressure off the seals.

- The seal has cracked. This generally occurs with older high quality seals or poorer quality Asian seals that dont have sufficent UV protection.
- The seal has a tear. A sharp object has punctured the surface and the seal is no longer completely pneumatic.
- The seal has a rough and raspy feel to it: Something has grazed the surface and the seal is no longer completely smooth.
- Water has entered the seal producing a hydraulic “lock”
- The seal is not joined professionally and the joint has a ridged and inconsistent surface at the join
- The join is not at the furtherest point of the seal away from the hinge point where control on the compression is easier to achieve.
- The sealing latches are not adjustable within the required range. The latches that hold the door or lid or roof of the camper trailer must be adjustable to set the right compression.

The way to test for the right compression on a perfect seal is:

1. Take a piece of clean copy paper (80 GSM approx)
2. Place the copy paper midway on the sealing surface and close the lid/door/roof.
3. Close the compression latch to the normal setting you are wanting to test.
4. Jerk the piece of paper by pulling about 40-50mm
5. If the paper tears, the compression setting is too tight
6. If the paper pulls through and doesn’t stop at the end of the jerk, the compression setting is too loose.
7. Keep adjusting the compression setting until this works at all points in the seal.

4. Bug Proof: Keeping out Biting Midges

Biting Midges are in Coastal Tidal Areas
It is only the female midges that bite. Biting midges do not transmit disease to humans in Australia. They do not, as is sometimes believed, urinate on people to cause discomfort.

In the process of biting and sucking blood, they inject a salivary secretion that produces a skin reaction of varying intensity, depending on an individual's reaction. Bites usually produce a classic allergic response, with the first bite producing no noticeable effect, and the subsequent bites producing the reactions.

If you are affected, you will need Midge proof screens. These have to be on EVERY door and window.

Insect Protection Requirements for Camper Trailers	Mosquito Screen	Midge Screen
Hole Size	1.00mm x 0.9mm 0.9mm square	0.6mm x 0.6mm 0.36mm square
% restriction on Airflow	58%	64%

There are no Midge proof screens made in Australia. **There are also none made in China**. These have to be imported from other countries.

Section 5:
Airflow and Comfort off-road

5. Airflow and Comfort off-road

Canvas is a thin membrane with the big advantage that it "breathes" letting heat and moisture pass up through the roof area. Polyester or nylon materials just "sweat" and are uncomfortable for sleeping in the tropics.
However, a big disadvantage of canvas is that in full sun, heat passes easily into canvas roofed areas making it unbearable.

There is a great solution though:
Have layers and the best air flow, a solution born in the tropics:

Tropical Roof requirements:

- The roof should be self erecting, otherwise you are on a ladder!
- The shape of the tropical roof is best kept "flat".
  This lets the airflow through easily with no heat build-up under a curved shape.
- Not only will the roof protect the camper from tree sap and other debris, but it also can be removed and replaced if damaged by falling branches.

Airflow is the next best natural coolant. When air can flow in and then accoss and up inside the camper trailer, it pulls through other stagnant air inside and gets gentle air movement. As heat rises, the best "tent " design for maximum airflow is a peaked roof design.

Camper trailers with "flatter" roofs have greater difficuty getting the air to flow up and out. It is like a flat roof house in the tropics without airconditioning... a real killer. A high pitched roof is cooler!

Even better is if the top layer of "hot air" in the high pitched roof can be sucked out, creating a gentle airflow.
There are models of camper trailers that have this air extraction.

5. Airflow and comfort off-road (cont.)

A guide to evaluate the amount of cross flow and up ventilation:

Good Airflow	Side, Front and Rear Windows	Roof level Air evacuation	In Wet and muggy conditions?
Cross Ventilation **In and up Ventilation**	Windows on all four sides and as large as possible will give perfect cross flow ventilation.	If the top “hot layer” of air inside a camper trailer can be evacuated easily, then more air is pulled in through the side windows regardless of the wind direction.	Ensure as many windows as possible either have an awning outside over them or the wall slopes outward. This means the windows can be left unzipped and open with less chance of rain coming in. Some camper trailers have automatic “all weather windows” that can be left open in the rain and still allow air flow

Awning Airflow

The same principle applies for the awning. If the awning attaches as close to the top of the peak roof, whilst it may be a little more difficult to zip on at times, it will be much cooler and there will be better air flow.

Second Bedrooms

A Fly or tropical roof for second bedrooms will give a cooler and more comfortable space.

5. Shower and Toilet off-road (cont.)

Do you or your partner just wish for a comfy toilet for your off-road travels? If so, don't be shy about speaking out. There are times when all of us dread going out in the middle of the night or worse still surrendering our tender parts to the sand-flys!
You may have wrestled with the old “porta potti” carrying it around looking for a dump station when you would prefer to be enjoying your trip. There is only one alternative to the porta potti (excluding the traditional ”as the bears do”) and that is a waterless composting toilet.

The eco waterless toilet is a “compostable” system.
These toilets are an engineering genius.

- They are 100% eco friendly
- They are waterless
- They look like a flushing toilet
- They take less than an hour per year to maintain
- The pedestal is shaped such that it is unlikely to be soiled.
- It is cleaned as you would a flushing toilet; just use eco friendly enzymes in place of disinfectant.
- There is absolutely no smell in the bathroom; any odours are removed by a 12 volt fan.

Here is how it works to setup and use in a camper trailer:

- When traveling, the toilet stores perfectly in the front section.
- If the camper trailer is “self contained” with solar and batteries, there would be enough power to run the small fan all the time.
- There is a filter fitted with the fan pulling fresh air through
- It takes less than a minute to remove the toilet from the front storage area and place it in an attached toilet ensuite
- It takes a minute or two to set up the shower and toilet ensuite.
- There is 12V power to the fan system on the side.
- Its that simple!

Section 6:
Kitchen, Cooking and Refrigeration

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Kitchen

Layout is number one. This is a social time of the day and the last thing you will want as you are cooking is staring at the camper trailer side or canvas wall. Any layout where you work side-on will give you more interaction with other people.
A “U” shaped kitchen is provided in some camper trailers, where the bottom of the “U” is the refrigerator and cooking is on one side, preparation and meal delivery on the other side. If there is a dining bench that is close, then you have the perfect setup for quick meals. Generally most people have meals on their lap by the fire at night so the dining table is secondary but great for breakfast and with kids.

Sink and Washing up

The dishwashers we have found for camper trailers all have 2 legs. But lets make the thrice daily task easier for them.
The best layout is if the person cooking and the person washing up can work at the same time without getting in each others way.
It also is important to have a very good light right at the sink.
Virtually instantaneous hot water (in less than 4 minutes) is a great plus and available in some camper trailers with diesel hot water systems. This doesn’t congest the cooking area with additional billies for washing up water.

Preparation Areas

Food prep areas need the best hygiene so stainless steel is best. These areas can be cleaned down easily.
Food prep areas with cookers immediately adjacent have to be watched as temperatures can stay “warmish” on the food prep top inviting bacteria issues.
It is better to keep the food preparation as far from the cooker as practical.

Section 6: Kitchen, Cooking and Refrigeration

Cooking

Saftey is number one. If the cooker is inside a storage area ensure that it can be totally disconnected from the gas bottle. When travelling off road, things can happen to valves and gas lines. Do not have a permanent connection but use a quick connect to the gas bottle.

The number of Gas Burners in a cooker

There may be a belief that the more burners in an appliance the better. In other words a 4 burner or 3 burner cook top is a better choice than a 2 burner. Well this is not necessarily the case. The gas law limits the heat from any one gas burner so that if all the burners are “on” there is a maximum heat energy output. So generally a 3 Burner will have less power per burner than a 2 burner. Unless the billy sits across 2 or the 3 burners, it may take longer to boil.

Having one large high powered burner in a separate cooker

A big advantage of a second high powered burner is that it can connect via a second gas hose to a second gas bottle. The large single burner can then have maximum heat output. You CAN’T do this if it shares a gas hose with another device. It must be physically separate. These large single burners are great for the one large cast iron pan. These are easy to clean and great to cook on.

Wind

This is the bugbear of cooking. It can reduce the heat transfer by up to 70% as the flame is blown around under the pan.
Wind deflectors around the body of the cooker are good. Even better is any wind protection close to the flame area. There are camper trailers with stainless steel rings between the cooker and the bottom of the pan or billy.

Section 6: Kitchen, Cooking and Refrigeration

Refrigeration

Chest style refrigerators are commonplace with camper trailers. This is the best design as a top opening model is more efficient than an upright model.
These generally run off 12V power and whilst most brands are reliable, ***efficiency is the big differentiator***.

There is a trap with needing to take a freezer: They use a lot of energy and do you really need one? Dual compartment fridge/ freezers take more space for the separation and the efficiency is reduced. Dual comprsssor models are cumbersome, heavy and very inefficient. Even a 40 Litre Freezer can consume 70 Amp hours/day!

Eutectic Refrigeration

This is the best general purpose refrigeration but has a high price because of the added sealed eutectic system. The temperature is even and uniform and is unbelievably efficient. A 75 Litre unit will operate at less than 20 Amp hours/ day in fridge only mode.

