



**VEHICLE CLUB  
Wellington**

# **4WD VEHICLE FAMILIARISATION AND DRIVING TECHNIQUES**

**SECOND EDITION  
October 2022**

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## Disclaimer

This document has been produced specifically as a guide to Prospective Members of Cross Country Vehicle Club Wellington Incorporated to assist in their participation in the clubs introductory training course.

It is a guide only and makes no claim to be the definitive 4WD document.

It has been compiled by club members based on their knowledge and experience gained over many years of four wheel driving.

Cross Country Vehicle Club Wellington Incorporated accepts no responsibility or liability for any injury, vehicle damage or loss of any kind resulting from any person using this document as a guide when four wheel driving.

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## Chapter 1 – INTRODUCTION TO CCVC

These notes will introduce you to the Cross Country Vehicle Club (CCVC), technical terms and details about 4WD vehicles, safety requirements, equipment and driving techniques that will be discussed and practised during the practical session of your 4WD Vehicle Familiarization trip.

### CCVC Web Site

The Club web site is located at <https://ccvcwellington.wildapricot.org/> and has information about trips, Club policy and notices.



### Trip Categories

CCVC trips are divided into a number of categories to accommodate the varying skill level of drivers and the capabilities of the wide range of vehicles that may be used. The trip categories are designated as follows (in order of increasing difficulty): Touring, Family Shiny, Shiny 4X4, Club 4X4, and Hard Yakka.

Prospective members and visitors (except those belonging to another recognised 4WD club) may only take part in Touring and Family Shiny category trips. There are no special vehicle requirements for these trips other than the vehicle must meet the club's current [vehicle requirements](#).

Members wanting to participate in Shiny 4X4, Club 4X4 and Hard Yakka trips need to have completed the driver training, have a current vehicle inspection sticker on their vehicle and meet any other requirements for the trip category. A full explanation of each of the trip categories can be found in the Club newsletter, the CCVC Visitors Guide and on the [Club web site](#). If in doubt, telephone and check with the trip leader. Also, do not just turn up expecting to go on the trip. Attendance on any trip must be pre-booked unless the trip listing specifically states that booking is not required.

### CCVC Club Committee

All members of the Club are eligible to serve on the committee. Committee membership is voluntary and endorsed by the members at the Annual General Meeting (AGM). Officers of the Club (President, Deputy President, Secretary, Treasurer and Club Captain) are elected annually at the AGM. The Club Rules (constitution) is available to members in the [Memberzone](#) on the Club website.

The Club Committee oversees all of the governance activities of the Club including:

- approval of all membership applications
- appointment of Trip Leaders and Vehicle Inspectors
- approval of Safety Rules and Safety Procedures
- approval of all Club expenditure

### CCVC Club Captain

The CCVC Club Captain is responsible for the promotion of safe practices and ensuring that the Club's established safety standards are current. The Club Captain also convenes the Trip Leaders' Forum, which enables all Trip Leaders to share concerns, lessons learned and best practices with each other.

Please help the Club maintain its excellent safety record by complying with the Club rules and safe driving practices. The Club Captain's name and contact details can be found inside the front cover of the Club monthly newsletter.

### Safety Equipment

[CCVC Vehicle and Equipment Safety Rules](#) require that all Club Members' vehicles used on Shiny 4x4 trips and above are equipped with a full set of safety equipment.

However, participants on Touring and Family Shiny trips are encouraged to carry the following basic equipment in their vehicle:

- fire extinguisher (0.9 kg dry powder or 1kg foam) and first aid kit,
- basic tool kit as supplied by vehicle manufacturer,
- spare wheel and tools to change a wheel,
- shovel.

**Note:** the fire extinguisher and first aid kit should be easily accessible. All loose items must be properly secured or stored to prevent movement, especially in the event of a roll-over.

### Tow Hooks and Recovery Straps

All vehicles on Club trips (other than "Touring" and 'Family Shiny' trips) must be fitted with 'rated' recovery points to the front and rear of the vehicle. These may either be 10,000 lb. / 4500kg 'rated' tow hooks or specially designed and ADR approved recovery points for the specific vehicle model. Tow hooks and recovery points must be inspected and approved by a Club Vehicle Inspector.

Recovery hooks must be attached to the vehicle by one of the approved methods as shown in the [CCVC Minimum Standards for Tow Hook Mounting](#) document on the CCVC web site. (See RECOVERY EQUIPMENT below for more on 'Rated'). ADR approved recovery points must be installed as per the manufacturer's instructions.

A rated 8,000 kg kinetic recovery strap / rope is also required for all vehicles participating in Shiny 4X4 trips and above.

### Roll Cage

All soft top or open top vehicles must have a roll cage fitted that has been approved by a Vehicle Inspector.

### Vehicle Inspectors

The CCVC Club Committee appoints approved Vehicle Inspectors. These are the only people who can issue a Vehicle Inspection Sticker (see below) confirming that the vehicle meets the [CCVC Vehicle and Equipment Safety Rules](#). The Club newsletter, web site and CCVC Membership Application Forms have a list of CCVC approved vehicle inspectors and their locations. Vehicle inspections are a free service so please remember that you are availing yourself of the inspector's valuable time, bookings may be required. It is strongly recommended that you discuss the fitting of recovery hooks with a Club Vehicle Inspector before you have them fitted to your vehicle.

### Vehicle Inspection Sticker

Trip leaders will not allow Club Members to go on a Club trip (other than Touring and Family Shiny trips) if their vehicle does not have a current Vehicle Inspection Sticker. Stickers are issued two (2) yearly by a CCVC approved Vehicle Inspector. Some vehicles may need modifications (at a cost to the owner) to meet the Club standard.

It is important to remember that the vehicle inspection sticker, like a WOF, is issued based on the vehicle "as presented" to the Inspector on the day. If any modifications or additions are subsequently made to any items subject to inspection, then the vehicle needs to be reinspected.

## Chapter 2 - KNOW YOUR 4WD VEHICLE

### Types of 4WD Vehicles

Four wheel drive (4WD) vehicles are available in a number of different types. These include single and double cab utes, large sport utility vehicles (SUV) or wagons, small and medium size SUVs or soft-roaders. 4WD vehicles can be divided into two broad classes based on the type of chassis construction, namely “body on frame” and “monocoque chassis”. Vehicles using body on frame construction are generally more heavy duty and include most utes and older SUVs. Newer vehicles tend to use monocoque construction to reduce weight while improving crash safety and ride comfort. It is important to understand what you want to use the vehicle for before making your selection. There is no perfect 4WD as each vehicle has its strong and weak points.

### Propulsion

4WD vehicles are available with petrol and diesel engines as well as hybrid and full electric propulsion.

Petrol engines develop their best torque at higher revs than do diesel engines; to get more power you use more accelerator. Diesel engines are able to produce high torque at low revs. Manual gearbox diesels are also able to harness the high engine compression to provide excellent engine braking during hill descents.

Electric 4WD vehicles are able to produce maximum torque from standstill, and with regenerative braking promise to be very capable off road. The jury is still out as to the real-world performance of hybrid 4WD vehicles.

### Drivetrain

One of the most important aspects of a 4WD vehicle to understand is the drivetrain. Vehicles may be fitted with either a manual or automatic transmission or gearbox. The transmission may be connected to the wheels through a part-time, all wheel drive or full-time 4WD system. Each system offers a number of advantages and disadvantages. Understanding these will help you select the vehicle that best suits the type of four wheel driving you want to enjoy.

#### ***Automatic Transmission***

An automatic gearbox gives good traction control in sand, water and hill climbs and has no clutch to cause problems when in water. Normally leave the transmission in D (Drive) unless you want to crawl over boulders, slowly traverse ruts and ditches or to use engine braking for descents. Use the manual override to select the appropriate gear. This also prevents the transmission from “hunting” (changing up and down erratically) when under load. Experiment with your vehicle to find which gear is best in each situation. “L” or 1<sup>st</sup> gear in Low Range (see High Ratio / Low Ratio below) will provide the best engine braking and control when descending steep hills. It pays to practice using engine braking in both High and Low ratio to get used to when the gearbox actually changes down – it will not change down if the road speed is too high.

**NOTE:** every type of automatic transmission has different characteristics; including lock-up torque converters (see **Drive-over Braking or Left Foot Braking** in **Chapter 6 – Driving Techniques**).

You should become familiar with your vehicle by practising driving as slowly as possible down steep suburban hills without using brakes. ALWAYS apply the handbrake and leave the transmission in Park when leaving the vehicle, NEVER leave the transmission in Drive.

### ***Manual Transmission***

Manual gearboxes provide good engine braking which helps control speed when going downhill. However, the clutch is prone to being clogged with mud entering through the breather linkage openings. Experiment with your vehicle to find which gear works best in which scenario. Practice smooth starts and gear changes. Also, you will find that you do not need to pull off in first gear in every situation, especially when Low Ratio is selected. In many situations it is preferable to pull off in a higher gear to avoid a gear change at a critical point while negotiating an obstacle. Gear changes result in lost momentum and can be catastrophic if you miss selecting the next gear.

It is also important not to “ride” the clutch as a way to control speed. This causes accelerated wear of the clutch and thrust bearing, can result in the clutch plate overheating and slipping even when fully engaged, as well as losing momentum when you least expect it. The clutch should only be used when changing gears. Get into the habit of keeping your left foot firmly planted on the floor to avoid putting any pressure on the clutch pedal.

### ***Transfer Case***

A transfer case is an additional section of the gearbox on a four wheel drive vehicle. It connects the engine drive to the front axle and may also include a ‘Centre Differential’ (see below).

### ***High Ratio / Low Ratio***

Most 4WD vehicles have both high and low ratio gears (also called “high range” and “low range”) in the transfer case. High ratio is the normal range of gears for on road use. Low ratio is an extra gear that when selected allows the driver a second run through the main gears but now in an extra low range. Low range is used for travelling slower up and down very steep slopes or crawling over rough terrain with more control due to increased torque being applied at the wheels. Some vehicles must be stopped before selecting low ratio, check your vehicle handbook on the exact procedure to use in your vehicle. When off-road, always use low ratio to descend a steep hill.

### ***Freewheeling Hubs***

Free-wheeling hubs are sometimes fitted to the front wheels of a part-time 4WD. They allow the wheels to rotate independently of the drive shafts when 2WD is selected, thereby reducing mechanical wear (they have minimal impact on fuel consumption).

Manual freewheeling hubs require either a knob or bolt head to be turned at the hub of each front wheel or electrical switching from the dashboard prior to engaging 4WD.

Automatic Freewheeling hubs self engage when the front hubs have torque applied to them. When this torque is removed such as at the point when forward movement changes to reverse during a failed hill climb, the front hubs might disengage. This could happen at a very awkward time so it is recommended that automatic free-wheeling hubs are locked manually if fitted with a manual override selector. Otherwise it is recommended that the automatic front hubs be replaced with manual front hubs, a simple job easily carried out (cost \$250 - \$400 for the hubs depending on type of vehicle).

### Differentials

A differential is a special gear system installed in a vehicle's axle that allows the left and right wheels to turn at different speeds. This allows the vehicle to go around corners without one of the wheels skidding or hopping as the outside wheel has to travel further than the inside wheel.

Another characteristic of a differential is that the power is passed to the wheel with the least resistance. This means that if a wheel is in the air or loses traction then that wheel will spin and the other wheel will not turn causing the vehicle to stop moving.

This is referred to as an open differential and is the standard configuration on most vehicles. There are a number of different ways the engine can be connect to the axles.

### Part-Time 4WD

Part-time 4WD vehicles only have differentials on each axle. The front and rear axle turn at the same speed when 4WD is engaged. These vehicles will stop moving when a wheel on each axle loses traction at the same time.

Drivers can use a number of different driving techniques to regain traction when progress is lost due to a spinning wheel.

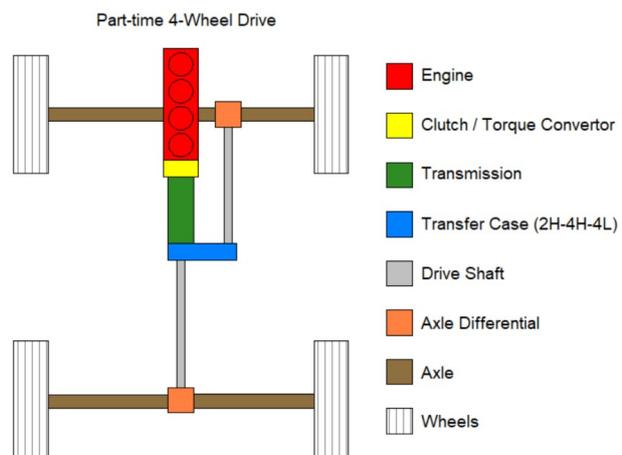
For non-ABS equipped vehicles this may be overcome by judicious use of the foot brake, or for the rear axle by a little use of the

handbrake if it is a drum type brake acting on the rear wheels. Do not use the handbrake in this scenario if the vehicle is fitted with a Transmission Shaft Brake (see under Handbrake below for more information).

Another option is to back up and attempt the obstacle again taking a slightly different line with a view to keeping all of the wheels in contact with the ground. If this doesn't work, then reattempting the obstacle using a little more momentum (i.e. speed x mass) to carry the vehicle across the section of track where traction is being lost may help. It is important to not drive too fast as the vehicle will bounce over the obstacle and reduce contact with the ground even further, risking damage to driveline components or a loss of control.

Practice the above techniques with your vehicle in a controlled environment to learn how your vehicle responds and what works best.

A number of different engineering solutions, such as differential lockers, are also available to overcome this problem and improve traction in slippery or undulating terrain (see below).

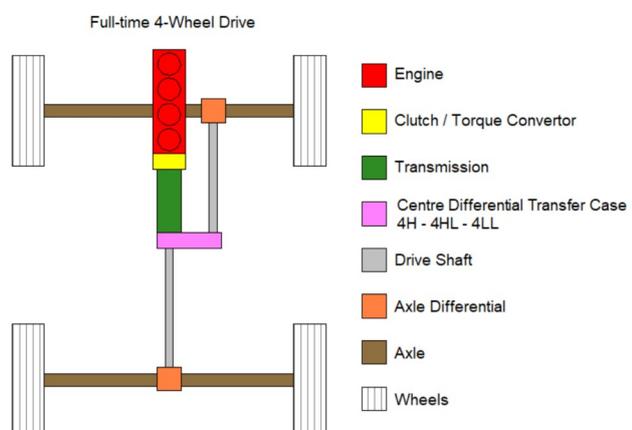


## Full-Time 4WD and AWD

Full-time 4WD vehicles also have a differential or a viscous coupling fitted in the transfer case. AWD vehicles usually have a differential or viscous coupling fitted somewhere in the driveline connecting the transmission to the rear axle. This allows the front and rear axles to turn at different speeds when the vehicle is going around corners. This system also favours sending the power to the axle with least resistance. As a result, an AWD or Full-time 4WD vehicle will stop moving when one wheel loses traction or is in the air.

### Centre Differential

Most 'All Wheel Drive', 'On Demand' or 'Full Time' 4WD vehicles have a centre differential which is located in the transfer case. The centre differential allows the front and rear axles to rotate at different speeds. If the centre differential can be manually locked either by means of a transfer case lever or an electrical switch on the dashboard, then 50% of available power from the engine will be delivered to each axle. You should not drive on a normal sealed road with the central differential lock engaged unless your vehicle handbook says you can. Engaging the centre diff-lock on these vehicles puts it into true 4WD mode and is recommended whenever leaving the paved road.

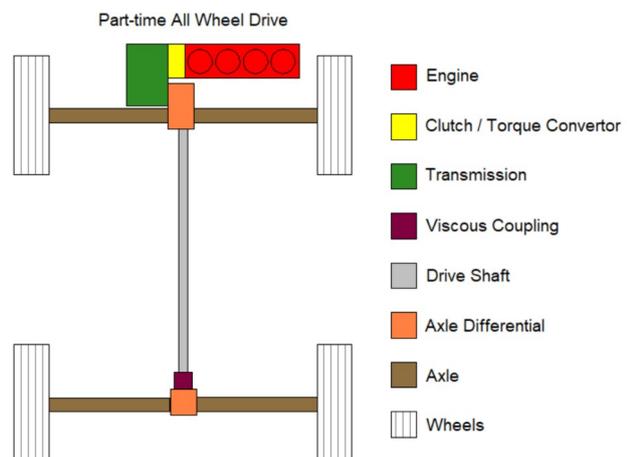


### Viscous Coupling

Some AWD vehicles have a viscous coupling instead of a centre differential connecting the transmission to the front and rear drive shafts. These vehicles may be called Automatic All Wheel Drive in that the viscous coupling locks up and sends torque and power to the other axle when the normally driven axle (usually the front axle) starts spinning. These vehicles are generally considered 2WD with AWD assist, also known as part-time AWD.

Some AWD vehicles have a viscous coupling installed between the centre differential and the driveshaft to one axle. When the driveshafts start turning at different speeds (usually due to a wheel slipping on one axle) then the viscous coupling locks up resulting in power/torque being sent to both axles equally. The viscous coupling is behaving like an automatic centre differential lock.

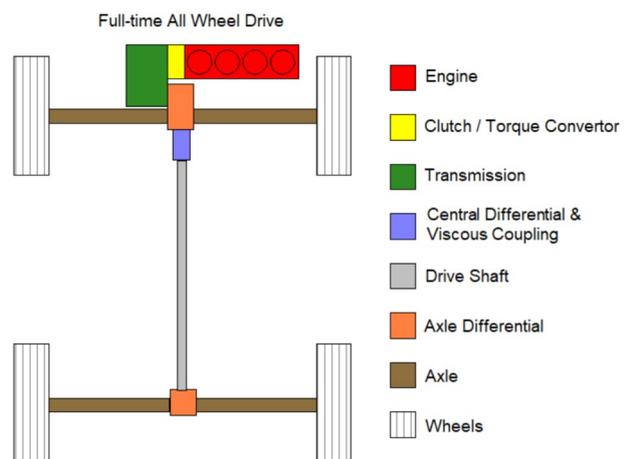
These vehicles are often referred to as having a full-time All Wheel Drive system.



Viscous couplings are slow to respond as they require a certain speed difference between the two drive shafts before “engaging”. Often this mechanical lag is sufficient for the vehicle to become stuck before the power is transferred to the other axle. The vehicle’s cornering dynamics also change as the vehicle transitions through a corner. This is most noticeable on tarmac under demanding driving.

### **Electronically Controlled Clutch Packs**

Some manufacturers of AWD vehicles switched to using electronically controlled clutch packs instead of viscous couplings. This allows the traction control computer to control the distribution of power/torque to each axle instantly. This enabled more responsive and predictable behaviour of the drivetrain.



## Traction Aids

### **Limited Slip Differentials (LSD)**

A limited slip differential is similar to an open differential at low speed or when both wheels are turning at the same speed. The slip limiting device comes into play when one wheel begins turning faster than the other. The slip limiter may be a spring loaded clutch pack, a viscous coupling or even an electronically controlled clutch pack. The slip limiting device serves to limit the speed difference between each wheel, thereby diverting some of the power from the spinning wheel to the wheel with traction, keeping the vehicle moving. As the LSD can slip it assists but does not guarantee drive to the loaded wheel if you should become cross-axled and lift a wheel off the ground. You need speed or momentum to assist the LSD diff to engage. Note, a LSD may pop you out of a rut when you least expect it to happen and could compromise traction when on a sideling (side slope).

### **Closed Differentials**

A closed differential is created when the two axle shafts are permanently bolted or welded together creating a solid axle between the wheels. Each wheel on the same axle receives equal power and turns at the same speed even if one wheel is off the ground. Closed differentials on either the front or rear of a vehicle are not Warrant of Fitness compliant (not legal on the road). Vehicles fitted with one or more closed differentials should not be operated on paved surfaces as this will result in excessive tyre wear or damage to drive train components.

### **Rear Differential Lock**

Some vehicles have rear differential locks fitted as standard. If selected, equal power will be delivered to each rear wheel. If one rear wheel is off the ground or spinning on a slippery surface the other wheel will continue to turn and if it is still on firm ground, provide traction. A rear diff lock is a very handy device, but it can cause you to jump out of ruts unexpectedly when engaged. Only engage it when you need it.

**WARNING:** DO NOT USE REAR DIFF LOCK ON A SIDELING

A locked rear diff works like a 'closed diff' and you may have the tail of the vehicle slide away when you are in a dangerous situation. If you have a rear diff locker and are in a safe place (no steep drop-offs, gentle slope) try driving across a slope on wet grass and then over the crown of a low hill with your rear locker engaged and see what happens!

After market diff locks are available for the most popular 4WD vehicles. These are either air operated or electrically operated.

### **Front Differential Lock**

Some 4WD vehicles are also fitted with a locking front differential. When the Front Differential is locked, then 50% of the power available to the front axle will be delivered to each front wheel. Even if one front wheel is off the ground or spinning on a slippery surface the locked differential will provide rotational power to the other front wheel. Obviously, if the front differential has been locked then there will be no differential effect available at the front wheels - steering will be very difficult if not impossible! The vehicle will only want to move straight ahead. A front diff lock, if fitted, should only be used to get out of a very slippery or cross-axle situation.

**WARNING:** USE FRONT DIFF LOCKS WITH EXTREME CAUTION and ONLY AT VERY LOW SPEED.

Vehicles have gone out of control and rolled over because the driver did not understand the limitations and dangers of front axle diff locks.

After market front diff locks are also available for most popular 4WDs.

### **Auto Lockers – (they are actually automatic differential 'un-lockers')**

Auto lockers are only available as an after market accessory. When the unlocking mechanism detects axle wind-up through the differential during cornering, one side axle will release, thus reducing wind-up. Auto lockers can be unsafe on a greasy sideling. In addition, they may pop you out of ruts unexpectedly. They MUST NOT be fitted in the front of a full-time 4WD vehicle as they effectively disable the steering.

### **Traction Control System**

Some 4WD vehicles are fitted with sophisticated off road traction control systems (Terrain Assist / Terrain Mode). These are usually computer controlled systems that use wheel speed sensors to detect wheel spin and the apply braking force to the spinning wheel. This enables driving force to be sent to the wheel with good traction by stopping the wheel without traction from spinning.

The off road traction control system should not be confused with anti-lock brake system (ABS), anti-skid control (ASC) or stability control systems. These systems are designed to control vehicle's behaviour while driving on paved roads and will generally limit engine power at the same time as taking action to control the skid (see Stability Control below). These systems should be turned off when going off road as they will intervene when least expected or not wanted resulting in the vehicle getting stuck.

## **Suspension**

There are two main types of suspension, namely "independent" and "solid axle". Vehicles will fit into one of three classes based on the type of suspension. These are "solid axle vehicles", "fully independent suspension vehicles" and "mixed suspension vehicles".

### ***Solid Axle Suspension***

Vehicles fitted with solid front and rear axles have been considered the best for off road performance. A **“Beam Axle”** is a very strong, solid axle that connects to the wheels on each side of the vehicle and provides very good articulation. The axle is suspended from the vehicle by either leaf springs or coil springs and linkages.

A disadvantage of leaf springs is that they give a very harsh ride. Coil springs on the other hand provide a more comfortable ride and great articulation. A major advantage of solid axle suspension is the lowest point of the vehicle is usually the axle (diff pumpkin or spring hangers) and this is lifted out of the way as the wheels ride over obstacles. Ground clearance is not affected as the vehicle compresses the suspension. A disadvantage is the effect of a bump at one wheel is also transferred to the opposite wheel.

### ***Fully Independent Suspension***

An **‘Independent Suspension’** has coil springs or torsion bars (or a combination of both) at each wheel. The springs allow each wheel to move up and down independent of what other wheels are doing as the vehicle moves over undulating ground. The differentials are bolted to the chassis and connected to the wheels through flexible drive shafts. Each drive shaft is fitted with two constant velocity (CV) joints. Each wheel hub is held in place with one or two wishbones or control arms and other linkages. The coil spring may be combined with the shock absorber into a unit know as a “MacPherson Strut” or “coil-over”.

Independent suspension provides for great ride comfort and on road handling. However, off road performance is limited by the amount of articulation provided. Another disadvantage is that the ground clearance under the vehicle is reduced whenever the suspension compresses as the vehicle moves over the terrain. Reducing the vehicle’s speed minimises the chance of impacting the ground. A useful tip when observing an unexpected bump or hole in the track in front of the vehicle is to briefly apply the brakes and release them before hitting the obstacle. This will allow the suspension to rebound, increasing the ground clearance before the vehicle travels over the bump or hole.

### ***Mixed Suspension***

Most 4WD vehicles are fitted with independent front suspension and solid axle rear suspension. This provides a good compromise for on-road handling and load carrying ability while still providing decent off-road performance. These vehicles often have limited articulation and will be seen lifting wheels when navigating undulating tracks.

### ***Axle Types***

Rear axles fall into one of three types. A **“Fully Floating”** axle is not load bearing. The weight of the vehicle is transmitted through the axle housing. The axle shaft only transmits power to the wheel. A **“Semi-Floating”** is load-bearing and transfers load from the wheel to the axle housing or suspension components as well as transmitting the driving force to the wheel. Semi-floating axle shafts are stronger than full-floating axle shafts for this reason. The third option are **“three quarter floating”** axles. The axle mounting arrangement is more complex than semi-floating but much more reliable. Breaking an axle shaft risks loosing the wheel from the vehicle unless the axle is a full-floating axle. Full floating axles are common in heavy duty vehicles with solid axle suspension.

**Live Axles** are driven axles. They are connected to the vehicle drive train. **Dead Axles** are not connected to the vehicle drive train. AWD and 4WD vehicle have 2 live axles.

### **Wheel Bearings**

Encounters with mud, water and sand are normal activities when four wheel driving. It is not unusual for water and grit to get into the front hubs and contaminate bearing grease. It is good practice to regularly examine your vehicle's front hubs to check for contamination. Clean and repack hubs with fresh grease as required.

### **Articulation**

Articulation is the term given to the amount of vertical travel that individual wheels can move up and down over bumps and hollows while each wheel still remains in contact with the ground.

**Ramp Index** is a measurement of articulation as measured by driving one wheel up a ramp till the other wheel on the same side is just about to lose contact with the ground. The higher this number (usually measured in inches or centimetres) the more articulation a vehicle has.

**Cross-Axled** is the term used when wheels on opposite corners (front and rear) of a vehicle are hanging over holes or depressions in the ground at the same time. Due to the action of the differentials when one wheel on an axle is off the ground, engine power is only delivered to that wheel. If a vehicle is cross-axled it will lose all traction on all wheels - unless you are able to lock a differential.

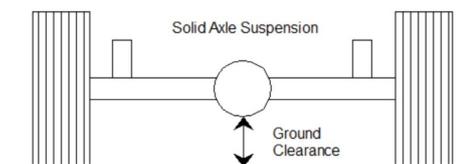
### **Steering**

When a part-time 4WD is in 4WD, the turning circle of the vehicle will be considerably increased due to the front wheels being engaged to the drive train through the front differential. Full-time 4WD will also experience an increased turning circle when the centre differential is locked due to both axles turning at the same speed. Unless the vehicle is on a slippery or loose surface where the wheels can 'slip' on the road surface, an effect called 'wind up' can occur.

Wind-up is when the axle on one side of the vehicle has a twisting load applied to it by the opposite wheel on the same axle. This is caused by the outer wheel travelling further (turning radius is wider) when a vehicle is turning. Wind-up on the front axle tends to inhibit turning and may impose loads that make it hard to turn the steering wheel.

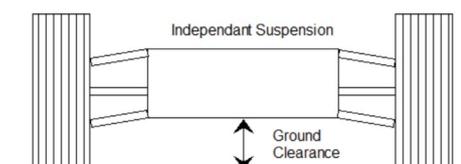
### **Ground Clearance**

Have a look under your vehicle and see where all of the low points are. The differentials are usually the lowest points on the drive train. Note that the front differential and probably the transfer case are not on the centre line of the vehicle. If you expect to be using your vehicle off road in rugged areas such as riverbeds you may wish to have a guard ('bash plate') fitted under your vehicle to protect the engine sump and transfer case.



### **Short Wheelbase / Long Wheelbase**

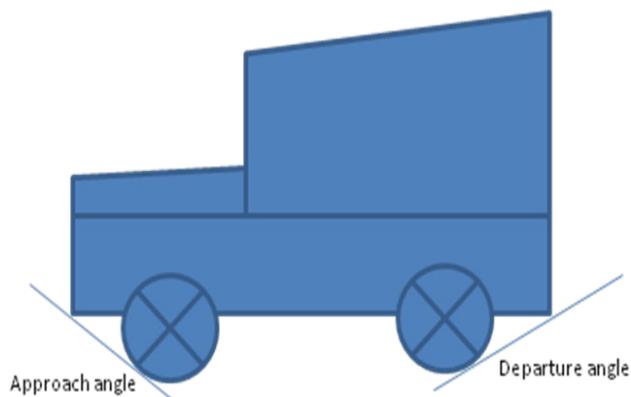
Short wheelbase (SWB) vehicles usually have less overhang at the rear and a smaller turning circle than long wheelbase (LWB) vehicles. Long wheelbase vehicles usually have more passenger seats, more room for luggage or equipment and a lower ramp-over angle (defined later).