A short cut technique with eutectic units is that they can be run as a fridge/freezer. The coldest section is at the bottom so you can place frozen food or ice there with layers of bubble wrap for insulation above. It is light and practical. For those who only want ice for their drinks, this works a treat, and generally 24 hours per “make” is fine.

Power Consumption

Depending on the brand and size and compressor style, the power consumption of a 75-80 litre fridge/freezer can be as low as 19 Amp hours/day to as high as 69 amp hours/day in Full Freezer mode. Add a second fridge and the power consumption is really getting up there. Carrying that frozen pie that Aunt Bertha gave you for the trip becomes very, very power consuming.

Freezer Alternative

An Alternative to using a Freezer is to take vacuum prepared food. This is far better for long term storage than frozen food with a camper trailer. Note **the word "Cryovac" is a trademark process that includes eliminating all air in packaged food at very low temperatures. The low temperatures kills the bacteria. Alternatives to this if not available are:**

Long Term

The air is replaced in a sealed bag with food grade CO2. This removes the oxygen (which is what spoils the meat) in the vacuumed pack. The result can be kept cool (slightly chilled) for months in a dark area.

Short Term

The air is not replaced in a sealed bag but just "sucked out". This is typically what the butchers do or if you have a machine at home. This perishable food must be kept chilled in the fridge and will usually keep for a limited time of weeks.

There is a caution on these processes with meat. You cannot guarantee that it will be free from pathogens (these grow even without oxygen), which may have been introduced when slaughtering. Larger cuts of meat are safer with a smaller surface area than say mince meat, which deteriorates rapidly. In general, meat is sterile below its surface, provided the animal was healthy at the time of slaughter. Never eat meat that is swollen as this is an indication that gas-forming anaerobic bacteria are active. The good thing is that harmful bacterium tell you when they are active - gas, foul odour, and slime.

Finally, always cook the meat right through - don't take chances with rare meat as this means the temp has not penetrated the whole slice and killed any bacteria present. It may be all right in a restaurant but not in the bush. Cook until the juices are clear. If in doubt, chuck it out.

Section 7:
Matching wheels & tyres

7. Matching wheels & tyres

How many tyres have you changed in the last 12 months?
If you are just driving around a local urban area, the stats would be zero. But if you are on country roads, then probably 1 or 2. However, if you are on poor bush roads then the number climbs above this. It is hard to say and depends on the roads in a particular year and season.

The best prevention is good eyesight and concentration as you look out for every conceivable stake or piece of wire visible from the drivers seat. Yet at sunrise or sunset, you will miss a lot of the warning signs (let alone if you have to drive at night). The inevitable can then happen.

Which tyre is most vulnerable?

Your vehicles tyres, particularly the “driven” tyres are most vulnerable. Then the rear tyres may have a higher load on them so may be the ones to watch. However, the camper trailer can also be vulnerable if the tracking width of its wheels and tyres are different to the vehicle. So for the majority of Jayco trailers for example, their width is at least 200mm wider than a large 4WD. This increases their vulnerability significantly.

The most valuable scenario when having a trailer of the same tracking width AND matching wheels and tyres is the second back-up spare for your vehicle.

Follow the scenarios below in the table:

7. Matching wheels & tyres

Leave Town with:	Vehicle with Camper Trailer behind; different tracking width to vehicle; wheels are not inter-changeable to vehicle	Vehicle with Camper Trailer behind, similar tracking width to vehicle; wheels are not inter-changeable to vehicle	Vehicle with Camper Trailer behind, similar tracking width to vehicle, wheels are inter-changeable to vehicle
Tyre is destroyed on vehicle at grid!	Use vehicle Spare wheel and tyre		
Subsequent action:	Have to divert from route if not carrying second spare.	Have to divert from route if not carrying second spare.	(No need to divert as trailer spare is second spare)
Flat tyre on 3rd day	Hope you diverted	Hope you diverted	Use Trailer spare as second spare
	Couldn't get a new tyre in bush town and had to get a repair done by locals		
Difficult roads ahead	You have BOTH the vehicle wheels and the trailer wheels vulnerable	Your vehicle wheels only are most vulnerable, not the trailer	Your vehicle wheels only are most vulnerable, not the trailer
Inevitable happens	You end up with a flat on the vehicle and then later in the day on the trailer coming into camp.	You end up with a flat on the vehicle	You end up with a flat on the vehicle
	You have no vehicle second spare and are vulnerable but trailer spare is OK		You have a second spare
What Action?	You must divert again for a tyre repair	You must divert again for a tyre repair	You can hold off.
On the way to get the new tyre, another tyre slowly leaks	You stop by the side of the road and decide: Do I leave my partner here with the trailer and hitch a ride to closest town for a new tyre		You use the second spare and keep driving
You see the sign post to Wolf Creek!	??	??	Camp and have fun!

7. Matching wheels & tyres

Benefits off-road of matching wheels and tyres:

- Reduced fuel consumption if towed trailer wheel track is similar as Vehicle Tracking
- Reduced incidence of damaged trailer tyres if they are travelling on same track as vehicle, and if not exactly the same, then very close.
- Improved travel in soft sand with less risk of bogging
- A Compatible additional Spare for the vehicle
- Peace of mind

There are some traps here so we will step through these:

Vehicle Track and Trailer Track width is the most important starting factor.

The closest match is when tyre footprint is same width on trailer to vehicle AND The Track width of the trailer wheels is same as vehicle.

7. Matching wheels & tyres (cont.)

To match your Vehicle Wheel Type you need to consider:

- Alloy Wheels are easily damaged off road and need more inspection and careful maintenance of any trapped gibbers between the brake calipers and the wheel
- The Wheels have a Stud Pattern, with a particular type of wheel nut to match the wheel type (steel or alloy)
- The Stud Pattern has a Stud Size and a Pitch Circle Diameter (PCD). This is the circle diameter of the studs as you see them.
- Some Vehicles have a small P.C.D. because of history of that particular make of vehicle. There is no technical reason for a small PCD.
- If the vehicle has a small PCD of the wheel studs, it means the standard vehicle wheel cant fit “over” the shaft and bearing of a 2 tonne axle on an off road camper trailer.
- In this case you are unable to match the wheel but you can match the tyre.

There is the option for small PCD wheels of a lower rated axle.

But what would you rather have:

1. A damaged axle because it is too light for the job?
2. Or a wheel matching work around (see paragraph below)?

7. Matching wheels & tyres (cont.)

How to Manage the situation if your vehicle has a small PCD and can't interchange the wheels:

- Match the exact tyres on your vehicle
- Choose a different wheel with same width
- If possible change vehicle to 16" wheels as this tyre size is most common
- Then when an additional spare is needed, simply change the tyre from the additional camper spare to the vehicle.
- There are plenty of tyre changing service centres available in the bush! Or carry a set of "tyre pliers".

Selected Vehicles Matching Wheels & Tyres:
This chart is for Kimberley Models.

	Possible Track Width 1625mm, 1575mm, 1555mm	Same Tyre	Interchangeable Wheel
Landcruiser 70,80,100,200 series, Prado, hilux	Hilux Diesel 1540mm Prado Diesel 1585mm 100 Series 1620mm 200 Series 1640mm	✔	✔
Landrover, Range Rover	Series 2 1560mm Series 3,4, RR 1612mm	✔	No
Nissan	Patrol Y61 1625mm	✔	✔
Mitsubishi	Pajero NT 1570mm	✔	No

Section 8:
What size batteries to carry?

8. What size batteries to carry?

Even if you have a suitable generator, you will need to decide on the size of batteries.

This ebook doesn't cover different options on sizing them, there are others that do. It covers the weight and bulk of the batteries the impact on traveling light yet having enough power for camping for periods without a generator.

One of the critical battery power consumers in an off-road camper trailer is the refrigeration, so we will re-visit this topic.

LPG-fuelled refrigerators use very little battery power but they have a major problem. They take a long time to get very cold in the warm weather and take some time after travelling to settle down. Even the compressor refrigerators we use at Kimberley have modifications so that you can make ice in Darwin.

The big issue with LPG refrigerators is that they are upright and very poor in space efficiency. They are bulky and have a short shelf size internally in most models even though the capacity looks sufficient.

By adopting 12V refrigeration , you will get these benefits:

- make ice in Darwin (assuming it has a freezer)
- Lower and more efficient profile
- performs well while travelling
- can get very cold, very fast
- deeper shelf space throughout
- Safer: no LPG inside
- Lower cost to operate if using solar.

8. What size batteries to carry? (cont.)

The disadvantage of 12V refrigeration is that good battery capacity is required.

In addition to suitable battery capacity, you will also need:

- Good 3-way Charging System
- Suitable 240V Battery Charger
- Suitable solar controller
- Solar Panels
- Power capacity meter option (showing capacity left in batteries)

This all costs more money to do properly and is the main reason the majority of caravan and some camper trailer manufacturers don't offer compressor refrigeration.

Looking at weight, space performance, and efficiency, compressor refrigeration is a long way ahead. However to be fair, you have to add into the weight calculation, solar panels, larger batteries and battery chargers. Are you therefore overall better off?

The common answer is that you are far more independent and capable of staying longer in a wider variety of places if you have good battery capacity and solar charging.

12V power is necessary for lighting, water pumps, LCD screens and other 12V devices if everything else is gas. So if you want this independence, then you will need larger batteries and solar anyway!

Quick Sizing Guide

Off road camper trailers are very light, or they should be! Because of this the amount of battery capacity is limited by space and weight. Typically with a fridge on board, most off-road camper trailers have 200 Ahrs capacity. What most people want to know is how long can I stay in a remote place without using a generator?

Off road camper trailers are very light, or they should be! Because of this the amount of battery capacity is limited by space and weight. Typically with a fridge on board, most off-road camper trailers have 200 Ahrs capacity. What most people want to know is how long can I stay in a remote place without using a generator?

Nearly every off road camper trailer has solar to charge or freshen the batteries. At Kimberley, we have a small 25W panel on the front that will always charge providing there is sun on the panel. This keeps charging the batteries even when you are driving or stopped on a beverage break and there is plenty of sun shine.

The next step up is a 100W folding glass panel “suitcase” that stores out of sight inside the front gullwing lid (photo shows an even greater capacity 156W

Super Thin Solar which is less than half the weight of a 100W Suitcase).

Even bigger still is the 220W Super thin solar attached to a rear awning that pulls out from the camper trailer when it unfolds (photo above).

Running a fridge uses between 25 and 60 Amp hours depending on the type and the brand. There is also increasing use of charging phones and laptops. An Ipad charger uses 2A on average at 13V so if left on charge for 3 hours there is 6 Amp hours. A Macair laptop uses a much greater 8A so for 4 hours there is 32 Amp hours. Phone chargers are far less at around 3 Amp hours.

So what is the best way to prepare for this?

This is our system: Calculate what you will use, decide on the battery capacity, purchase sufficient solar capacity. Then tune how you use this combination based on the actual solar power that you get!

Here is a quick calculation of the items running on charge and the power they will consume in a 24 hour period “typically”. Fridge 40Amp hrs (well used) , LED lighting 15 Amp hrs, iPad Charger 6 Amp hrs, 2 x Phone chargers, 6 Amp hrs, Water pumps 5 Amp hours. This gives a total of 72 Amp hours every 24 hours.

We recommend you start with a reasonable battery capacity of 200Amp Hours. The “usable” battery capacity for AGM batteries is half the nominal capacity for a reasonable battery life. So you will

then have 100Amp hours and if using 72 Amp hours, you have a day and a half without charging.

Select the folding suitcase capacity of say 125W, then you have roughly 8 amps going in for a typical “peak period” of 5 hours which is 40 Amp hours. (assuming the panels have good orientation to the sun). This will extend the battery capacity by about a day or two but not much more.

Lets step up to the 220W with good sun orientation: This will increase the charge capacity to 15 amps and so for 5 “peak hours” you should have 75 Amp hours going in. This would give you close to an indefinite period, providing the sun is good and you capture it well.
There is a catch though: The 220W awning can be slightly twisted during the day for maximum orientation but you will still loose some capacity because it cant be perfectly orientated to the sun. So you would be working hard to get the full capacity from it.

You can step up and have the 220W and the 125W suitcase. This should exceed your needs!

Now the last part is the tuning. In the example above, you purchase 220W of solar but for the first few days, but it is overcast and you are not getting much solar power.

How long can you stay?

You need a meter to calculate this and not a Volt meter unless you are an electrical genius. The meter measures current flow in and out of the battery and then calculates the “state of charge” of the battery.

After a day you can see how much capacity you have used and how much longer you can stay before charging with a generator.

There is a step up from this which is included in the Kimberley Platinum off-road camper trailer. The smart touch system measures the current (and therefore the power) coming in from the solar as well as the overall battery capacity.
It will give it to you in amp hours just like the calculation above. This allows you to see if you have less solar coming in as planned or if you are using more battery capacity than planned. Now you can really tune up how you use the power. If you are driving off in 2 days and the vehicle will fully charge the batteries on the up-coming trip, you can plan to juggle usage until then based on up to date solar readings. It makes it far easier to plan your days.

There are locations like National Parks and World Heritage Area that don't allow you to run the generator. In these spots, understanding your use and capacity is important.

There is the alternative of a Fuel Cell. It is silent and can run in areas where generators are banned. Its output is pure water as well as power. These can produce up to 210 Amp hours per day, if you use this much but typically the smaller model with 140Amp hour capacity is well suited.

These Fuel Cells use a methanol liquid cartridge that last for 200hours at full capacity per cartridge for the 140 Amp hour model. If you only get 30-40 Amp hours from solar, then the remaining 30-40 Amp hours per day can be gained from the fuel cell. This would be 5-6 hours of run time from the 200 hour capacity per cartridge.

It is not an exact science while you are relying on solar power. Every day will be different. However, the technology available will make it easier for you to use and decide when to move on and how long to stay!

Section 9:
The weight of adding batteries and solar

9. The weight of adding batteries and solar

AGM Battery Capacity (Lead acid in an "Absorbed Glass Mat")	100 Ahrs	200 Ahrs
Usable Capacity (50% discharge)	50 Ahrs	100 Ahrs
No. of Days Capacity (with Typical Off Road Daily Use* of 30 Ahrs/ day and no solar)	less than 2	6
Weight of Batteries	36kg	75kg

You can add solar to charge the batteries. The larger the battery capacity, a larger the solar bank is required to optimize the investment.

Traditional glass-based solar panels are heavy, and bulky to carry. So there are Traps here.

Glass Monocrystalline Solar Panels	100 Watts	200 Watts	400 Watts
Usable Efficiency on Ground-Mount (placed at fixed angle to sun)	50W	100W	200W
Typical Power Output (usable efficiency with std solar controller)	less than 3 amps per hour	6 Amps/hr	12 Amps/hr
Typical Power Output (usable efficiency with MPPT** solar controller)	4 Amps/hr	8 Amps/hr	16 Amps/hr
Weight of Glass Solar Panels	10kg	23kg	46kg

* Assumes compressor refrigeration, dual water pumps
** MPPT stands for: Maximum Power Point Tracking

9. The weight of adding batteries and solar (ctd.)

An alternative is the Smart Weight Saving of Lithium Batteries and Super-Thin Solar. Let's see the Paired Weight Saving:

AGM Battery Capacity (Lead acid in an "Absorbed Glass Mat")	100 Ahrs	200 Ahrs	400 Ahrs
Glass Monocrystaline Solar Panels	100 Watts	200 Watts	400 Watts
Paired Combined Weight	50kg	100kg	200kg
Lithium Battery at an Equivalent Size & Weight	6.8kg	13.8kg	27.5kg
Super-Thin solar Weight	3kg	6kg	12kg
Paired Combined Weight	9.8kg	19.8kg	39.5kg
Paired Weight Saving	***40kg***	***80kg***	***160kg***

Lithium Batteries are very expensive but offer a lower cost per cycle than AGMs in most applications. This is calculated in the Webinar we run shown below.

The benefit of the Lithium and the Super-Thin solar is significant weight savings as well as significant performance improvements and lower cost to operate.

Lithium Batteries have 96% charge efficiency, whereas AGM is 60% which means 40% less time to charge than Lithium's for the same size battery charger!

Section 10:
The weight of additional water tanks

10. The weight of additional water tanks

As well as Batteries, the other heavy items on board an off-road camper trailer are the water tanks full of water.

Water weighs 1 kg per litre, so carrying 200 litres of water adds 200kg to your weight. Yet water can be the scarest commodity at times and we should always carry more than we think we need.

Is there an alternative to this?

Most travellers carry multiple water tanks. One for pure drinking water and one for showers and washing up. The second tank may be filled with whatever water can be sourced on the way. Additional tanks can be fitted for additional water.

There is a third option.

Pump from a stream or billabong. What this does is expand your available water to potentially an endless supply while camping. Yes, endless hot showers! (assuming your run off is outside!)

This significantly changes the effective on-board capacity when camping.

It also means that if you are travelling to a location with known available water, you dont need to travel with as much water on board. You can travel lighter!

10. The weight of additional water tanks

Is there a catch?

The problem with pumping from a stream or billabong is that you will need to filter the water and pass it through a heat exchanger. This cant be done with traditional gas (LPG) of electric water heaters. But it is done with the Diesel Hot Water from Kimberley.

The other issue is that you dont want to be filling a tank in one operation from the stream and then using the tank. This is laborious. A single switched system is far easier to use.

With the use of heat exchangers, not only is the hot water virtually instantaneous (55 degrees C in less than 5 minutes in most cases) but to switch to a stream or billabong is simply a matter of turning 2 valves and dropping the hose in.

With the Kimberley system you can park near a creek and run endless hot water using the outside shower to clean down nearly anything... preferably it is all natural material!