### **Suspension Lift / Body Lift**

Some people modify their vehicles by giving them a 'Suspension Lift' by increasing the spring and shock absorber length; this will increase the ground clearance. A 'Body Lift' has blocks inserted between the body and the chassis creating space for larger wheels / tyres however, gear levers, brake hoses and fuel filler pipes may need extending if a body lift is done. Both of these modifications must comply with [LVVTA](#) (Low Volume Vehicle Technical Association (inc)) rules if the vehicle is to be driven on the road.

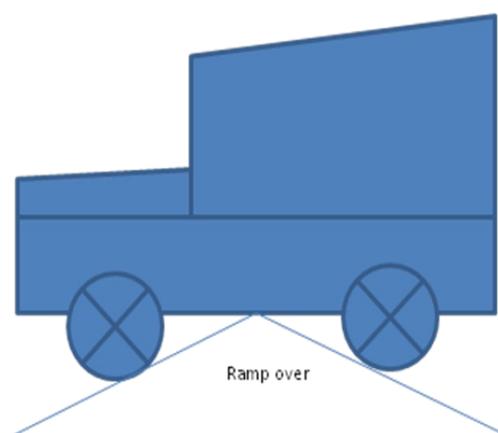
**Approach Angle** is the angle between the lowest part of the body at the front of the vehicle and the ground where it touches the front edge of the front wheels. It is an indication of the steepness of transition a vehicle can make from level ground to climbing a steep bank. If your front bumper hits a bank before the front wheels start climbing the bank then the approach angle of your vehicle is not great enough to climb that bank.



**Departure angle** is the angle between the lowest part of the body at the back of the vehicle and the ground where it touches the rear edge of the back wheels. It is an indication of the steepness of the transition

a vehicle can make going down a steep bank onto level ground or the height of a step the vehicle can descend. If your rear bumper hits the top of a step before the back wheels touch the ground then the departure angle is not big enough and your vehicle is likely to get hung up on the step. Similarly, if the bumper hits the bank before making the transition to level ground then the back wheels may lose traction as the vehicle gets hung up.

**Ramp Over** is the term given to the angular measurement that indicates how sharp a hump your vehicle can drive over. If you have a hump under the middle of your vehicle and you are stuck upon it rocking like a see-saw and going nowhere, then your 'Ramp Over' angle was too small for that hump!



### **Overhanging Attachments**

Some equipment fitted to your vehicle may affect the approach, departure and/or

ramp over angles of your vehicle and could become damaged if caught on the ground during an off road trip. Be aware that any of the following may become damaged or cause the vehicle to get 'hung-up':

- Tow bar and trailer electrical connections,
- bumpers, bull bar, winch
- side steps,
- spare wheel, exhaust system, fuel tank.
- Gearbox or transfer case chassis cross-member

## Engine Air Intake & Filters

Know where the engine air intake is located on your vehicle. Some vehicles have the engine air intake located behind a headlight or in the wheel arch. Some vehicles have the air intake located in front of the radiator at the top of the grill. When crossing a river or deep water hole in a vehicle with a low-level or exposed air intake water could be sucked into the engine and cause serious damage(\$\$\$\$). A snorkel extends an air intake and relocates it high up on the vehicle where water is unlikely to be ingested into the engine. A snorkel may also provide cleaner air to the engine (less dust higher up).

Disposable paper element air filters should be changed regularly if your vehicle is used on dusty roads or tracks, check your vehicle owner's manual for how often you should change the air filter.

Oil Bath Air Filters consist of fine mesh screens coated with a thin film of oil. Dust sticks to the oil film as air passes through the mesh and into the engine. These filters may be cleaned and reused.

## Batteries

Four wheel driving is often on rough roads or tracks so ensure that your battery is securely mounted. Some owners fit quick-disconnect devices so that one turn of a knob will isolate all electrical circuits in case of an accident or electrical problem. If an electric winch is fitted to your vehicle it is important to ensure that winching operations do not flatten the battery. Some vehicles have a second battery fitted to provide power for the auxiliary equipment such as winches, air pumps, refrigerators etc.

## Brakes

Brake pads, shoes and actuating mechanisms can be damaged by abrasive mud, grit and sand. Water (especially salt water) can cause rusting of brake actuators and springs. Sand, grit, pebbles and mud may fill the slots on vented brake discs. It is good practice to remove all wheels to check and clean the brake mechanisms after driving through rivers, mud, or on a beach.

### ***Handbrake***

Regularly check that your handbrake is serviceable and will hold on a very steep grade. Some vehicles have what is known as a 'Transmission Shaft' or 'Cardan Shaft' handbrake. A transmission shaft brake is a drum type brake mechanism mounted on the drive shaft. Find out what sort of handbrake your vehicle has, if you do have a transmission shaft handbrake, NEVER apply it while the vehicle is moving, it may cause the rear axle to wind-up and snap. Caution, a transmission shaft brake will not work if a rear wheel is lifted off the ground or is on a slippery slope due to differential action at the wheels. NEVER jack-up a vehicle with a transmission shaft handbrake without chocking the wheels first.

### ***Anti-lock Brake Systems (ABS)***

An ABS keeps the brakes from locking up when a driver stands on the brake pedal. It works by sensing the rotational speed of each wheel and momentarily releasing the brake on any wheel that is turning slower than the others. If your wheels lock-up on slippery ground you will lose steering control, ABS has been designed to prevent this, however most ABS only works at speeds above about 5 - 8 kph. Some modern 4WD's have combination ABS & Traction Control.

ABS can be dangerous when driving off road on slippery surfaces. This is due to the ABS continually engaging to prevent sliding when applying the brakes, especially on a slippery descent. Take the time to learn when the ABS is turned off automatically (e.g. if speed is less than 10km/h or vehicle is in 1<sup>st</sup>

gear Low Range) and how to do this manually (ABS / ASC / TCS off switch). ABS can only be disabled in some vehicles by pulling a fuse due to it always being active, even in low range.

### ***Stability Control***

Some modern vehicles have electronic devices (Anti-skid control (ASC)) that sense the speed at which each wheel is turning. If any wheel is turning at a different rate to the others, an electronic brain decides that the wheel is spinning (skidding) and applies or releases the brake on that wheel and manages the power output to the other wheels to correct the situation. Some traction control systems (TCS) only work for about 30 seconds without being reset so continuous wheel spinning in sand for longer than 30 seconds may turn off the traction control. There are both advantages and disadvantages of having a 'reaction control system' (See HILL CLIMBING and DESCENDING HILLS below for more details.)

There are several different names for traction-control systems such as DAC – Downhill Assist Control, when switched on it automatically applies braking on each wheel individually as needed to give a downhill speed of 5 – 7 kph without touching the brakes; HAC – Hill Assent Control or Hill Start Assist Control, this gives maximum traction without wheel spin for hill starts without stalling or rolling back.

## **Tyres**

It is a common saying that 90% of tyre problems occur in the last 10% of the life of the tyre. Keep all your tyres in good condition and check regularly for cuts in the sidewalls. Don't forget to check the tyre on the spare wheel; it should also be in good condition.

### ***Tyre Treads***

There is no universal tyre design or tread pattern that will be ideal in all conditions. Tread patterns are made by cutting grooves into the surface of the tyre leaving a series of rubber blocks, gaps between these blocks are known as voids. The tread surface on a normal 'road' tyre as used on paved roads around town has a ratio of about 65% rubber and 35% void. Small cuts across the edge of the tread called sipes channel trapped water away from under the blocks into the main tread grooves. Road tyres are not suitable for use in muddy conditions or rough terrain.

### ***All Terrain Tyres (AT)***

AT tread patterns have deep coarse treads with a ratio of around 60% rubber and 40% void. AT tyres are alright on unsealed country roads but not really suitable for use on wet grass, slime or deep mud.

### ***Mud Tyres (MT)***

The tread surface on MT tyres is about 45% rubber and 55% void. MT tyres may also have large blocky chunks on the edge of the tyre known as lugs. These help traction when the sidewall of the tyre is in a rut or against the side of a bank or rock. A good mud tyre also has 'self-cleaning' properties. The deep blocks of the tread are wedge shaped with rounded lower corners so that mud and debris rather than being compacted in the grooves is squeezed out or flies off the tyre as it spins.

Please note, MT tyres make a lot of road noise, offer less traction, poorer water management and do not stop as quickly as normal road tyres when used on paved roads.

Directional Treads have a chevron (arrowhead) patterned tread and must only be mounted in one direction. The arrowhead formation points forward when looking down at the tyre from above.

Generally, the deeper the tread depth, the better the traction on a soft, slippery surface. If however, the surface is soft sand then the larger the tyre 'footprint' the better the traction.

### ***Tyre Sizes***

There are two different systems used to describe the size of a tyre, Imperial & Metric.

The **Imperial System** is in the form:

- 31 x 10.5 x R 15 (spoken as: thirty one - ten point five – R fifteen)
- The first two digits in the example above (31) indicate that the tyre has a diameter of 31 inches.
- The second group of numbers indicates that the tyre is 10.5 inches in width at the tread.
- R indicates a radial ply construction and 15 means that the tyre fits on a 15-inch diameter rim.

The **Metric System** is in the form:

- 265 x 60 x R 15 (spoken as two six five - sixty – R fifteen)
- The first group of numbers (265) is the width of the tread in millimetres.
- The second group of numbers (60) indicates the height of the tyre measured from the rim to the top of the tread expressed as a percentage of the width. R stands for radial ply and 15 means that the tyre fits on a 15-inch diameter rim.

Note that both the imperial and the metric system use inches to describe the wheel diameter!

### ***Load Index & Speed Symbol***

After the size numbers moulded on the side of a tyre there are another two digits and a letter. The two digits indicate the 'Load Index' and the letter is the 'Speed Symbol'. The load index is a numerical code associated with the maximum load a tyre can carry at the speed indicated by the speed symbol e.g. 87S. The 87 is the load index, in this case equal to 545kg (1201 lbs), and the letter is a speed symbol, which in this case 'S', is suitable for 180 kph. Tables are available from tyre suppliers.

### ***Tyre Shelf-Life***

Tyres deteriorate over time, even when not used. The chemical composition changes as volatile compounds are released weakening the bond between the rubber and reinforcing structure. You will also notice that the tyre starts to develop small cracks in the sidewall and becomes hard. The date of manufacture is moulded into the sidewall as a 4-digit number corresponding to MMY. Manufacturers recommend replacing tyres older than 10 years regardless of the state of wear as they are no longer considered safe to use.

### ***Ply Rating***

During the construction of a tyre, reinforcing material of steel, rayon or cotton is used in layers known as plies. A tyre manufacturer may use different types of material and different numbers of plies when making tyres. For example cotton may be used in the sidewall and steel across the tread. The ply rating is the number of layers of these plies used in that particular tyre e.g. 4 ply steel on the crown and 2 ply cotton in the side walls.

Never use a mixture of tyres that are different sizes or have radically different tread patterns on your vehicle at the same time. Never use a mixture of cross-ply and radial ply tyres at the same time.

### ***Benefits of Cross Ply or Radial Ply***

The thinnest and most vulnerable part of a tyre is the sidewall. Cross ply tyres are often said to be good for off road driving as they do not flex in the sidewall as much as radials, this means that the sidewalls stay more upright and are not as exposed to damage on sharp rocks or stakes. Radial tyres, because of their softer sidewall construction, are able to 'flow' over small rocks and give a more comfortable ride than cross ply.

### ***Tyre Pressure – Foot Print***

The footprint of a tyre is that part of the tyre that is in contact with the ground. If the air pressure in a tyre is reduced, the footprint of the tyre is lengthened. When going off-road, it is good practice to reduce your tyre pressure (up to 10 psi. or 0.7 bar less than when on a sealed road). Talk to your trip leader if you have any doubt about what tyre pressure to use when on a 4WD trip. Caution, if you are using tubeless tyres and reduce the tyre pressure too much you risk breaking the bead seal where the sidewall of the tyre meets the rim. If the bead breaks away from the rim, the tyre will go flat immediately. When driving on loose sand use as low a pressure as you can without damaging your tyres or endangering your vehicle.

Be aware that steering is affected when you reduce tyre pressure. If you lower your tyre pressure DO NOT travel at speed and remember to re inflate your tyres before driving on a normal hard road surface.

### ***Changing the Size of Your Tyres***

Some people change the height and width of their tyres to give greater ground clearance and a larger footprint. This may mean getting a set of wider rims with a different or altered offset so that larger tyres do not rub on the inner mudguards. Spacers could be used but may need to be certified.

Changing the offset will also affect the castor angle (the king pin axis line should meet the road at the mid-point of the tyre) and place undue stress on the wheel bearings.

A change to the offset and / or, the fitting of spacers may require [Low Volume Vehicle Technical Association Certification \(LVVTA\)](#), this is a certificate to show that the modifications have been done properly and the vehicle can be operated safely. It should also be noted that no part of the tread of a tyre is allowed to protrude beyond the width of the vehicle; if it does you will probably be refused a Warrant of Fitness. A change of tyre size that increases the diameter by more than 5% will require a recalibration of the speedometer or altering of the final drive ratio (diff gearing). This is to maintain legally accurate speedometer readings and in the case of diesels, to ensure that correct road user charges (per km) are paid. Torque will be reduced unless the differential gearing is changed. Larger tyres may also reduce brake effectiveness due the increased angular momentum of a larger rubber mass.

### ***Tyre Repairs***

It is possible to repair the sidewall on a tyre. Some tyre shops will try and sell you a new tyre, if you need a side wall repaired ask a trip leader where you can get repairs done.

## **Wheels**

Wheels are created when the tyre is fitted to a wheel rim

### ***Rims***

Wheel rims are easily damaged when driving over rocks and boulders on a beach or riverbed.

Magnesium ('mag'), or alloy wheels are stylish, shiny and expensive when new but are easily damaged and spoilt if taken off road. Steel rims are relatively cheap, easily replaced or panel beaten back into shape if damaged. Many 4WD owners have two sets of wheels, the original vehicle rims with road tyres for use around town and a set of steel rims with mud grip tyres for off road use.