Separate or Connecting Water Tanks?
We have to report the terrible story of a camper trailer customer who were on a long trip off the beaten track. They had “taps” fitted to the drain of both water tanks. After an overnight stop and a brief hike during the day, they returned to find both taps had been turned “open” by mischieveous visitors.

At Kimberley we now only fit a “tap” to the drain on one tank and require a spanner to remove the “bung” on the second tank. The 2 tanks are not connected!

Section 11:
Braking - how this affects your travelling?

Vehicle Standard (Australian Design Rule 38/04 – Trailer Brake Systems) 2013

Compilation:	1 (up to and including Vehicle Standard (Australian Design Rule 38/04 – Trailer Brake Systems) 2013 Amendment 1)
Preparation Date:	19/09/2014

11. Braking - how this affects your travelling?

Most people travel at a speed and style that matches the braking performance of their combined vehicle and camper trailer.

The better the performance of the camper trailer braking, the more relaxing and stress free for the driver.

Before we compare different braking systems, what are the standards on brakes under the law?

ADR 38—Trailer Brake Systems and...Rule 128 - Performance of Braking Systems. This rule specifies the minimum performance requirements for trailer braking systems, including combinations.

Compliance includes a requirement that a trailer parking brake must be capable of holding a vehicle or combination stationary when positioned on a twelve percent gradient.

The Australian standards require manufactures to know the performance of their brakes on the camper trailer model. They have to certify that it complies to the standard which is a deceleration performance. This test has to be under a special rule “128” which describes how the testing is to be done.

What do these results mean?

The Australian standards test is the deceleration rate of the brakes. This is calculated on speed and the “distance to stop from brake applied” so that comparisons can be made to the standard no matter what the size or configuration of the trailer or caravan. The standard specifies a minimum value and numbers that are greater than this show a higher level of performance. The numbers are negative as it is “deceleration”.

If you load a trailer up or increase the rolling diameter of the tyres then the deceleration will reduce for the same braking system. For this reason the brake manufacturers guide on capacity is not accepted. It must be a complete measurement noted by a certified engineer.

11. Braking - how this affects your traveling.

Lets look at some actual results. The Australian standard is -3.8m/s/s:

The table shows the electric drum brakes comply with the law; the power assisted disc is nearly twice the deceleration compared to the drum brakes. More significant is the power assisted discs have a similar braking performance using the camper trailer brakes ONLY on the vehicle and camper trailer combined compared to the electric drums with the vehicle.

The larger the negative number the greater the braking performance. The legal standard is -3.8m/s/s	4WD Only	4WD and Classic Kamper with Electric Drum Brakes	4WD and Platinum Kamper with power assisted disc brakes	4WD and Kamper with Power Assisted Disc Brakes **BUT only using KAMPER brakes**
Toyota 200 Series Diesel GVM: 2650 kgs	-11.16	-4.45	-7.56	-4.31
Toyota Hilux Dual Cab Diesel: GVM: 1650 kgs	-8.67	-5.02	-8.03	-5.98
Parking Brake		Complies	Complies	N/A

The photo on the left is a prominent “off road” caravan, the one on the right is a Kimberley.

11. Braking - how this affects your traveling.

So what type of brakes are best off-road?
The “industry standard” of braking is drum brakes with electric magnet activation as shown in the photo above. In this braking system, the brake shoes are the same “drum” type brake shoes that used to be used in vehicles except the activation of the brakes is done by pulling the shoes to the drum with an electric magnet. The system then applies pressure all the way along the shoe to the interior surface of the drum.
These brakes comes in two main sizes: 10inch and 12 inch.
The 10inch size is used in the Kimberley test above as they have the lightest weight. They comply with the ADR rules with a 31.5inch tyre and an ATM of less than 1600kgs.
Proper electric brake adjustment is essential before banging occurs in the brake coupler.

One of the problems to look for with electric drum brakes is the quality of the installation.

Look at this close-up photo of the same image above to see the “joining” of the white electric wire from the inside of the brake drum to the black curly cord to the trailer plug.

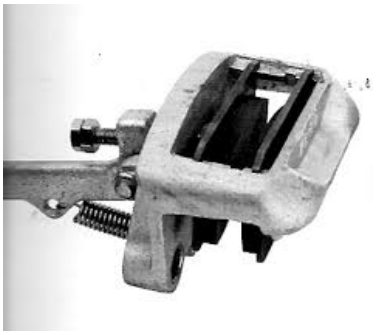
It is held onto the axle ***with a plastic electrical tie.*** This won’t last very long off-road and your brakes would fail if the cable separated at the join. Worse still would be to lose one brake and snake across the road!

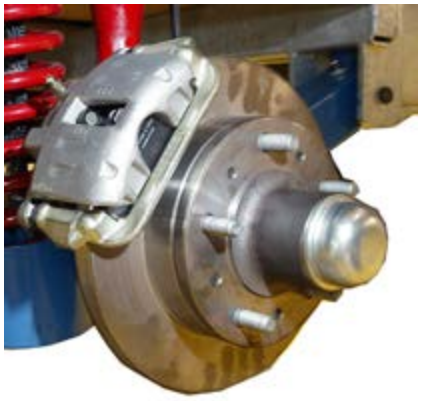
11. Braking - how this affects your traveling.

The other type of braking are Disc brakes and these come in 3 different set-ups:

1. Mechanical disc
2. Hydraulic Disc
3. Power assisted Hydraulic Disc (using electric brake controller in 4WD)

1. Mechanical disc brakes have the lowest level of performance and are also the lowest cost. The common brand is “Alko”. At Kimberley, we don’t use, and would never use this low level of braking. They are often included with camper trailers offering “no frills” in their setup. They may just pass the standards test with no or a light load and 14 inch tyres!





2. Hydraulic Disc is popular where there is no mountain travel. This setup uses the “over-ride” pressure from the vehicle to apply the brakes. They are great off-road where there is no significant mountain travel.
3. Power assisted Hydraulic Disc uses an electric brake controller in the 4WD to signal to a hydraulic actuator which is power assisted. These are the top of the line in braking and commonly used in military applications as well. This is the type Kimberley use on the Platinum model camper trailer.

11. Braking - how this affects your traveling.

You will feel that the “rig” is lighter and more flexible to drive with better braking.

Power assisted disc brakes can offer nearly twice the stopping performance to Drum Brakes and on make a noticeable difference in stopping in an emergency. They also don’t require a huge vehicle.

A common setup with off road camper trailers is:

- 2 x 10 inch Drum Brakes
- Electric control of magnets to Activate
- Hand mechanical cable for parking brake

The problems with these brakes are:
- Drum Brakes fade when hot
- Drum brakes reduce performance with wet
- Drum Brakes with magnets are heavy

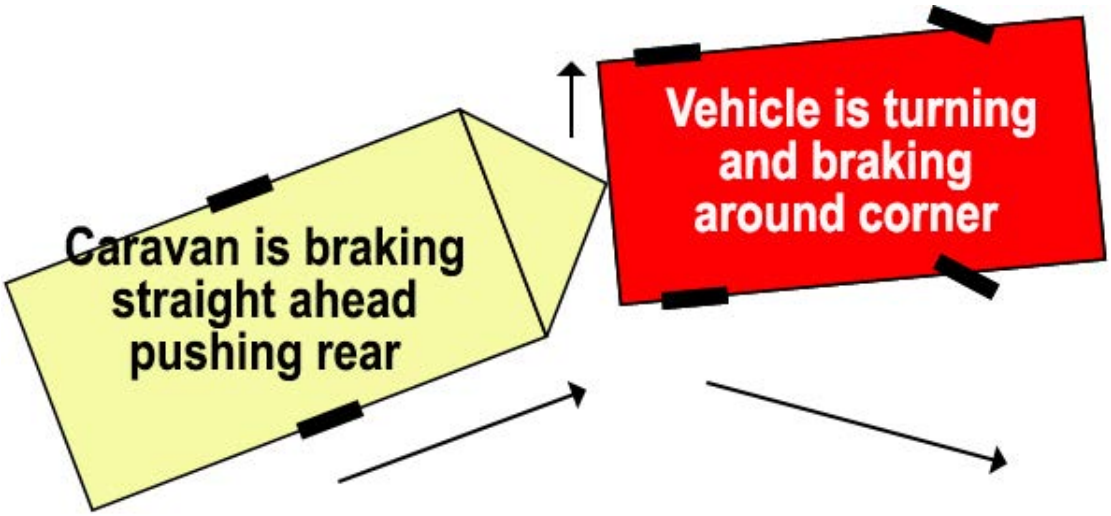
If you pay to upgrade to Hydraulic disc brakes you get:

- Half the weight
- Easier to maintain
- Should have thick rotors, which fade less when hot
- Have twice the stopping power
- Electric control of hydraulic activation
- Can have one touch hydraulic parking brake

Whilst Hydraulic disc brakes are more expensive to buy, the maintenance costs are a fraction of drum brakes.

What would suit you?

11. Braking - setting up for an emergency.



Have you had to do a emergency caravan braking on a sharp corner? Or have you found that stray animal in the middle of the road at a bend and you have to brake and turn?