Split Rims are usually only found on heavy vehicles (trucks & buses) and not seen on modern 4WD vehicles these days. Split rims are made up of three parts, a conventional wheel centre with a normal

size inner rim and a lower sized outer rim, a separate second rim and a split steel ring. Unless you are well practised, leave any work on a split rim to trade experts.

Spacers are packers that are fitted between a wheel rim and the hub backing plate. When fitted, the packer causes the wheel centreline to be offset moving the centre line of the tyre away from the body of the vehicle. This offset allows wider wheels to be fitted onto the vehicle without having the tyre rub against the vehicle body or brake hoses.

**CAUTION** Wide offset rims and spacers put extra load on stub-axles and wheel bearings

Wheel spacers are illegal for on-road use. LVVTA have strict rules about wheel rim widths and offsets (the wheel track width should not be widened by more than 50mm). Your vehicle may need to be certified by a specialist engineer if the track width is increased by more than 50mm.

### ***Bead Lockers***

A bead locker is a device for preventing a tyre from being mechanically forced away from a wheel rim when driving. When the air pressure in a tyre is reduced the tyre bead can more easily be pushed towards the centre of the rim if the tyre wall hits a rock. A bead lock may be used to keep the bead pressed against the rim.

The traditional bead locker is a mechanical device that effectively is an external ring that bolts to a modified wheel rim and traps the tyre bead between the two. With the bolts tightened it assists in stopping the tyre either being pushed off the rim or the wheel rim spinning within the tyre (particularly at low pressures).

Internal bead lockers are specially reinforced inner tubes inserted inside the tyre like a regular inner tube. However, this 'inner tube' is only able to expand within the limits of its reinforcing and only fills a small portion of the depth of available space within the tyre. It is however, able to expand sideways pushing the tyre bead against the rim acting as a bead lock. Fitting this type of bead locker requires modification of the rim to allow for the fitting of another inflation point. One inflation valve is for the internal bead locking tube and the other valve is for the 'tubeless' tyre itself. Internal bead locks work best on high profile tyres.

### ***Tubes – In Tubeless Tyres***

To allow for a large reduction in tyre pressure without risking breaking the bead seal or rolling a tyre off of a rim you can fit tubes inside your tyres. Even if a tyre should be pushed away from the rim and lose the bead seal, air pressure in the tube prevents the tyre from going flat. Many 4WD owners use heavy-duty tubes as used on tractors, the large heavy duty valves facilitate quick deflation to off-road pressure. If intending to use tubes inside tubeless tyres be sure to remove any manufacturer's labels inside the tyre before the tube is inserted as these labels can scuff a tube and cause a puncture.

**WARNING:** RUNNING TUBES AT LOW PRESSURE AND HIGH SPEED CAN CAUSE BLOWOUTS!

### ***Chains***

CCVC does not permit the use of chains on any of our trips unless their use is a requirement for access due to snow (e.g. ski fields often impose this requirement). The use of chains is not recommended with mud tyres.

Tyre chains are not only for use on ice and snow. If you do not have mud tyres and become stuck on a slippery dirt road or track then tyre chains may well get you home. Put chains on long before you think you may get stuck. Some landowners do not allow chains to be used on their property as they dig-in and can churn up the ground on hillside tracks. Drive slowly; there will be considerable

vibration through the wheels if you are driving on a hard surface. Avoid wheel spin when using chains as a spinning wheel is likely to snap a chain.

A question often asked is “should I fit chains to the front or rear wheels”? The only sure answer is, if you need to use chains then ideally they should be on both the front and rear wheels. If you fit chains to the rear wheels only you will have little or no traction and braking on the front wheels and rather ineffective steering. If you fit chains to the front wheels only and are driving down hill you risk having the rear of the vehicle wanting to slide and overtake you. Total braking could be reduced by 50% in either case.

There are two main types of tyre chain, ‘ladder’ and ‘diamond’. The ladder type chains are ok for general snow conditions. Diamond tyre chains are more complex, cost a bit more and are designed to give more penetration and traction on hard packed snow or ice and when used in mud they give more lateral control on a side slope.

When fitting chains, care should be taken to ensure that they are tight and there are no loose ends. Carry soft wire or cable ties to tie back any loose ends securely. Several short ‘stretchy’ bungee cords to thread through the chains to maintain tension are useful. After fitting chains, drive slowly for about half a kilometre and then check to ensure the chains are tight and have not slipped. If a chain comes loose when driving it may flail inside a guard and cut a brake line.

If you own tyre chains, practice fitting them many times in good weather. It is no fun learning how to fit chains when your hands are wet and it is freezing cold.

## Towing

Towing a trailer off road greatly increases the difficulty of negotiating any obstacle and increases the time it takes to travel any given route. Most club trips are not suitable for towing trailers. Trailer-friendly trips are usually advertised as such. Be sure to check with the trip leader beforehand whether or not your trailer is suitable for the trip.

The trailer adds additional weight and one or more axles into the mix. The trailer’s ramp-over angle is often very flat due to the length of the drawbar and available ground clearance making it very easy for the trailer to get hung up on high points in the track.

Ideally, you want the wheel track of the trailer to match that of the tow vehicle so that the trailer is more likely to follow in the tow vehicle’s tracks. Narrow trailers will hunt from side to side due to only one wheel being in the tow vehicle’s tyre track at a time. A wide trailer will require additional care to negotiate obstacles alongside the track. Also pay attention to the amount of clearance required when negotiating overhanging obstacles such as tree branches and overhead structures.

It is also recommended to install a high articulation or off-road hitch to your trailer if you plan on towing anywhere other than public roads. This is due to the increased undulations in back country tracks resulting in greater drawbar / towbar angles. The high articulation hitch will prevent the tow coupling detaching while traversing an obstacle such as a wash or crest across the track.

The combination of tow vehicle and trailer requires a lot more room to turn around. Specific attention is required when negotiating sharp corners on narrow tracks to prevent the tow vehicle falling into the drainage ditch on the outside of the corner as you make a wide turn to avoid the trailer falling into the drainage ditch or culvert on the inside of the same corner.

## Chapter 3 – PREPARING YOUR VEHICLE

### Insurance

Are you insured? It is better to ask this question before you head out on the trails for the first time than after you have damaged your vehicle.

Read your vehicle insurance policy carefully. Some insurance companies do not cover vehicles when they are not on a formed road or 'off-road'. If you have doubts, ask other club members which company they are insured with and why.

### Vehicle Maintenance

It is important to ensure that your vehicle is in tiptop mechanical condition before heading out on the trails. You will be depending on your vehicle to keep you safe on the track and get you back home at the end of the trip. Driving 'off road' will increase the wear & tear on your vehicle. You will need to carry out service checks more often than for vehicles only use 'on-road'. We recommend taking your 4WD vehicle to be serviced by a mechanic who is familiar with the demands of off road driving.

Regularly check the fluids in your vehicle including battery, brake, clutch, radiator, power steering, engine oil, transmission oil, transfer case oil, differential oil. If any oil is white and soapy looking then it has been contaminated with water and should be changed.

- Grease the drive shaft universals, wheel bearings, suspension ball joints and swivel pins.
- Check brake pads, discs, shoes, drums, handbrake adjustment, especially after driving in sand or mud.
- Check drive belts and idlers for alternator, radiator fan, air-conditioning, power steering.
- Change air & oil filters at intervals recommended by vehicle manufacturer.
- Check radiators (air con, engine, oil cooler, auto-transmission) are not blocked by mud, grasses, bugs.

Keep a small plan of your vehicle fuse locations in the glove box. It can be difficult checking each fuse one by one on a wet cold night if your lights are not working after fording a river.

### ***Number Plates***

Check that your vehicle registration plates are securely attached to your vehicle. It is recommended to use at least four nuts and bolts on each plate so that they do not work loose and come off or get caught in bush or mud.

### Essential Equipment

Vehicles used on Shiny 4X4 trips and above are required to carry a number of specified items (those are marked with \* below). It is recommended that participants on any 4WD trip carry the following equipment.

#### ***Fire Extinguisher\****

Carry at least one 1kg dry powder extinguisher securely mounted in your vehicle. Regularly check that your fire extinguisher is serviceable and accessible. All dry powder extinguishers should be given a shake and rotated monthly.

### ***First Aid Kit\****

Carrying a first aid kit in your vehicle and knowing how to use it is strongly recommended. Check your kit regularly and replace any out of date, contaminated or damaged items. It is also recommended that you carry sufficient quantities of any medication and other medical supplies that you may need while away from home on a trip.

Trip leaders carry a supplementary first aid box to assist with larger incidents. During the trip-briefing trip leaders will identify persons in the group with first aid training or experience. Be sure to raise your hand during the briefing if you have been trained or have experience.

### ***Spare Wheel and Tools\****

Every vehicle on a CCVC trip is required to have a spare wheel as well as a jack and the tools required to change a wheel. Be sure to check that your wheel spanner fits all of the lug nuts on your vehicle and that you have all of the parts to make your jack work. Also, check that you have the key for any locking lug nuts that you have fitted.

We highly recommend that the rim and tyre combination of your spare is identical to those fitted to your vehicle. If the spare rim is different to the other rims fitted, then you may need to carry a different set of lug nuts. The lug nuts used on alloy rims are different to those used on steel rims. Also, if the tyre-rim combination of your spare has a different rolling circumference to the tyre-rim combination fitted to your vehicle then this may lead to transmission / driveline damage when the spare is fitted to the vehicle.

### ***Clothing***

Be sure to carry some warm clothing such as a spare jacket, beanie, gloves and some wet weather gear. Having some gumboots on hand when the track gets muddy is also very useful.

### ***Food and Water***

Pack in refreshments for your trip as well as some additional rations just in case you should be stuck out on the track for longer than expected. Be sure to pack in a couple of litres of drinking water for each person in the vehicle too.

### ***Other supplies***

We recommend also packing a torch, some toilet paper, insect repellent and plastic bags for rubbish, wet clothes & muddy footwear.

## **Storage Arrangements**

### ***Loose Articles***

Look under your seats, loose articles could roll forward under the driver's feet when travelling downhill on a bumpy track. You want to ensure that there are no other loose items in the cabin that can move around, especially should you be unfortunate enough to experience a rollover.

### ***Storage Systems***

It is important to have a secure way to store all of the additional items that you will be carrying with you in the vehicle. This may range from a canvas bag, a plastic box with a secure lid up to a commercial draw system for your vehicle. What ever solution you choose, it needs to be secured in your vehicle to prevent it moving. A draw system needs to be bolted into the floor of the vehicle. Any

loose items should be secured using a cargo net. The last thing you want to happen is to be struck on the head by a piece of gear in the event of a rollover.

### **Body Armour**

A wide range of after market accessories designed to protect your vehicle from incidental damage on the tracks are available. You may also be able to get these items custom-made for your vehicle if what you are looking for is not available off the shelf.

#### ***Bull Bars***

Front protection bars in various designs are popular on 4WD vehicles. These components need to be ADR compliant if fitted to late-model vehicles due to crash safety requirements. Bull bars may affect crumple zones and air bag actuation. If fitting a bull bar, check that the type you choose is legal on your vehicle. Front bars may also reduce the vehicle's approach angle. Do not mount recovery hooks to the bull bar.

#### ***Bash plates***

Bash plates are heavy gauge metal plates (steel or aluminium) designed to replace light weight metal or plastic guards installed to the underside of the vehicle. They protect vital components from damage. These are often the best value for money body armour that you can install on your vehicle.

#### ***Rock Sliders / Side Steps***

Generally, factory side steps are not very robust and are easily damaged when driving off road. After market side steps are often confused with rock sliders. The key difference is that a rock slider is specially engineered to support the weight of the vehicle without bending if they make contact with the ground. They protect the side sills of the vehicle from damage. Side sills are very difficult to repair and severe damage may result in the vehicle being written off.

#### ***Tow Bar***

A tow bar serves many uses. Firstly, it enable the vehicle to tow a trailer. Secondly, the tow bar provides some protection to the rear overhanging bodywork as it is usually the lowest point of the vehicle. A well designed and securely mounted tow bar is also useful for attaching recovery points. Using a properly designed hitch receiver recovery point is essential. Do not use the drop hitch or tow ball mount for recoveries. These components are not designed to handle the forces generated during a recovery.

#### ***Rollover Protection***

Rollover protection is essential for any soft top or open top 4WD. Many 4WDs used on Club 4X4 and Hard Yakka trips will have external cages installed to provide increased rollover protection. These items are custom made and will need an engineering certification for use on road.

### **Raised Air Intakes and Breathers**

Water is one of the biggest enemies of our vehicles and requires special attention to avoid flooding of the engine and contamination of the drivetrain fluids.

#### ***Raised Air Intake (Snorkel)***

Fitting a raised air intake or snorkel to your vehicle will relocate the air intake to a location that is less vulnerable to sucking water into the engine. An added benefit is that the air at roof level is generally

cleaner (less dust), therefore resulting in less engine wear. It is important to note that the height of the snorkel is not what determines the depth of water that a vehicle can safely negotiate. Vehicles contain a lot of vulnerable electrical equipment such as onboard computers that cannot be submerged.

### ***Diff and Transmission Breathers***

Check the height of breather pipes fitted to differentials, transmission and transfer case. If necessary have them extended to a higher point so they will not suck in water when these components are rapidly cooled when entering water.

## **Radiator Blinds**

These are usually home-made devices that can be quickly attached to cover the front of the radiator before entering water. The 'blind' prevents water flowing through the radiator and being sprayed all around the engine bay by the fan. Water can even bend fan blades into the radiator! A square of canvas with pre-fitted domes or short ropes to tie onto the grill would work well. You can try slipping a plastic land agents 'house for sale' sign down between the air conditioning radiator and the engine radiator. Removing the fan belt before entering water is not usually done these days, use a radiator blind instead. Remove any radiator blanking device after crossing the water.

## **Lighting**

Normal vehicle lighting is usually very inadequate when driving off road.

### ***Driving Lights***

Fitting additional driving lights provides better illumination of the track ahead. Also consider installing lights that illuminate the sides of the track. This makes driving twisty mountainside tracks a lot easier as the inside of the corner is illuminated and not just the bank ahead of you. Improving the reversing lights will make backing up on the track in the dark so much easier.

### ***Area Lighting***

Installing work or camp lights on the vehicle is a great idea if you go camping with your vehicle. These lights also provide great illumination on the track should you have to negotiate obstacles, perform a recovery or track-side repairs in the dark.

## **Communications**

Being able to communicate easily between vehicles during a trip greatly improves the safety of the trip. This enables the trip leader to inform participants of hazards encountered along the way and to give directions to the participants. This is normally done using radios.

### ***Citizen Band (CB) Radio***

CB Radios operating at 27 MHz are not used very much these days, mainly due to the extremely long antenna that need to be fitted to the vehicle.

UHF CB (PRS) radios operating at 477MHz are becoming very common. They operate in an FM band and have very clear reception. Their range is generally limited to line of sight or about 3km due to the limited power output. That said, they are good for use in a convoy situation.

Older versions of these radios had 40 channels while new versions have 80 channels. Channels 1-40 match on both radios. Channels 22 & 23 are not to be used for voice communications. Channels 1-8 and 31-38 may be used with repeaters. Refer to your radio's handbook on how to set this up.

CCVC does not routinely use UHF CB radio on our trips. However, some members may have this capability and will generally operate on Channel 30 to enable visitors to communicate with others during Family Shiny and Touring trips.

### ***Club Radio***

The Club holds an approved radio license for two E-band VHF commercial radio frequencies (150MHz). The Club authorises members to use these frequencies through the allocation of a call sign. Club members are encouraged to obtain a suitable radio for this purpose and apply for a call sign. Radios are also available through the club from time to time. These radios usually have a higher output power than what is permitted in the citizen bands.

More information about [Club radios](#) is available on the Club website.

### ***Amateur Radio***

Several CCVC members are Amateur Radio Operators. Having this capability within our club has been life-saving in the past. Amateur radio groups maintain an extensive network of repeaters throughout New Zealand.

### ***Radio Antenna (aerials)***

While it is possible to communicate with a handheld portable radio (walkie-talkie) from inside the vehicle, you will obtain much better results when using an externally mounted antenna. For best transmitting strength, antennas should ideally be mounted in the centre of the roof of your vehicle. Unfortunately this is also a place where they can be easily damaged by low hanging tree branches.

Most people mount the external antenna on their vehicle bull bars (if fitted) or on a front mudguard where they can be seen by the driver and folded down if in danger of being damaged. For best reception, the antenna should be tuned to a  $\frac{1}{4}$  or  $\frac{1}{2}$  wavelength of the frequency being used, e.g. the length of the antenna for the CCVC VHF 'club radio' is about 500 mm or 1m in length.

### ***Radio Communication Etiquette***

These days there is little formality and you can use normal conversational style when using a radio. It is good procedure to use "Roger" or "Copy" to confirm you have received and understood a message. "Over" means that you have finished speaking and expect a reply. Communication should be kept short and to the point, minimising chitchat that may interfere with emergency transmission by another convoy member. Please do not play music, swear or talk over someone else.

### ***Cell Phones***

Everyone who uses a cellphone regularly knows they only work when the phone is in range of a cell tower. Therefore the cellphone will not be of much use in rural areas and hilly terrain. Smartphones may be able to provide some additional functions such as navigation when out of network coverage provided you made the necessary preparations such as downloading offline maps.

### ***Personal Locator Beacon***

Anyone travelling off the beaten track in New Zealand is encouraged to carry a personal locator beacon (PLB). These devices allow the user to call for help in life-threatening situations when they are unable to call 111. PLBs are available to rent or purchase from [Southland Locator Beacon Charitable](#)

[Trust \(SLB\)](#). Several retail chains have a range of PLB devices available for purchase too. Some of our trip leaders carry a PLB with them on trips. The club also owns a number of PLBs that members can loan on request.

### ***Satellite Communications***

There are two satellite networks that cover New Zealand: Iridium and Inmarsat. Access to either network is by means of a proprietary handset that allows the user to make voice calls and send text messages. Data services are extremely slow. Alternatively, a number of text based satellite communicators are available (Garmin Inreach, ARC Bivy Stick, Zoleo). These devices require a subscription plan from the supplier and connect to the Iridium network. SPOT is another provider that makes use of the Globalstar satellite network on a monthly subscription plan.

The main benefit of satellite communications is that they are much more versatile than a PLB while still having the ability to send out an SOS message. You are able to check in with family or friends to keep them up to date on the progress of your trip when you are “off grid” as well as being able to request specific help and/or advice through a two-way text message conversation rather than the generic one-way SOS alert sent using a PLB. The disadvantage is that these devices require a monthly subscription to make use of the service.

## **Navigation**

Navigation is essential for finding our way off road. It is important to know where we are, where we are going and the route we need to take to get there. There are a number of options to ensure we have the necessary information to accomplish this.

### ***Paper Maps***

A **road atlas** is a handy reference for trip planning and finding your way to and from tracks. A few of the more well known 4WD tracks are marked on these maps.

**Topographical maps** are available in 1:250 000 and 1:50 000 scales covering the whole of New Zealand. They provide a lot of detailed information and enable accurate navigation away from the road network. You will probably need more than one map to cover the area you intend to visit.

**Local maps** of varying quality may also be available containing valuable local knowledge.

It is important to always carry one or more paper maps covering the area that you intend to explore, especially if you rely on electronic navigation as your primary source of information.

### ***Electronic Navigation***

In this modern era, we are blessed with satellite navigation technology. The first of these is the US-based Global Positioning System (GPS) which has been around the longest and is the most widely supported. The Russian GLONASS system and EU Galileo systems are becoming more widely supported too. Several other nations are also launching similar systems.

There are two main ways to make use of this military grade technology that civilian activities have become more dependant on:

- Satellite Navigation or **GPS Device** is a dedicated piece of hardware that includes a satellite receiver and onboard microcomputer. It receives a special radio signal from several satellites and then uses this to accurately calculate its position on the earth’s surface. Modern units are almost as powerful as a smart phone. Some even include satellite communication technology (see above). Most include a screen that can show your location on a digital

moving map and provide powerful tools for route planning and turn-by-turn navigation. A key point when choosing a GPS device is to look for one that is capable of off road navigation as some devices are only able to navigate using street maps.

- A **Smart Phone** or **Tablet** that has an onboard GPS receiver can also be used for satellite navigation provided the correct app is installed, of which there are several to choose from. This is an area that is constantly under development, so check out the reviews online and look for recommendations of which app to use.

**Digital Maps** are an essential part of satellite navigation. Many of the paper maps are also available as digital maps. [OpenStreetMap](#) is a wikimap of the whole world and is available as a free download in many formats. You can even build your own version using the map data or contribute by adding details to the map. LINZ has made the full set of [topographical maps](#) available for free too. There are also a range of maps that you can purchase for your chosen device. Alternatively, you could use your favourite browser based online map (Google, Bing). It is important to download and install whichever map you want to use before leaving home. Versions of these maps are available in many formats that are compatible with your chosen GPS device, smart phone or tablet. Most people will use more than one map when navigating off road and compare map data frequently to ensure that they are on the right track.

### ***Navigation Tools***

It is also important to learn the skills and carry the essential tools for navigation using a paper map and dead reckoning. These include a **magnetic compass**, **pencil**, simple **ruler or dividers** and a **protractor**. Binoculars may also be useful for checking out distant landmarks.

## Chapter 4 - RECOVERY EQUIPMENT

### Basic Recovery Gear

There are a number of items that are considered basic recovery equipment and should form part of every 4WD's inventory, especially if you are going to travel solo. These items should always be your first go-to should you get stuck.

#### *Tyre Deflator and Compressor*

Adjusting tyre pressures is often the simplest thing you can do to getting unstuck on the trail. Often, the reason for getting stuck is that the vehicle's tyre pressures are too high for the terrain you are trying to cross.

A compressor goes hand-in-hand with the deflator as this allows you to reinflate your tyres when returning to the black top or after having dropped the tyre pressures really low (10psi or 0.7kPa).

#### *Shovel \**

A shovel is really useful for removing material from under the vehicle or in front of the tyres. Building a ramp to drive up greatly improves the chances of being able to drive the vehicle out.

#### *Jack and jacking boards*

Using the vehicle's jack in combination with some short pieces of 2x12 planks or thick plywood will allow you to get the wheel off the ground and fill in the hole with rocks.

#### *Recovery Boards*

Recovery boards are commonly made from plastic and are great for providing a firm surface to drive on. It is important to shape the terrain in front of the tyres and get the end of the board under the tyre. Inserting one board under each tyre greatly improves your chances of being able to drive out.

It is important to choose good quality boards for longevity. Cheap boards often bend and break on the first use or quickly deteriorate and become brittle when exposed to sunlight for a few months.

Pressed metal recovery boards are also available. These are generally larger than the plastic ones and are significantly heavier. These are commonly used by the military or with heavier 4WDs such as light trucks.

### Tow Balls and Drop Hitches

**NEVER** attach a recovery tow strop or tow rope to a tow ball. Tow balls and what they are attached to are not designed to withstand the shock load of a vehicle recovery when stuck in mud or sand. A tow ball may become a lethal missile and hurtle at one of the vehicles involved in the recovery or into bystanders.

Drop hitches are also unsuitable as an attachment point for recoveries, even without a tow ball fitted. The welds connecting the various parts of the hitch are unable to withstand the shock load forces experienced during a recovery. This may lead to a catastrophic failure of the drop hitch with similar results as the tow ball.

Attaching the tow rope to the hitch receiver using the hitch pin is acceptable if you have no other means of connecting to the vehicle. However, this is likely to result in a bent pin trapping the tow

rope in the hitch receiver. A much better solution is to carry a suitable hitch receiver recovery point.

### Rated Recovery Equipment

Good quality and safe recovery equipment are supplied with one or more of the following ratings:

- **Minimum Breaking Load (MBL)** This is the minimum load applied to samples of the equipment during testing that resulted in failure or yielding of the equipment. Also called Minimum Breaking Strength (MBS).
- **Working Load Limit (WLL)** The maximum load that the piece of equipment may be safely subjected to without fear of failure as designed by the manufacturer. This term is now used instead of Safe Working Load / Limit (SWL)
- **Safety factor** This is the ratio between the minimum breaking load (MBL) and Working Load Limit (WLL) ( $MBS/WLL = SF$ )

A variety of units of measure are used by manufacturers when rating their equipment including pound-force (lbf or lbs), kilogram-force (kgf or kg), tons (metric tonne (1000kg), imperial / long ton (2240lbs), US or short ton (2000lbs)) or Newtons (N). Newtons is the standardised unit of measure for force and is commonly used by the lifting and rigging industry. It is important to use the correct conversion factor when comparing equipment with ratings in different units of measure.

Equipment supplied to the lifting and rigging industry are normally supplied with equipment data sheets that include dimensional and performance data that has been verified through destructive testing. Some equipment is even supplied with test certificates confirming that the item has been subjected to a specified proof load using a standardised testing method.

Hard rigging such as shackles and pulleys normally have the WLL or MBS permanently embossed or engraved on the equipment. Soft rigging like ropes, slings and straps are normally marked with a permanently attached label.

It is important to understand which rating the recovery equipment manufacture is using when marketing their products as standards for the design, testing and labelling of recovery equipment have not been set. Some manufacturers will use MBS and not provide a WLL while others will use WLL without declaring the MBS or Safety Factor. This results in a lot of fudging of the numbers to make a product appear to be better than a competitor's product (i.e. a bigger number is perceived as being better). Some manufacturers don't even do destructive testing to confirm the design or manufacturing quality of their products. A number of people have done comparative destructive testing and found a lot of variability in some products such as recovery (snatch) straps.

Where the WLL is not defined, you can choose a desired safety factor and calculate the WLL using the known MBS as the starting point. Depending on the application and other factors, the Safety Factor may be as low as 2 (e.g. in situations where the load is not suspended or supported), not less than 4 (e.g. when chain is used), or as high as 10 (e.g. when a person is suspended by a fibre rope).

### Tie-down Points

All vehicles have factory fitted tie-down points. Do not confuse tie-down points with recovery points. Do not use tie-down points as recovery attachment points; they are for anchoring a vehicle during transport on a truck or ship and are not strong enough for use as recovery attachment points.

## Tow Hooks

Tow hooks are a very important part of vehicle safety equipment and MUST have a manufacturers rating stamped on them. The rating of tow hooks and acceptable methods of mounting are laid down in the [Club safety documents](#) and can be viewed on the [CCVC web site](#). There is no ideal mounting angle for tow hooks. Hooks may be mounted open side up, open side down, open side left facing, open side right facing.

**WARNING:** Rated tow hooks are designed to straighten at the specified rating (MBL), releasing the tow strap. This reduces the chance of a structural component (e.g. chassis, hook mounting point) failing during the recovery. Therefore **DO NOT** connect metal hardware (shackles, winch hooks, chains) to these hooks.

## Tow Hook Attachment Bolts

**Metric bolts** have a numerical shear strength loading code stamped on the bolt head.

**Imperial bolts** have angular marks pointing from the circumference to the centre of the bolt head. Add a value of 2 to the number of marks on the bolt head to get the grade, e.g. no marks will be a grade of 2 and 6 marks will be a grade 8. Tow hook attachment bolt shear strength, locking nut torque levels and approved mounting methods are shown in the [Minimum Standard for Tow Hook Mounting](#).

## Straps / Strops

Straps & Strops are the same thing; they are used for towing and recovery. Learn to identify the difference between stretch and non-stretch strops, misuse could be fatal!

### ***Kinetic or Snatch Straps***

Kinetic straps have elastic qualities and can stretch up to 20% of their length when dry and 10% when wet. Do not join more than two kinetic strops together as the resulting rebound may cause loss of control or exceed the safe load limits of your recovery tackle. Some straps have special coloured marker threads which, if broken, indicate that the strop has been over stressed. NEVER use a shackle to join kinetic straps; if a strap breaks the shackle could become an unguided missile!

Regularly examine all straps to ensure that there are no cuts, the stitching is sound and over-stress marker threads are intact.

### ***Tree Protector***

If a tree is used to secure any equipment it is good practice to use a tree protector. This is a short wide strap that can be wrapped around a tree to minimize damage to the bark of the tree.

### ***Tow Straps***

Tow straps are non-stretching straps. Using rated lifting straps is preferred to using cheap tow straps that include metal hooks. Tow straps can also be used as bridles for spreading the load between recovery points on the vehicle.

### ***Strop Management***

Roll up a strop by starting from the middle. Double the strap and coil it like a fire hose so that both ends finish up on the outside. This helps avoid twists when you unroll them and leaves both ends in the hands of the operator. After use (usually in sand or mud) wash with water and a light detergent

and hang up to dry before storing.