If you have done this successfully you would most probably have applied the caravan or camper trailers brakes remotely from the vehicle first, then applied the vehicle brakes. Why?

If you apply the vehicle brakes hard and fast and turn the wheel, the vehicle will turn but the caravan or camper trailer is still in a straight-line. It will tend to push the rear of the vehicle out and induce a dangerous spin inertia on the vehicle.

If you apply the caravan brake hard and fast just a second or 2 before the vehicle, there is the reverse effect. The caravan or camper trailer acts like a large parachute on the rear and slows the whole turn inertia down. You feel more in control to get out of a difficult predicament.

11. Braking - setting up for an emergency.

For this to happen, you need 2 things:
1. The brake controller in your vehicle has to be so close to where you normally keep your left or right hand. You need to be able to locate and slide/activate it fully without taking your eyes off the road.
2. You need very good brakes on the caravan or camper trailer that can apply fully braking and not fade.

For the first point, there are many electric brake controller installers that want to install the manual controller “out of the way” or on a dummy dash position that has minimum impact on how the vehicle looks.
Please say “no thanks” unless it is the perfect position.
If looks are a concern, here is an alternative: On a fairly expensive Range Rover, the author has a “hard shell velcro strip” on the top of the brake controller and this presses up on a discrete metal bracket with the matching “hard plastic” velcro. This sits just under the dash 100-150mm from where the left hand is on the wheel. It can be applied as fast as a flash.
Several practice runs are made at the start of every trip to get the reflexes and “feel” just right. On every trip so far it has been used at least once!

The second point is the most important. The Australian Standard on braking stipulates a measurement of the effectiveness of the braking with a tow vehicle. The problem with this measurement is if you have a powerful tow vehicle, the caravan or camper trailer braking test will probably pass every time. The 6 pot disc brakes on the Range Range will even pull up an un-braked trailer within the standards. So this doesn’t give good assurances for emergency caravan braking when you are applying JUST the caravan brakes.

11. Braking - setting up for an emergency.

A simple way to measure how effective your brakes are is by doing an emergency “pit stop” at a low controlled speed and then measuring the distance covered. This is broadly how the Australian Design Rules describe the testing of Caravan and camper trailer brakes. Rule 128 stipulates the exact testing process.

Vehicle Standard (Australian Design Rule 38/04 – Trailer Brake Systems) 2013

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Preparation Date: 19/09/2014

Manufacturers should do this on each model to ensure that they comply.
Then do this on the caravan brakes only and you can compare it to our findings below.
Please do this in a safe section of private road with no traffic. Use a maximum speed of 35klm/hr. No faster please!

Brake manufacturers issue guidelines from what they estimate their brakes should be able to achieve but we have never seen these documents state compliance to the Australian standard brake tests. Why not?
There are 9 factors that link the braking capability of your caravan or camper trailer with the braking outcome as described by the standard:

1. The size of the wheels and tyres: a larger rolling diameter requires higher braking capacity
2. The weight of the caravan or camper trailer: the heavier the weight, the higher capacity required
3. The weight of the vehicle: The heavier the vehicle, the stronger the stopping capacity if the vehicles brakes are more effective
4. The matched balance between the drivers and passenger’s side braking components and/or the electric signalling system: Any imbalance and the caravan or camper trailer will push to one side

11. Braking - setting up for an emergency.

regardless which can be dangerous.
5. The speed of the vehicle: the faster the speed the greater the braking capacity need. For double the speed, it is 4 times the capacity required.
6. The road conditions: Uneven loose stones give less grip
7. The weather, specifically if it has been or is raining: water can cause aquaplaning and brake fading
8. The vehicle's braking ability: How many pots and what size on the vehicle?
9. The change in drawbar weight when the braking is applied; and the effect this has on the rear brakes of the vehicle: if the nose goes down because the caravan or camper trailer brakes are highly effective, there is more pressure on the rear of the vehicle for potentially a better result.

Given these factors, it is impossible for a braking component supplier to make a compliant statement with respect to the standard without a practical test. It is the caravan or camper trailer manufacturer that should do a practical test for the peace of mind of their users!
The test describes a precise way to calculate the braking deceleration of the combined vehicle and caravan or camper trailer.
The standard of braking performance is 3.8 metres per second per second that has to be complied with. Don't be concerned with this number, we will give you practical meter distances in this article for you to compare with.
Before looking at some data, consider again the impact of your vehicle size:
At Kimberley we use a Hilux Diesel with a GVW of 1650kgs and a Toyota 200 Series with a GVW of 2650kgs. Both vehicles are at least 5 years old and fairly represent a "typical" tow vehicle in their class. Neither have been modified nor have non-standard braking systems. This gives a fair range of results and representation for users.

11. Braking - setting up for an emergency.

The results below are in meters after applying brakes with an off-road camper trailer or off-road caravan attached to a vehicle.

Distance to perfect stop in a straight line from 35km/hr to zero.

Distance to perfect stop in a straight line from 35km/hr to zero.	Vehicle + 1.2 tonne Kimberley Kamper power assisted Disc Brakes	Vehicle + 2.1 tonne Kimberley Kruiser S Class power assisted Disc Brakes	Vehicle + 2.8 tonne Kimberley Kruiser T Class power assisted Disc Brakes
With Hilux Dualcab Ute towing (Amarok Dual Cab Ute with T Class Kruiser) (1.65 tonne)	6.05m	5.7m	4.84m
With Land Cruiser 200 Series (2.65 tonne)	5.55m	5.43m	4.59m

There are some interesting points here to note.
The power assisted discs are very powerful brakes. Their stopping power is in excess of the independent report published by “AL-KO Sensabrake TM” for their own braking system (we calculate the deceleration from their report).

The Tandem axle braking is superior to the single axle caravan because the double braking capacity outstrips the additional weight. The other interesting thing is the stopping distance for the heavier single axle Kruiser is less than the Kamper with the 200 Series.

Why is this? The weight distribution on the Single axle S Class is just perfect for maximum braking. The wheels don’t lock and the brakes are right on the money.

This is 220% of the requirements of the Australian Design Rules!

11. Braking - setting up for an emergency.

The results below are in meters after applying the brakes **manually** on the off-road caravan or camper trailer ONLY and stopping on just these brakes.

So the vehicle brakes are not used and this is a measure for emergency caravan braking STOPPING USING THE CARAVAN OR CAMPER TRAILER BRAKES ONLY

Distance to perfect stop in a straight line from 35km/hr to zero.	Vehicle + 1.2 tonne Kimberley Kamper power assisted Disc Brakes ***USING THE Kamper BRAKES ONLY***	Vehicle + 2.1 tonne Kimberley Kruiser S Class power assisted Disc Brakes ***USING THE Kruiser BRAKES ONLY***	Vehicle + 2.8 tonne Kimberley Kruiser T Class power assisted Disc Brakes ***USING THE Kruiser BRAKES ONLY***
With Hilux Dualcab Ute towing (Amarok Dual Cab Ute with T Class Kruiser) (1.65 tonne)	7.95m	20.02m	14.95m
With Land Cruiser 200 Series (2.65 tonne)	10.95m	21.0m	16.54m

There are some interesting points here to note. The lighter combined vehicle mass with the caravan or camper trailer gives the best result. This is to be expected.

The Tandem axle braking is superior to the single axle caravan because the double braking capacity outstrips the additional weight.

These results are at 35 km/hr. If you are going much faster you need a much longer distance. But this data gives you a practical guide of the “parachute” effect of apply the caravan or camper trailer brakes ahead of the vehicle.

12. Suspension- Leaf, coil or Air?

Suspension innovation is probably the most important factor in a 4WD's off-road superiority.

In 1970, at a time when almost all 4WDs used primitive leaf springs, Range Rover pioneered the use of soft, long travel coil springs on all four wheels. This caused a lot of skepticism among off-road journalists. The result was a delay until 1987 introducing this feature to the USA for fear the market may not accept such innovation. The benefit of extreme axle articulation became clear to everyone.

Other 4WD manufacturers started incorporating it some 5 years later. No one could then believe they were ever skeptical and this innovation became the norm!

Then in 1993, Range Rover suspension design took another leap ahead into the next generation of innovation: electronically controlled, self leveling, variable height pneumatic suspension. (This is where we are today with off-road caravan air-suspension, some 20 years later)

This gave the driver the ability to reduce ride height for high speed cruising, increase it for off-road clearance, maintain a level ride regardless of load, and maintain articulation. The staggering capabilities of this system, in combination with the simultaneously introduced electronic traction control, took the 4WD world by surprise.

Now the Range Rover suspension innovation has progressed: The air-springs are cross-linked (left to right) when off-road, reducing the effective spring rate to near zero. This not only softens the ride but increases the ground contact force and traction considerably on a drooping wheel. It also makes the independent setup simulate the articulation motion of a beam axle, getting around the usual criticisms of reduced effective off-road clearance on uneven terrain that independent suspensions usually receive.

This is where we are heading at Kimberley but it will take some development and test time to get there.

12. Suspension- Leaf, coil or Air?

High end models can be equipped with an air suspension system. We studied the theory of suspension in commercial trailers which is a closer starting point than most people realize.

Our motto on innovation is: “Without understanding the theory, experience will not teach”. So it has taken years of experience layered on top of the theory of suspension in trailers to get to this point.

We believe you cant “add on” top of the line suspension. It has to be part of the design right from the beginning. So lets look at our journey to get to this point!

Leaf Springs

Leaf springs were common-place pre-2000 with most focus on the dampening of shock absorbers over the difficult terrain. Independent suspension was being used in higher end camper trailers.

We had our own experience with leaf springs which we fitted to our “Escape” and early ”SportsRV” models. The photo on the right shows the electric drum brake hub and Old Man Emu shock absorbers with a 7 leaf spring. Note the red “bump stop” was used in the leaf spring.

This set up resulted in no spring failures.

However, the load range for this type of suspension is limited.

In the photo you will see a 300kg+ quad bike loaded on the front of the author’s Kimberley Kamper that had leaf suspension. There was a 300mm jump to get onto this bridge!

In poor roads and conditions, travel speed slowed to a snails pace

12. Suspension- Leaf, coil or Air?

and the rig jumped around like a kangaroo. Every bump was noticed and the tie down straps re-tensioned every 100 klms (or less).

Whilst this is an extreme weight, it is the extremes that test the theory of our designs. After towing this, it was decided to leave the leaf springs and standardise on independent suspension for every model. This has been the case since 2005.

The one benefit of leaf spring suspensions is higher inherent roll stability. This is now overcome and in fact surpassed in the coil and air suspensions by adding anti-sway bars.

The coil springs on a Kimberley Kamper go deep into the cups and the upper mounts for secure positioning. Inside the coil spring is a sewn web strap to prevent over extension of the shock absorber.

In this photo you can also see secondary “bump stops” to also limit compression of the shock absorber. These secondary bump stops are polyurethane and compress at a higher spring rate to absorb any huge thumps on the suspension!

The shock absorbers in this photo are Fox mono-tube.

Aside from the advantages of much-improved ride and steering control over bumpy terrain, one of the difficult design constraints is the load on the vehicle and travel conditions.

Using soft coil springs improves the ride until the vehicle load goes over the design limit and the coils are struggling to hold up. Then trouble is on the horizon.

When air-springs (air-bags) were first introduced, the story was similar. The air-bags were rated at a maximum pressure and heavy

12. Suspension- Leaf, coil or Air?

vehicle loads pushed past this.

Although Range Rover were using major manufacturers like Firestone for the actual bags, the fittings and compressor were not always as reliable for the high duty rate.

Overall, the market accepted the innovation but reliability stories held back overwhelming acceptance. The author has had 4 Range Rovers and whilst only one required some minor air suspension refit, it was expensive and could not be done “in the bush”.

The designers have now understood that it is not just the actual “airbags” that are the weak link in the system but all the fittings, compressor and tank that go with it.

Reliability is now up to par with mechanical systems. Prices are now reasonable especially replacement air-bags which can be sourced in many locations around Australia.

Leaf Springs	Coil Springs	Air Springs
Low price	Moderate Price	High Price (for system)
Limited spring rate range for weight; good inherent “anti-roll” capability	Moderate range of travel length and weight carrying ability	Widest range of weight and spring rate for softest ride potential.
Limited travel	Can have long travel length	
Friction of the leaves gives some variable spring rate	Generally no variable spring rate	Can have variable spring rate (Kimberley premium air springs do)
Needs wheel chocks or digging holes to “level” camper trailer in camp.		Quick adjustment when camping for a level trailer.
Good for consistent loads over reasonably good roads at moderate speeds	Good for difficult roads with good stability at speed if designed with low unsprung weight of hubs/ brakes/ wheels	Good for adjusting ride height: low on the black top roads for better fuel consumption and stability at speed; high when off road. When combined with anti-sway bars, very good stability at speed.

Section 13:
Shock Absorbers: Saviour or Slave?

13. Shock Absorbers: Saviour or Slave?

Every modern vehicle in Australia has shock absorbers. They are an essential part of the suspension and it would be hard to have a suspension legally approved for a vehicle without them. It would be unsafe with independent suspension if there were no shocks.

The science of Shock absorbers

In simple terms, a shock absorber's purpose is to dampen the suspension as it goes up and down. Without them, your caravan or camper trailer would continue to bounce up and down until all the (kinetic) energy is finally dissipated by friction in the springs.

Energy can't be "destroyed", so the shock absorber converts this (kinetic) energy into heat as it dampens the "bouncing" of the springs. So in difficult terrain, shock absorbers have to get hot or they aren't doing much.

How does a shock convert to heat energy and then dissipate it?

By forcing a piston through oil, shocks develop hydraulic "friction". There are tiny holes (Orifices) in the piston head and these orifices let only a small amount of fluid through the piston, which in turn slows down spring and suspension movement.

The heat is then dissipated through the body of the shock absorber. If the shock absorber can't dissipate the energy fast enough, the seals will overheat and fail. Then the shock absorber can no longer function. Then it is a pain-full "limp" to the repair centre.

13. Shock Absorbers

Some suspensions, generally “multi-leaf spring”, may not use shock absorbers. They rely on the rubbing of the steel leaves to “dampen” the energy. While this is a simple concept, the amount of energy absorbed is far less than using shock absorbers. Some of the energy has to transfer to the vehicle or to the camper trailer/caravan.

Driving with this type of suspension will be totally different!

How much of Australia do you want to experience?

Shock Absorber Choices

There are broadly 2 types of shock design.

Lets look at the table below:

	Single Dual-Tube Shock Absorbers	Single Mono-tube Shock Absorbers
Light weight Camper Trailer less than 1,400 kgs ATM	Are fine	Are fine and allow travel at better speed
More loaded Camper Trailer with higher ATM than 1400 kgs	May require lower travel speed	Are preferred
Off Road Caravan	Not Advisable	Are excellent

13. Shock Absorbers

Mono-tube shock absorbers are much more expensive. They cost more than double the typical twin-tube shock absorber.
Are they worth it?

Monotube shocks have an advantage, since their larger pistons displace more oil for a given stroke. This is especially true for the rebound stroke. The greater the amount of oil moving through a shock's piston, the easier it becomes to regulate the flow and thus control the dampening forces of the shock.

Monotube shocks are also less prone to fade and failure due to heat. They stay cooler because the piston and oil are in direct contact with the outside wall of the cylinder allowing for better dissipation of heat.

Most twin tube shocks use a rupture-prone gas bag or "foam seal" to hold the nitrogen. When this seal or bag breaks the nitrogen mixes with the oil making the shock skip as the gas moves through the piston orifices. A bubbling noise can be heard when the shock is actuated by hand.

Corrugations are the killer and should be the determining factor in shock absorber choice!

When travelling over corrugations, the "up and down" cycle, whilst small, is fast. The faster the speed of the cycle, the more resistance the shock absorbers provide. The more resistance, the higher the heat energy.

Because at higher speeds the shocks do not move very much (as low as 5-10mm across corrugations), the build up of heat is concen-

13. Shock Absorbers

trated around a very small area adjacent to where the valving and seals are located. The heat build up is in the oil, which is in contact with the shock body, which then dissipates the heat. The critical success factor becomes how quickly the shock absorber can dissipate that heat before the seals “blow”.

The energy dissipation calculation for a typical 41mm twin tube shock in the corrugation example is less than half that of a 52mm Monotube shock. This is because of several design factors:

- Increased surface area
- Increased oil volume (and the quality of the synthetic oil in a monotube)
- Increase in the heat transfer: In a twin tube, heat has to pass from the inner tube, through a steel case and air to an outer tube and then to the ambient air. Whereas, in a mono-tube, the heat passes from the oil to the Aluminium tube to the ambient air.

Aluminium is also a far great conductor of heat than steel. And it is during the corrugations that the rate of heat build up is dramatic. Kimberley originally used OME Twin tube shocks. the failures were more frequent than we liked and the “bushings” of polyurethane often melted. When you see melted bushings it is a case of high speed over corrugations. We now only use stainless steel bushes on the mono-tube shocks.

Shock design is the first factor and geometry is the second factor with shock absorber performance.

Often, dual twin tube shock absorbers are used because the suspension design does not allow a 90 degree orientation of the shock

13. Shock Absorbers

to the wheel travel and it is a way to gain more capacity. Twin tubes are also typically shorter. So you may see 2 short shocks at an off set angle in the suspension frame to make up for the acute angle.

The third factor with shocks is in fact not the shocks but the “unsprung weight” of the suspension. The “unsprung weight” includes the weight of the independent suspension arm, the hub, the brakes, the wheels, and the tyres. It is called “unsprung” because it sits below the springs.

The best suspension design reduces this weight to a minimum. It is why alloy wheels are so popular with performance cars. By reducing this unsprung weight to a minimum increases the resonant frequency so at any speed the effects on your caravan are similar to what you would get if you SLOWED DOWN towing a caravan with a higher unsprung weight.

We are assuming that everyone wants to travel as fast as they can.

If you pick up speed to say 100 klm/hr over corrugations then your tyres only hit the road at the tops of each bump and the car is in the air the rest of the time.