**Joining Straps – Joining Sticks**

Never tie knots in recovery straps, ropes or cables - this will seriously weaken or damage them.

<p>To join two straps, thread the end of one strap through the eye of the second strap</p>	
<p>Thread the other end of the second strap through the eye of the first strap</p>	
<p>Pull the second strap all the way through the eye of the first strap until the eyes interlock</p>	
<p>Place the joining strap in the space between the two eyes and pull the straps tight around the joining stick. Pull the joining stick out to loosen the connection between the two straps after the recovery. Reverse the process to disconnect the two straps.</p>	

## Ropes / Cables

Never attempt a snatch recovery using any type of rope that is not specifically made for kinetic use. It is handy to carry a length of rope or cable as the round cross section allows the rope to be threaded through a 'pulley block' to gain a mechanical advantage and / or change the direction of pull.

**Synthetic Rope** is very lightweight and will float but is more expensive than other ropes. It is extremely strong (more than ten times stronger than steel by weight) and easy to handle. Keep synthetic rope covered to avoid exposure to ultra violet light (sunlight) and free from abrasive grit. Sharp or abrasive items can easily damage synthetic rope.

**Hemp Rope** is easily damaged by sharp objects and should be kept clean and dry. Inspect regularly and destroy immediately if it shows any signs of rotting, unravelling, broken strands, cuts etc.

**Wire Rope or Cable** must be handled with care, use leather gloves to avoid injury due to sharp strands. Wire rope should be kept lightly greased and clean from sand and grit. Old wire rope that has kinks, broken strands or is rusty should be destroyed and replaced.

### **Snatch Block**

A snatch block is a pulley block with swivel opening side plates, this allows the block to be placed on a cable or rope while both ends of the cable are fixed, thereby removing the need to thread the cable through the block. If multiple blocks are used on a recovery rope attached to a vehicle then a large mechanical advantage can be gained. Another use for a snatch block is to change the direction of pull by attaching it to a vehicle or tree when it is being used as an anchor point.

### **Shackles**

**IMPORTANT:** All shackles must be rated.

There are several types of shackles (also known as a 'clevis'), one type is known as a 'Bow' shackle and the other called a 'D' shackle. Bow shackles are so shaped to be used with multi leg slings and will show any deforming caused by overloading (straightening of the sides). If this is evident the shackle should be discarded. 'D' shackles are mainly used for single leg slings. If you should lose the threaded pin that closes the shackle do not replace it with a bolt, as the bolt will not be rated.

Soft shackles are starting to be used commonly by four wheel drivers. These shackles are made from the same material as synthetic winch rope and are available in a range of sizes. They are light weight yet very strong.

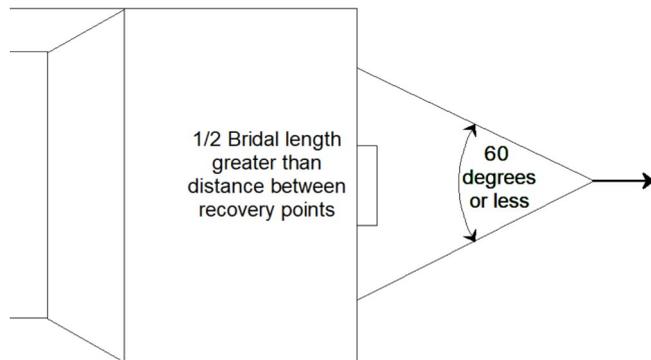
**WARNING:** Metal shackles must NEVER be used to join ropes or straps together. You do not want a heavy metal object in the middle of your soft rigging that will become a projectile in the event of a failure.

### **Recovery Chains**

Do not use if they are not 'rated'. Never 'snatch' a vehicle using a snig or any other type of chain. Chains can be used with a hi-lift jack to create a hand winch. Chains are great for connecting recovery gear to the chassis to avoid cutting straps on sharp edges. They are also useful if you need to drag logs or rocks out of the way as they are resistant to abrasion.

### **Bridle Strap**

If you have recovery hooks on each side of your vehicle a short strap such as a tree protector, can be used as a bridle between the tow hooks to distribute recovery loads between both hooks. It is important that the length of the bridle is more than double the distance between the recovery points. This ensures that the bridle forms an angle of 60 degrees or less at the centre. This will result in the recovery force applied at the middle of the bridle being divided and shared by



each recovery point. The resultant horizontal crushing force applied to the chassis between the recovery points will also be minimal. A shorter bridle will increase the load applied to each recovery point and apply a large crushing force to the chassis. A longer bridle will reduce the angle, reducing the load on each recovery point and the crushing force applied to the chassis.

### **Winches**

**Power Take Off (PTO).** The drive power for this type of winch comes from a drive shaft connected to the transmission. Both capstan and drum type winches can be PTO winches.

**A Drum Winch** is a winch that winds and stores the cable layer by layer on a windless type drum.

**A Capstan Winch** does not hold any reserve cable. A couple of turns of cable are wrapped around the rotating capstan and held taut by the operator to maintain a friction lock.

**Electric Winches** are drum winches powered from the vehicle battery. They draw a lot of power and can get very hot, depending on the type of brake mechanism fitted. Be aware that under severe use the drum temperature of an electric winch could get high enough to cause critical damage if using a synthetic rope.

**Hydraulic Winches** are drum or capstan winches that get their rotating power from a motor driven by hydraulic fluid under pressure. The hydraulic fluid is delivered by hose from an engine driven pump.

**Shear Pins** are safety devices (sometimes known as a fuse), installed in a winch drive mechanism.

They are designed to break and disconnect a load before the winch self-destructs or the cable breaks.

A pawl mechanism prevents cable spooling out if the shear pin breaks. Shear pins look like a short medium size nail with a waist (designed weak point). A sheared pin is relatively easy to replace although you may have to crawl under some vehicles to do this. Replacement requires the broken bits of the old pin to be knocked out, the shafts between the winch motor and the winch gearbox aligned and a new pin inserted (not easy though if you are the middle of a bog or river!)

**Hand Winches.** A common type has a straight handle that is manually rocked backwards and forwards, which, with the aid of a ratchet mechanism winds the cable onto a small drum. Another type of hand cable puller, sometimes known as a 'come-along' has a similar arm action but the winching system has a cable gripping friction lock and pulls the cable through the body of the winch.

**A 'live' winch rope or tow strop** is any rope or strop that is connected at both ends to an anchor point or vehicle. Treat with caution, DO NOT STEP OVER A LIVE ROPE OR STROP!

When winching, keep the vehicle wheels turning at the same speed (or slightly faster) than the in-feed speed of the winch – in other words try and assist the winch.

ALWAYS keep at least six full turns of a winch rope on a winch drum. This can be ensured by installing a small webbing keeper under the last few wraps of winch line.

**A Hi-Lift Jack** can also be used as a winch. The jack is used horizontally and can be used to pull up a chain almost the full length of the jack. The chain is then locked off, and the jack released, reset at full length and the operation started again. In a series of short pulls of about a metre each time the jack can be used as a very successful hand winch.

**An Armstrong Winch** is simply a long rope or strop with lots of people using the strength of their arms and traction of their feet to pull on the rope. You may be very surprised how effective a one-team tug of war can be!

## Chapter 5 – TRACK-SIDE REPAIRS

### Jacking

Read your owner's manual to learn where your vehicle jacking points are located. When driving off road you need a robust jack that may have to be used in restricted space on uneven ground. A jack is usually used for lifting the corner of a vehicle to change a wheel. On a 4WD trip it may be used to lift a vehicle so that material can be packed under a wheel to drive out of a hole, or lift the vehicle to remove an obstruction stuck beneath it.

If you have to lift a vehicle to do repairs NEVER get under a vehicle when it is jacked up. Always chock wheels and use something to support the vehicle and prevent it from crushing anyone if the jack should fail (and they occasionally do). You could stack two spare wheels under a vehicle as an emergency safety cushion.

If your vehicle is modified, be sure to check that the jack you are carrying is able to lift the vehicle high enough to change the wheel. If not, you may need a jack with more lift, but check that the bigger jack is able to fit under the jacking point.

### Base Boards

When using a conventional jack it is very important to use a base-board to spread the load on sand, mud or soft ground. A piece of 16 mm plywood about 300mm square under the jack will do fine. It is also useful to carry some 2x8x12in solid timber boards that can be stacked to shore up the vehicle or raise the jack.

### Hi Lift Jack

A hi-lift jack is a large, heavy-duty lever operated jack and as its name suggests is capable of lifting much higher than the jack supplied with a vehicle. They can also be used as a vice, a hand winch and a spreader.

**CAUTION:** The higher the lift the more unstable the vehicle becomes.

A vehicle will also need special lifting points for a hi-lift jack to be attached to (usually on a bumper or protection bar). Most 'shiny' 4WD vehicles do not have any suitable lifting points where a hi-lift jack can be used.

### Air Jacks

A deflated air jack is slid under the vehicle and an inflating hose held over the vehicle exhaust pipe to inflate the air bag. A mat or piece of old carpet is usually placed on top of the bag to prevent it being punctured or cut by any sharp parts of the vehicle. This type of jack is very useful in water, mud or sand. The air bag has an advantage over conventional jacks as it does not have to be placed anywhere special under the vehicle except, of course, it is important to avoid a hot exhaust pipe as this could melt the flexible air bag!

### Tyre Repairs

It won't be long and you will probably experience a flat tyre (yours or someone else's) while out on the trails. Having a tyre repair kit on hand will be a bonus. Punctures through the tread area of the tyre are easily repairable track side, provided the hole is not too big. Damage to the sidewall is usually unrepairable. It is often safer to repair the tyre in situ rather than jacking the vehicle up and

changing wheels. This will allow you to drive to a location when swapping wheels will be safer before getting back onto tarmac and heading home.

Look for a tyre repair kit with solid metal tools as these are much more robust and won't break during use. Some kits even come in a neat carry case to keep everything organised. Carrying a set of tyre levers in your group will make reseating a tyre that has been run off the bead / rim a lot easier too. Tightening a ratchet strap around the tread will help create a seal before the bead pops back into place. Be sure to keep your fingers out of the space between the tyre and the rim when inflating the tyre.

Naturally, a compressor is essential for completing your track side repair as you will need to air up before continuing.

## Chapter 6 – DRIVING TECHNIQUES

Always travel with caution when off road. Be prepared, you may come across other vehicles, walkers, trail bikes, horses or cattle at any time. Consider all roads and tracks to be two-way and expect to meet on-coming traffic at any time! Use normal road rules even when not on a formed road.

### When to Use 4WD

When travelling on a gravel road or track, selecting 4WD may help you maintain control. If the rear wheels should lose traction when cornering the front wheels will continue to pull the vehicle forward, this helps to keep the back end from sliding sideways and perhaps off the road. Do not use 4WD on a normal hard seal road unless your vehicle has a 'full time' 4WD transmission. When off road, do not try and see how far you can drive without engaging 4WD, when you become stuck you will inconvenience others who have to spend time and effort helping to recover your vehicle. You may also cause damage to the track by unnecessary wheel spinning when in 2WD (two wheel drive). Engaging 4WD also reduces strain on the drivetrain, especially on steep or slippery terrain.

### Engaging 4WD

Generally, do not put a vehicle manually into 4WD unless travelling at less than 5 kph, however on some newer vehicles 4WD may be selected at higher speeds, read your vehicle owners handbook.

On a manually selectable 4WD vehicle, engage 4WD by moving the transfer case gear stick or switch from the 2WD position to the 4WD position. If you have manually operated 'Free Wheeling' hubs on the front axle then they will have to be separately engaged before the vehicle can be used in 4WD.

### The secret to four wheel driving

Successful four wheel driving can be summed up in the following statement:

**As SLOW As Possible AND As FAST As Necessary!**

Wheel placement (choosing the right line) has a huge impact on how easy it is to negotiate an obstacle. Choose a line that ensures both wheels on an axle are making good contact with the terrain at all times (i.e. keep the axle parallel / level with the ground). This ensures that both wheels maintain traction and keep moving the vehicle forward. Also, avoid situations where one wheel has to climb over even a small obstacle / step while the other has a smooth path. This will create the situation where one wheel is blocked and the other loses traction.

### Hill Climbing

High torque is required for hill climbing. Use a gear that will comfortably allow you to climb the hill without the engine labouring. However, keep in mind that you will be travelling slowly and airflow through engine radiators will be limited. Keep an eye on the engine and transmission temperature gauges when driving a long hill climb. If you have a belt driven radiator fan and either temperature is climbing, then use a lower gear and increase engine revs to get more air moving through the radiators. An air conditioning system uses considerable engine power, turning it off may help lower the engine temperature. Do not over-rev the engine and keep up vehicle momentum.

When climbing, the weight of a vehicle acting at the centre of gravity will be angled towards the rear. Traction and braking will be more effective on the back wheels and less effective on the front wheels.

If your vehicle has been in water shortly before you start climbing a hill, check your brakes to make sure they are effective. Do not start a hill climb with wet brakes. In the event of a failed hill climb or another vehicle stopping and preventing you moving forward you will suddenly be dependent on your brakes and will expect them to be working properly!

### **Failed Hill Climb**

#### ***Manual Transmission***

Always use low ratio when climbing a very steep hill. If the hill becomes too steep for your vehicle or you lose traction and are unable to continue climbing then you are in a 'Failed Hill Climb' situation.

Select reverse gear immediately and start a controlled descent in reverse. Be careful, use cadence braking and maintain traction.

#### **DO NOT ALLOW A VEHICLE TO RUN BACKWARDS USING THE CLUTCH**

**REMEMBER:** Start slow – Stay slow – Stay in control!

Stay in gear at all times. If you miss the gear change into reverse, do not allow the vehicle to move backwards with the clutch depressed. Stop the vehicle and start over, stall the engine if necessary.

Hold the vehicle on both the foot brake and handbrake, select reverse gear, and centre your steering wheel and front wheels so you know which way the vehicle will move when started. Let out the clutch, release handbrake, slowly release footbrake, the vehicle should hold its position by resting on engine compression. Flick the start switch and the vehicle should start instantly in reverse.

When parking on a steep hill, use the hand brake, leave in gear and angle the wheels away from the downhill slope if you are going to get out of the vehicle. This will ensure that the vehicle runs into the bank instead of off the cliff or straight down the track if it should start moving.

#### ***Automatic Transmission***

Select reverse as fast as possible. BUT avoid putting into reverse gear whilst still moving forwards.