The benefit at this speed is the suspension should not resonate and the forces on you and your suspension are less. The shock absorbers will experience less heat buildup.
The disadvantage is you will have poor steering and braking. You are in the air so the tyres cannot help you if you need to change direction or speed. (Please don’t try this as it is really deadly).
As you slow down, the reverse occurs. You get better road control for safety but the heat build up in the shock absorbers is increasing.

13. Shock Absorbers

A better approach is to lessen the tyre pressures. Set these pressures to below 30PSI for corrugated roads. Then travel at the safest (high) speed for the road and conditions (visibility, unseen corners etc) and for these lower tyre pressures.

Reducing tyre pressures reduces the frequency of oscillation of the tyres and makes the tyres absorb more of each bump. When the tyres are hard they act as a solid and the whole wheel and suspension must bounce upwards on each bump they hit. But if the tyre is softer, it flexes and the suspension receives less of the energy of the bump thus reducing the stresses on the suspension while still maintaining tyre to road contact.

At Kimberley, we try to guide customers on where they are with speed and tyre pressures. We do this by fitting heat sensors to the back of the high capacity shock absorbers. For a given road, you can see the temperature impact of speed and pressure. You don't need to keep examining these, it is a guide for you to get a feel and education on what is working best. Once you establish this, you may not look at the guide for weeks.

This customer guide has been a huge success with very, very few shock failures in a travel season. We estimate that 50% of the 6,000+ Kimberley's built are traveling every year so the facts speak for themselves!

Section 8:
Size of the vehicle - size of the off-road caravan

14. Size of the vehicle - size of camper trailer

The “off-road guidelines” for balance between the size of the vehicle towing the caravan and the caravan are significantly different to “on-road”.

If the Vehicle GVM is less than the all up weight of the off road camper then you will be in the precarious situation of the camper being heavier than the vehicle. When going off-road, this is the tail wagging the dog! Big tail, small dog.

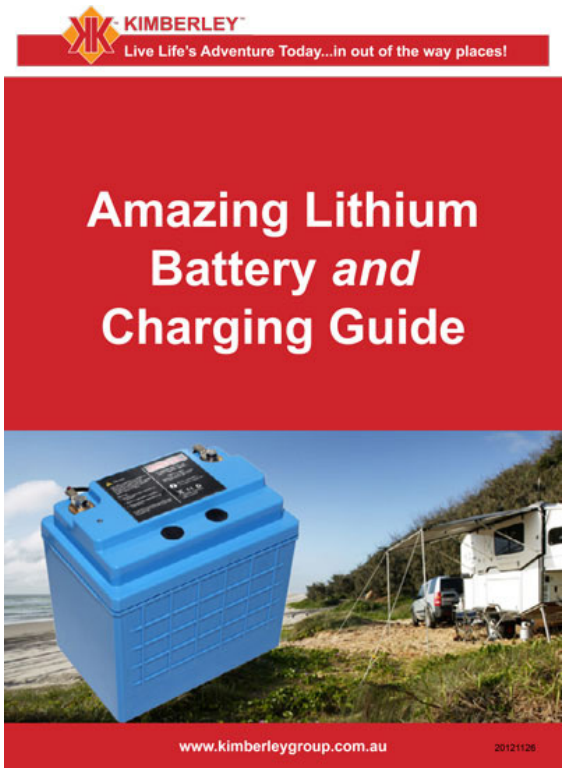
This table was originally developed for much heavier off road caravans. However, the same principles apply.

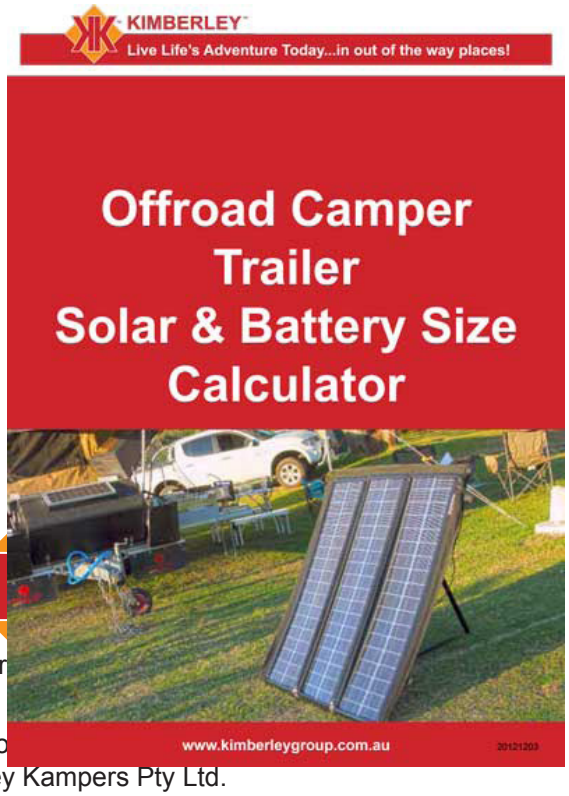
The table below are our own guidelines based on experience with 6,000 or more units off-road.

	On-Road	Outback	Off-Road
Percenatge weight of the off-road camper all up weight (called ATM) that the vehicle should equal or be less than	The vehicle specification lists the maximum total weight that can be towed and ball weight.	Generally the vehicle GVM should be more than 100% of the camper ATM.	Generally the vehicle GVM should be more than 115% of the camper ATM.
Example	*Most vehicles list maximum towing weight at 2500-3500kg.Typical ball weights are 200kg+*	*If the Camper trailer ATM is 1500kg then Vehicle GVM should be similar*	*If the Camper ATM is 1500kg, vehicle GVM to be 1725kg A heavier vehicle than this just improves the ratio!*

Eight eBooks and growing!

These are the other guides available on the Kimberley Kampers website:





More on next page

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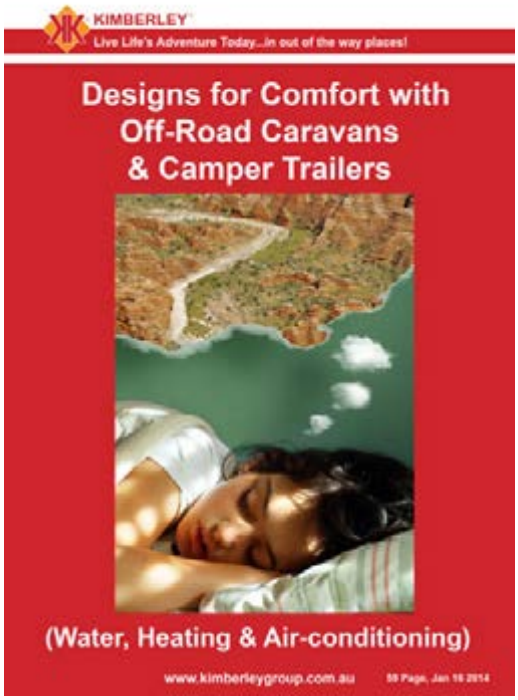