After selecting reverse gear you may also need to blip the throttle to accelerate the engine a little - this will re-engage the automatic transmission's torque converter. Doing this on a hill may result in the vehicle getting away from you. Rather use the drive-over braking technique below.

#### ***Drive-over Braking or 'Left Foot Braking for Automatics'***

A little throttle may be required to ensure that the torque converter is engaged and stays engaged. Use your left foot to apply the brake while you gently apply throttle with your right foot. As you start to feel the engine pushing against the brake, gently release the brake to allow the vehicle to move off slowly. Carefully balance power and brake to control your descent, allowing engine braking to take effect. This is not a normal driving technique and requires lots of practice in controlled conditions!

#### ***Traction Control***

This is a type of ABS in reverse and pulses the wheel brakes. The traction control system (TCS) will 'see' which wheel is turning the fastest (a spinning wheel that is off the ground or on a slippery surface) as a wheel that has lost traction and so applies the brake on that wheel to get the differential to deliver more power to the other wheel on the same axle. A drawback however may be that the ABS system does not allow you to deliberately spin the wheels and clear the tyre treads of

any loose mud etc. Depending on the design, TCS may also limit engine power at the same time. This results in a failed hill climb. It is important to practice getting the most out of your vehicle.

### ***Positioning Your Vehicle For A Turn***

When approaching a very tight, uphill hairpin corner, look ahead and position your vehicle so as to take the corner in one bite if possible. If it looks like you will need to make more than one bite at the corner then try and manoeuvre wide to avoid becoming cross-axled and losing traction.

## **Descending Hills**

**REMEMBER:** Start slow – Stay slow – Stay in control!

Always use low ratio when descending a steep hill. If you have to park on a steep hill use the hand brake, put vehicle in gear and angle the wheels away from the slope towards the bank if you plan to leave the vehicle. This ensures that the vehicle runs into the bank if it should start moving.

If you cannot see the track over the front of your vehicle – get out and have a look or get someone to give you directions - do not make guess at what is in front of you.

### ***Manual Transmission***

Select first gear or second gear in low range, let the clutch out and use engine braking to control the speed of the decent. Do not depress or ride the clutch during the decent. If you find that you are in the wrong gear for the decent, bring the vehicle to a stop before changing gear. You don't want to risk missing a gear selection during a decent as this will result in a run-away situation.

### ***Automatic Transmission***

Use the same technique as described in, Failed Hill Climb, Drive-over Braking. This is sometimes known as 'Left Foot Braking'. Select low, 1st or 2nd gear, brake with your left foot and to ensure that the torque converter stays engaged use a 'very little' throttle with your right foot. As you do not want the vehicle to accelerate downhill, you need to use your left foot on the brake pedal at the same time – this requires practice. Hold the vehicle stationary by applying just enough brake to do so, and then move the vehicle forward by applying a little accelerator to overcome the effect of the brake, reducing pressure on the accelerator will bring the vehicle to a stop. Practice this technique on a flat road, do not try it on a steep four wheel drive track without practice.

### ***Vehicle Weight***

When travelling down a hill the weight of the vehicle acting at the centre of gravity will be angled forwards giving increased traction and braking at the front wheels and less effective on the rear.

### ***Changing Gears***

Make your gear selection before you are established on the downhill slope. Use a gear one lower than you would use to climb the hill. Be careful, if you should miss a gear change or have a problem with the clutch you will lose the effect of engine braking.

### ***Braking***

When descending a hill it is VERY important to maintain traction at all times. You must have effective braking and steering to remain in control of your vehicle. If the track is slippery it is very easy to lose traction by braking and causing the wheels to turn at a slower speed than the vehicle is actually moving forward. When this occurs you are skidding and your tyre tread will rapidly become clogged making the braking even more ineffective. You may actually have to accelerate the wheels slightly

and hope that your large void mud tyres advertised as being 'self-cleaning' really do! If you are going to lose control it is better to lose it at 5 kph than 20 kph.

Drive slowly as you approach a wet clay or muddy area on a track, don't race up to it and then be surprised if your brakes have little or no effect. If you are on a rough rocky section of track you can take advantage of the hard surface to slow the vehicle or clear your treads while you are still able to effectively use your brakes. If your vehicle loses traction you have to increase the vehicle wheel speed up to the speed that you are moving forward at to regain traction. If it is safe to do so try changing up a gear, this will increase your speed a little but at least you may now have control again.

Start your descent slowly in either your lowest gear or at least one gear lower than you would use to climb the hill. If track conditions permit (good gritty or rocky surface), you can use your brakes (see "Cadence Braking" below) to maintain a slow descent. If you are in your lowest gear and the vehicle continues to slowly accelerate, try turning on your air-conditioning, this will add more load to the engine and increase the effect of engine braking. DO NOT follow close behind another vehicle.

**REMEMBER:** Start slow – Stay slow – Stay in control!

### ***Cadence Braking***

Always use smooth squeezing action if you need to apply the brakes during a decent. You do not want to brake sharply during a decent as this has the tendency to lift one or both back wheels off the ground and may end with a catastrophic cartwheel down the hill. Apply the brakes in very short pulses to slow the vehicle without actually stopping the wheels turning. This is known as Cadence Braking.

### ***Descent Control or Traction Control***

This is a type of ABS in reverse, it releases the wheel brakes in short pulses to obtain braking without skidding. Traction control checks to see that all wheels are turning at the same speed. Any wheel that is turning slower than the others is skidding so the traction control releases that individual wheel brake momentarily until all wheels are again turning at the same speed. A drawback however is that you may not be able to blip the throttle and spin the wheels to clear the tyre treads of any loose mud.

Descent Control generally uses the brakes only to control the speed of descent with very little use of engine braking. This can result in the brakes overheating and fading. Take some time to practice using this in controlled conditions and compare results with just using engine braking. You may find that engine braking gives you much more control.

### ***Use of Ruts***

Ruts can be useful on a slippery track. By deliberately positioning your wheels in ruts, the sidewalls of your tyres can have a braking effect if gently turned against the side of a rut. Ruts may also help guide you around twists and turns when your steering is not very effective due to loss of traction. This will feel a bit like tobogganing in a 3 ton sled.

### ***Positioning Your Vehicle for a Steep Descending Turn***

When approaching a tight, downhill hairpin corner, look ahead and position your vehicle to take the corner wide. If it looks like you will need to take more than one bite at the corner, try and start wide then turn, manoeuvring on the part of the track with the least camber to avoid becoming cross-axeled and losing traction.

### ***Catching a Slide***

If your vehicle loses traction and is still moving then you are sliding and you have lost control. You must regain control immediately. If the vehicle is not going to stop by itself, try gently accelerating to see if your tyres can clear their treads and bite the ground to regain traction, ease off the brakes. If you have a choice, stay in ruts they may help to guide you like railway lines with little steering required.

### ***Run-Out***

Plan an escape route. Look around to see where you can head for if things do not work out as planned.

## **Stability**

### ***Centre of Gravity***

The centre of gravity (C of G) of an unmodified 4WD vehicle is usually at about the height of the driver's seat and alongside the driver on the centreline of the vehicle.

A 4WD is designed to have a high ground clearance. By being higher off the ground the centre of gravity will be higher and the vehicle roll-over angle will be less than a low vehicle such as a family car. This must be taken into account when deciding what angle of slope you can safely drive across.

A vehicle with a high C of G can roll over easier than a vehicle with a low C of G. A sideways force in the range of +0.8 to +1.1 G is all it takes to roll over a high C of G vehicle. A sudden swerve or a slide that stops against a bump or rut may result in side loads that cause the vehicle to roll over.

Lowered tyre pressures will increase the effect of any body roll. Do not overload your vehicle, stopping distances are increased. Any load on a roof rack will also raise the C of G and affect stability.

### ***Live Loads***

Live loads such as animals or humans can alter the centre of gravity by moving around inside the vehicle. Loose freight or a tank of liquid should also be considered a 'live load'.

### ***Side Slopes (Sideling)***

If you need to drive across a slope and it looks a bit steep, try walking the slope before you attempt to drive across it. If you have difficulty walking across the slope then your vehicle will also have a problem. If your vehicle starts to slide sideways when crossing a side slope, there is only one thing to do – turn into the slide and drive down hill immediately. Look to see where your down slope run-out may be before you attempt to cross it. If you don't turn and drive down slope immediately there is a chance that your vehicle could roll over.

When crossing a slope most of a vehicle's weight will be on the down slope wheels. If the vehicle does start to slide then a small bump may be all it takes to lift the up-hill side of the vehicle slightly and start a roll over. If you only have to traverse a short distance it may be possible to dig yourself a rut for the up slope wheels, this will lower the effective angle of the slope and forms a channel to prevent the wheels breaking away into a slide.

The maximum side slope angle that a normal 4WD vehicle can safely negotiate is about 25 degrees or 15 degrees if you have a loaded roof rack. Any angle greater than this and you should be sure that the ground surface is firm and has excellent traction. The vehicle may not roll until the slope angle is much higher, but the vehicle can slide sideways resulting in loss of control.

## **Soft Surfaces (Sand, Beaches, Snow, Ice, Mud)**

Soft surface are less able to support the weight of a vehicle. This results in the tyres compressing the ground and forming grooves. The soft terrain is also pushed forward in front of the tyres forming a “mound” that the wheel needs to continually climb over. This saps a lot of energy and can slow or even stop the vehicle. The smaller the tyre foot print and the wider the tyre the worse this effect is. There are a number of different things that we can do to counteract this.

### ***Tyres***

If your tyre treads have become clogged with mud then traction will be poor. A very careful throttle blip to accelerate the wheels may clear the tread by throwing off any soft debris.

Narrow tyres are offer less resistance in soft terrain than wide tyres (tyre pressure and foot print being equal).

### ***Tyre Pressure***

Reducing tyre pressures by half will increase the size of the tyre footprint by over 25%. Generally you should always reduce tyre pressures when off-road driving EXCEPT, when using tyre chains. If you find the going tough even after lowering pressure, try dropping tyre pressure by 5 PSI / 0.3 Bar. You will be surprised how much of difference this will make.

High Torque is required when driving through clinging sand, snow or mud. Try and travel at a low to medium speed, avoid wheel spin and over revving. Try and use the highest gear that allows you to still make good headway without the engine struggling. Maintain constant power so that you conserve momentum.

### ***Sand Hills***

Approach straight on when climbing or descending. If you start to slide when descending, accelerate gently to keep steering control. Be very careful when moving down steep sand dunes, keep the wheels turning and ride the avalanche (do not drive faster than what the sand is sliding). Avoid driving across the slope to avoid sliding sideways and a possible roll over.

### ***Turning the Steering Wheel To Gain Traction***

Gently turning the steering wheel from side to side through about 30 degrees from centre may allow the side lugs of tyres to dig in and aid traction. Do not try this if you are still making headway as the wheels turned at any angle other than straight ahead act as a bulldozer and causes more drag. Be careful though, if your vehicle suddenly gains full traction it may take off in the direction that the wheels are pointing and not the direction you want to go.

### ***Reversing If Stuck***

If you become stuck while moving forward in snow, sand or water, try putting the vehicle immediately into reverse and backing out over your own wheel tracks onto a firm surface but avoid wheel spinning as this will just dig a deeper hole!

## **Rivers / Water Holes**

### ***Check the Water Depth***

Know the depth of water that your vehicle can safely negotiate without floating – usually not much more than wheel height! If the depth of water or strength of current is too strong to walk across then

think very carefully about attempting to drive across. If you are unable to walk across then you should not try and drive across in a small to average sized 4WD vehicle.

### ***Engine Air Intake***

Know where your engine air intake is located. Do not allow water to get into the engine air intake, it can kill your engine and be VERY expensive to repair! Some vehicles are fitted with snorkels to lift the engine air intake well above water level. In an emergency it may be possible to temporarily disconnect an air intake or redirect it within the engine bay to avoid ingesting water.

### ***Engine Management Computer***

Know where the computer is located (usually under the carpet above passenger's feet below the dashboard). If water enters your vehicle and gets into the computer it could be a long walk home and cost a lot of \$\$.

### ***Entry Point / Exit Point***

Carefully check that your entry and exit points are clear before entering a river. If you need to reverse, is it practical to use the entry point to get back out again? Are you sure that your chosen exit point is attainable and the riverbank is not too steep to climb out? If in doubt walk your intended route first.

DO NOT drive up to the river edge as soon as the vehicle in front has started the crossing, leave room for the vehicle in front to reverse out again if required.

### ***Hidden Obstacles***

Look out for hidden objects just waiting to cause you grief. Deep holes, large boulders or tree branches may ruin your day. Pick your route carefully, watch carefully where others in front of you go. If you see them suddenly lurch or drop into a hole make a mental note to avoid those spots. A wave / "white horse" in a flowing river usually indicates a rock or other object hidden just below the surface.

### ***Travelling Against the Current or With the Current***

If you have a choice, it is best to cross a river driving either straight across or angled downstream. This avoids the current pushing water up into the engine bay or the vehicle having to fight against the current when heading upstream.

### ***Bow Wave***

When crossing a river or pond try to do so at a speed that produces a small bow wave about 20 – 25 cm high (about one and a half hand spans). A trough is formed behind a bow wave beneath the engine bay area. Be aware that your bow wave could cause problems for someone driving towards or alongside you. If you are in a tunnel a wave pushed ahead of you may reflect back off of the wall of the tunnel and come up under your engine. Be observant of what is happening around you when in water. Do not travel too fast! If you slow down suddenly then the bow wave may collapse and swamp your engine.

### ***Prepare Your Escape***

Before making a high risk water crossing (water more than knee deep, soft bottom, fast flow, etc) prepare your vehicle for recovery and escape. Get your recovery straps ready and attached to the recovery points. Unspool the winch rope so that it is quicker to deploy. Have your winch controller plugged in and winch isolator turned on.

Open the door windows and remove seatbelts before entering the water. This allows you to escape quickly if the vehicle should be swept away or become flooded. You will not be able to open the doors if the windows are closed until the pressure inside has equalised with the water pressure outside.

### ***Additional Hazards***

Beware of hidden objects when driving through water or on snow, sand and mud. Items such as seaweed could hide driftwood or rocks on a beach. Muddy water may hide logs, boulders and deep holes. When driving on a beach be aware that tides may cut off your return. Do not travel at speed near the water, large waves moving up a beach may force a sudden swerve and roll-over (especially if you have reduced tyre pressure). Don't park on saturated sand near the water's edge – your vehicle may sink!