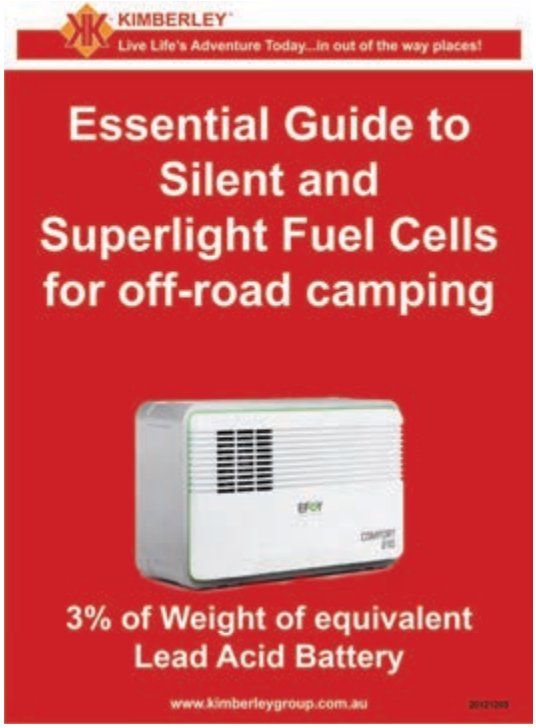

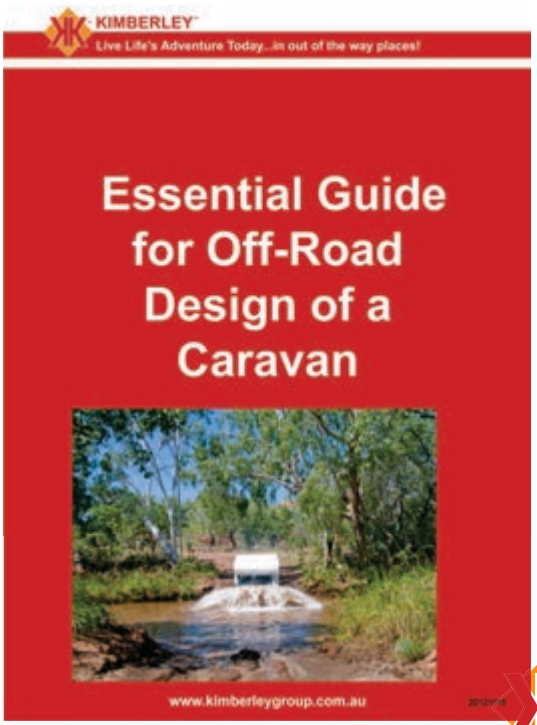

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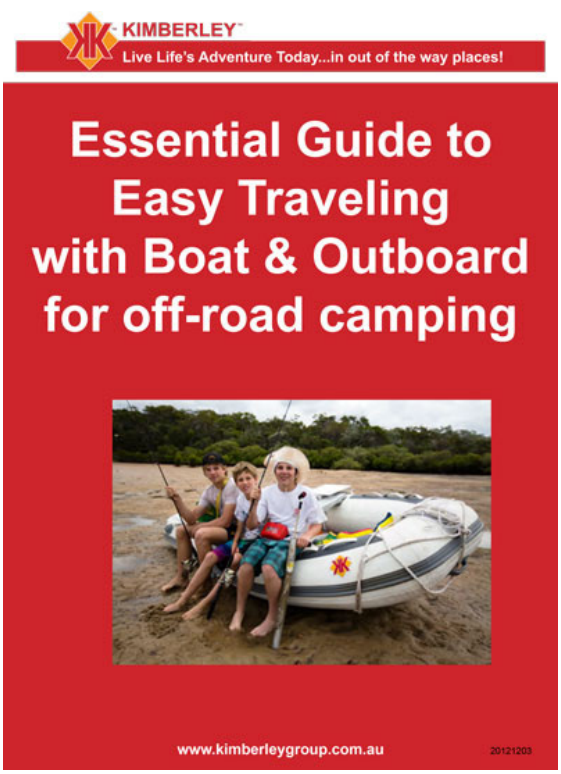

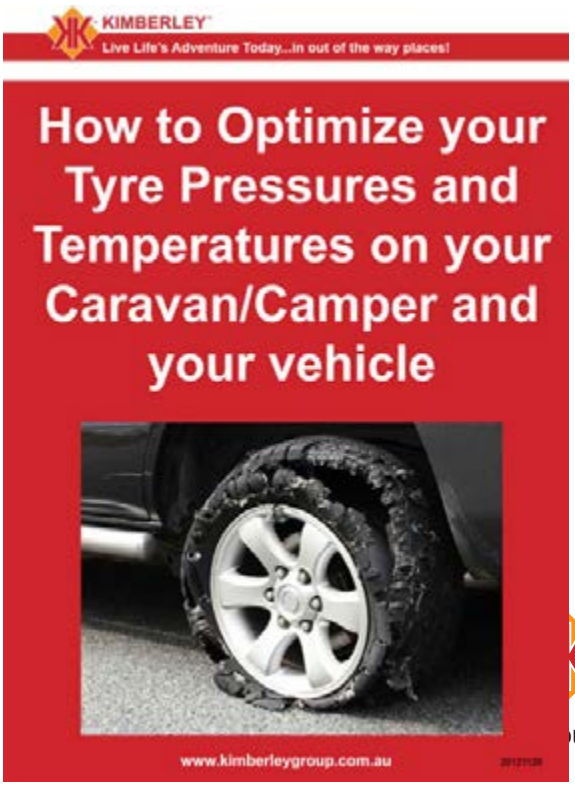

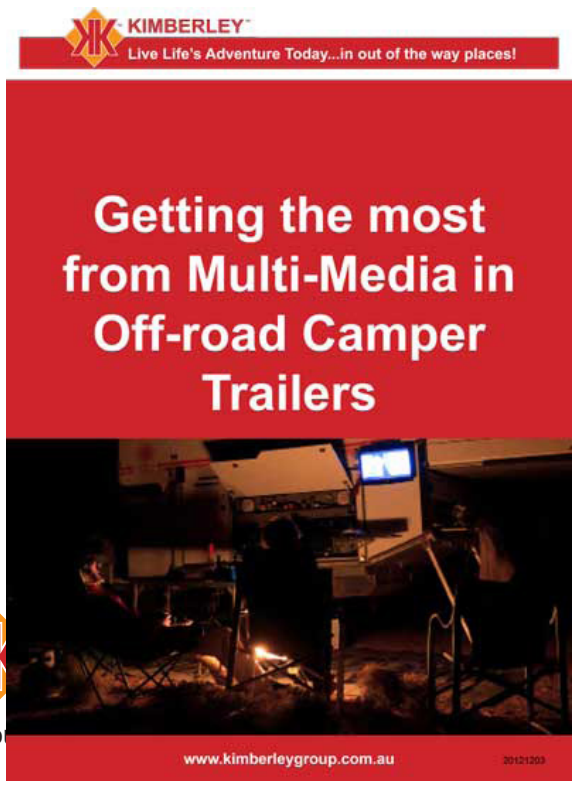

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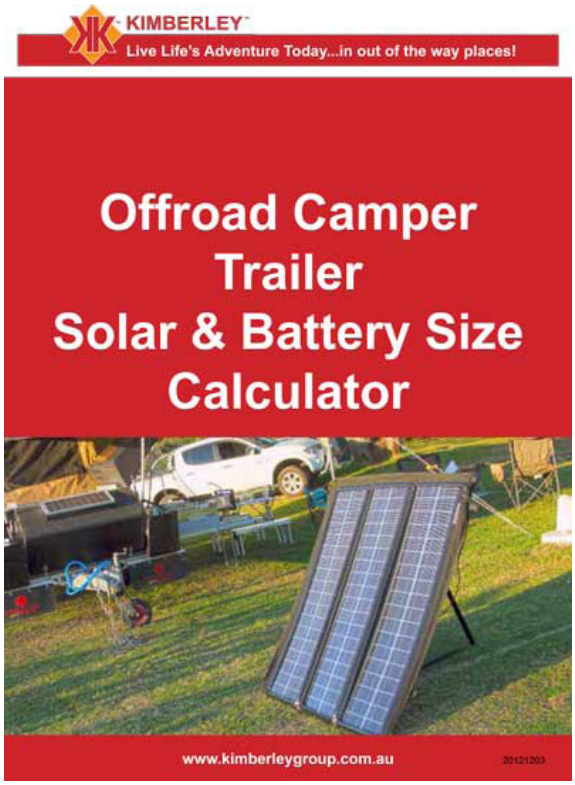

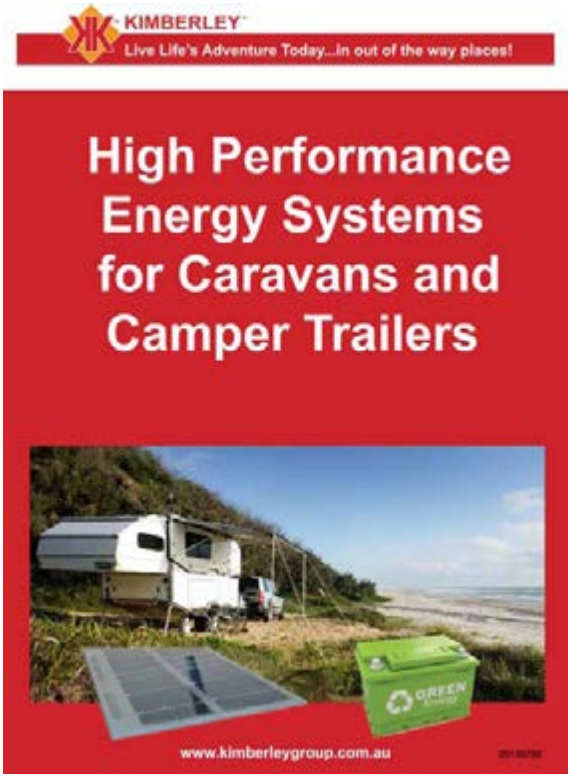

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Conclusion & Additional Resources

We hope this eBook has at least one thing that has assisted you. Our Vision is:

- to have safer and easier to tow caravans and camper trailers
- to have more self sufficiency to not leave a trace
- to pro-long the use of national parks with free camping, unlike USA!

so that more Australians can Experience all of Australia.

Summary of Questions	On-Road	Outback	Off-Road
Do you want to go anywhere and experience all of Australia?			
Is the setup time and pack up time fast enough to match your pace?			
What kitchem, cooker layout are you comfortable to use?			
Do you want to interchange camper wheels with vehicle?			
Do you want to stay in National Parks that don't allow generator use?			
Do you want to be cool and comfort-able? Does the heat affect you?			
Do you want to travel to locations that specify "leave no trace" ?			
Do you want to use local water from a stream or billabong easily?			
Do you want maximum airflow with midge proof screens?			

Tooloom National Park's scrub rainforest is World Heritage Listed and includes important areas of red and flooded gum. There are ten species of kangaroos and wallabies in the park, including the threatened long nosed potoroo. Location:
10km South-West of Urbanville in NSW