When driving in snow, white-out conditions may occur at any time reducing visibility to zero and making driving hazardous if not impossible. Snow may hide holes and drains or the edge of the road. Keep your speed down when driving in soft sand or snow. A sudden swerve could cause a rollover.

### ***Headlights***

Most working forests require that you have headlights on at all times. Switch off your headlights before entering water. If cold water comes in contact with a hot light bulb the bulb will almost certainly fail. After finishing water crossings for the day get out of your vehicle and look at your lights to see if there is any water inside of the glass before you switch the lights on again. Modern polycarbonate lens and or globes are not subject to the same likelihood of failure in cold water.

### ***After crossing water***

If you have a manual gearbox and change gears when in water you risk getting mud and water between the clutch plates causing the clutch to slip. If you do have to change gear in water, accelerate the engine before releasing the clutch pedal, centrifugal force may help clear the clutch plates.

After crossing a river or large puddle it is tempting to park, switch off and watch other vehicles make their crossing. If you have a petrol engine it is a good idea to leave the engine running for a while, this keeps the fan moving hot engine air around the ignition and other electrics to dry them out.

Test your brakes after you come out of water. Gently ride the brake pedal for a short distance to dry out brake shoes. Caution! Do not start a hill climb or descent with wet brakes!

If you plan to make a lot of river crossings seek advice about how to prepare your vehicle by protecting items such as the alternator, ignition system and starter motor, these items can be expensive to repair.

## **Tell Someone Where You are Going**

Before you go on a trip always tell someone where you are going, any emergency plans (alternative routes) and when you expect to return. This is important if you are carrying a PLB. Your nominated contact person will be contacted by the Rescue Coordination Centre to verify your travel plans if you set off your SOS Alarm. So make sure they have a copy of your travel plans.

## Convoy Rules

- Recognise the authority of the trip leader.
- No dogs or firearms.
- Guests are the responsibility of the person who invited them.
- Always wear seatbelts when driving.
- No drinking and driving.
- Keep the vehicle immediately behind in sight.
- Wait at all intersections to ensure the following vehicle makes the correct turn.
- Keep your position in the convoy - no passing.
- Do not use excessive accelerator and dig holes by unnecessary wheel spinning.
- Do not leave the convoy without telling the trip leader.
- When driving in a working forest always have your headlights turned on.
- Leave gates as found.
- Take all of your rubbish home
- Following distance –
  - (a) Allow plenty of room to stop safely should the vehicle in front brake suddenly
  - (b) Ensure the vehicle in front has cleared an obstacle before you attempt it.
  - (c) Allow room for the vehicle in front to reverse if necessary to make another attempt at an obstacle.
  - (d) When travelling on the open road, leave room for other road users to overtake you and move on through the convoy.
  - (e) Keep well back from the vehicle in front when on a steep or slippery slope.

## Corner or Gate Person

When travelling in a convoy on public roads it is sometimes handy to use a 'corner person'. The trip leader is in the lead and when the convoy comes to an intersection the second vehicle is directed to wait at the corner to indicate the direction of travel to other vehicles in the convoy.

When the tail vehicle comes to the intersection it will flash headlights or make contact by radio to indicate to the corner person to re-join the convoy immediately in front of the tail vehicle.

A similar process is used when travelling on rural roads with lots of gates. This allows every vehicle in the convoy to have a turn opening and closing gates. Otherwise the trip leader and Tail End Charlie will get tired very quickly from having to get out each gate.

## Respect the Environment and Other Users

CCVC encourages its members to respect the environment and the rights of other users at all times.

Take only photos, leave only foot prints / tyre tracks.

Access to land is a privilege, not a right. Please comply with instructions from Trip Leaders and at all times respect the properties we drive on.

**REMEMBER:** "Abuse it and we'll lose it"

### Towing

When towing a trailer off road, articulation and break-over angles become very important and a conventional tow ball and hitch may not be suitable. If twisting articulation or break-over angle becomes excessive, disconnection or breakage of the coupling may occur.

When towing another vehicle that has broken down be aware that a vehicle without a running engine has no power assisted brakes or steering. Stopping and steering a vehicle without power assist is very difficult and dangerous. In some circumstances it may be useful to tether a third vehicle behind the 'dead' vehicle to assist with braking. Caution, if any vehicle gets into difficulties then other vehicles attached by ropes or strops may also be compromised. Make sure that all drivers know the plan.

Use a marshal to give directions when manoeuvring in a tight spot. An extra pair of eyes can spot where your wheels are heading and how much space you have to move in.

### Night Driving

When driving on a 4 wheel drive track at night PLEASE remember to watch your following distance. Make sure that your headlights do not annoy or blind the driver in front by flooding the inside of their vehicle either through the back window or reflecting from rear-vision mirrors. At night, a driver needs to concentrate on the unlit track in front and does not want to be distracted by having more light inside the vehicle from the vehicle behind, than can be seen on the ground ahead!

### Parking

When stopping for lunch, cup of tea or photo shot etc. park in an orderly fashion, close up and leave as much room as possible for other vehicles. It is very annoying to find a vehicle taking the space that three vehicles could share if the first vehicle was sensibly parked!

### Returning To 2WD After Being Off Road

**Select 2WD or unlock centre diff.** Disengage four-wheel drive. Do not use 4WD on hard surface roads unless your vehicle has an all-wheel drive transmission system.

**Tyre Pressure.** After being 'off road' it is very important that you re-inflate your tyres to normal road pressure. Running with reduced tyre pressure is ok for slow speed travel on an unsealed surface but is unsafe at normal road speed and will damage your tyres. When pumping up your tyres take the opportunity to inspect them for any cuts that may have occurred while driving off road.

**Free Wheeling Hubs.** If you have free-wheeling hubs, you only need to unlock them at the end of your trip. It is safe to leave them locked between off-road sections when driving on hard seal roads.

**Clean Headlights and Number Plates.** If you have been on a muddy track your headlights, indicators and number plates may be covered with mud, wipe with long grass if you can't find anything else or a Police vehicle may have cause to stop you.

## Chapter 7 - VEHICLE RECOVERY

### Safety

Recovery operations are the most hazardous part of any 4WD trip. It is important to keep safety at the front of mind at all times. A useful acronym to achieve this is **STOP**:

- **S**      **Stop** what you are doing, there is no need to rush
- **T**      **Think** about what you need to do next
- **O**      **Observe** the situation in front of you to identify any hazards and danger zones
- **P**      **Plan** what you want to do
- then **Act** on your plan

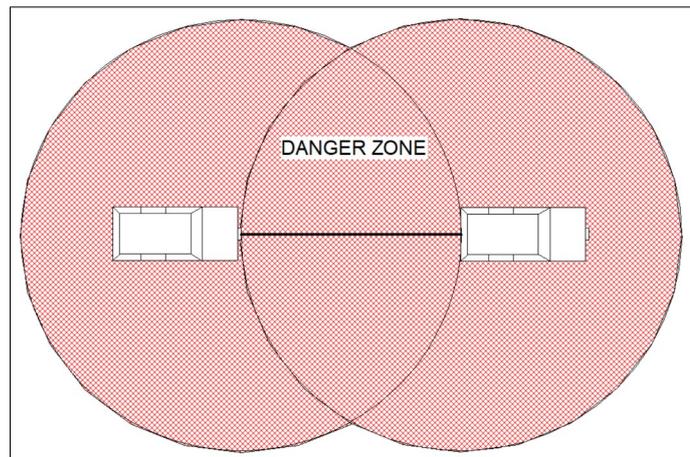
It is important not to rush in if a vehicle gets stuck or has run off the track, even if you think someone is injured or the vehicle is unstable. You don't want additional casualties if the vehicle moves unexpectedly.

### **Danger Zones.**

Significant forces are involved in recovery operations. The energy captured in recovery rigging will catapult equipment at great speed over a fairly large distance should a failure occur. Any metal components launched in this way can cause lethal injuries should they strike someone. Don't be lulled into a false sense of safety if only using soft equipment as these can still cause serious injuries.

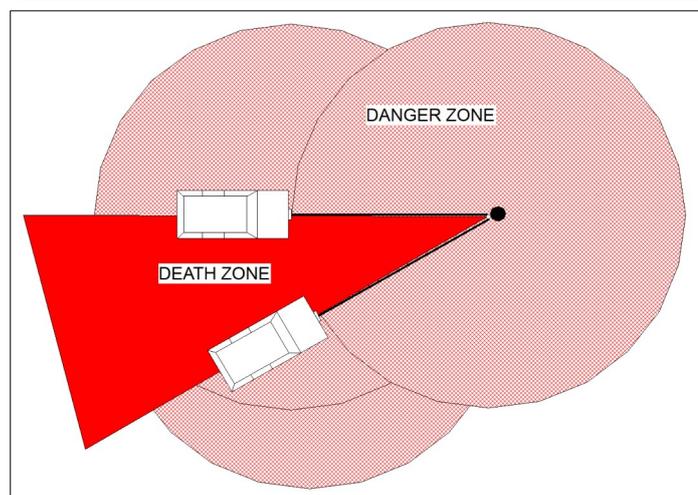
It is important to evaluate your recovery setup and consciously identify the danger zone. Plot out in your mind where any cable or strop might recoil if it or what it is attached to should break.

When towing, snatching or winching in a straight line, the danger zone is a circular area around each end of the line with a radius equal to the length of the rigging between the vehicles. No one should be standing in this zone during the recovery.



When winching through a pulley or snatch block, the danger zone is a circular area around each vehicle and the pulley with a radius equal to the distance between the vehicles and the pulley.

The triangular area enclosed by the winch line is an extremely dangerous area known as the death zone. An equipment failure near the pulley will eject the winch line and pulley towards the open side of the triangle. It is critical to keep people out of this area at all times during the recovery.



In addition, any area on a slope below the vehicles involved in the recovery is also considered a danger zone. People should avoid entering this area unless the vehicle is secured to prevent it sliding down the hill, and then the time spent in the area below the vehicle should be kept to the absolute minimum necessary to complete an essential task such as extricating an injured person or securing a line to the vehicle.

It is important to inform everyone on site of the location and extent of the danger zones and any death zones. Instruct everyone to remain well clear of these areas. Any movement of people inside these areas needs to be controlled by the person in charge of the recovery. All actions need to be carefully coordinated to avoid putting anyone in danger.

### Hierarchy of Recovery

Experienced four wheel drivers have developed a hierarchy of recovery. This is just fancy terminology referring to the prioritised sequence of applying various recovery techniques, starting with the simplest / lowest risk technique and working towards more complex / hazardous / high risk techniques that apply more energy to the stuck vehicle.

The idea is to use each of the techniques in order, applying subsequent techniques when the previous one has failed to get the vehicle unstuck. It is important to recognise that the **three techniques marked in red** cannot and should not be applied in every recovery situation. You will need to decide which of these techniques are suitable for the situation in front of you.

TECHNIQUE	DESCRIPTION
<b>Engage 4WD</b>	Check that 4WD is properly engaged including centre diff lock, check free wheel hubs are locked, select low range, engage axle lockers if fitted
<b>Reduce tyre pressure</b>	Check tyre pressures, reduce tyre pressure further (as low as 15 psi / 1 Bar or lower if necessary)
<b>Dig</b>	Use a spade to remove material in front of wheels to create ramps, fill in holes, remove material from under the vehicle and in front of axles. Repair the track.
<b>Traction boards</b>	Position one traction board in front of each wheel with the tip of the board well under the tyre for best results. Digging is essential. Boards laid end to end can also be used to build a road on soft terrain.
<b>Tow</b>	Use a rated snatch strap / rope attached to rated recovery points, gently take up all of the slack in the system with the recovery vehicle, then pull off gently using traction of recovery vehicle to tow stuck vehicle out. Do not jerk the vehicles.
<b>Winch</b>	This is the slowest and most controlled of the high energy recovery techniques. Rig up one or more winches and slowly pull the stuck vehicle free. Carrying out a winch recovery safely takes time, careful planning and meticulous rigging. Let experienced people (usually trip leaders) direct these recoveries.
<b>Snatch</b>	This is the most dangerous recovery technique as it involves a lot of energy that is employed quickly with limited control. Only use rated recovery points and rated snatch straps / ropes. Gradually increase speed with each attempt (crawl, walk, jog). The force applied increase with the square of the speed. These recoveries should only be undertaken by experienced people using the correct rated equipment in a carefully considered manner.

### Recovery Operations

Only one person who has a sound knowledge of recovery techniques should direct everyone involved. This person is the designated Recovery Leader and must be identified to everyone involved with or observing the recovery operation. This is normally the CCVC trip leader or someone designated by the trip leader on club trips.

The Recovery Leader must brief everyone involved in the recovery of the plan and how the recovery is going to be carried out. Each driver must know what is going to happen and be confident in what they need to do. What signals or commands are going to be used must be agreed beforehand as well.

Everyone involved in the recovery is encouraged to put ideas forward, raise concerns and ask questions to ensure understanding. Recovery Operations are a team effort. Once the recovery is rigged, ensure that all occupants in vehicles are secured and sitting upright. Whenever possible, each vehicle should only be occupied by the driver. Other occupants should exit the vehicles unless the terrain prevents them from doing so.

Once the recovery manoeuvre starts, then the Recovery Leader is the only person giving instructions. Everyone else only speaks when spoken to by the Recovery Leader. This avoids conflicting instructions coming from different people which may cause confusion. Anyone involved may issue the "HOLD" command which brings everything to a controlled stop maintaining tension on all rigging. At this point the situation will be assessed and next steps decided. The Recovery Leader will issue instructions to proceed when it is safe to do so.

### Recovery Loads

Loads incurred when recovering a vehicle can be very high. In the following tables LW is the Loaded Weight of the vehicle being recovered:

- A pull of 100% of LW is required to free a vehicle stuck up to the top of the sidewall of a tyre.
- A pull of 200% of LW will be required to free a vehicle stuck up to the hubs of its wheels.
- A pull of 300% of LW will be required to free a vehicle stuck up to the body.

Add the following load if a vehicle is to be recovered up a slope.

- 15 degrees - add 25% of LW
- 30 degrees - add 50% of LW
- 45 degrees - add 75% of LW

### Winching

This is the slowest and most controlled of the high energy recovery techniques. Progress can be monitored closely and when unexpected or undesirable movement starts to occur then the recovery can be stopped, checked and adjusted as needed.

Sturdy gloves should always be worn when handling wire rope to avoid injury from tiny broken strands which are present along the whole length of the wire rope.

#### ***Winch Safety***

ALWAYS use rated tow hooks, cables, shackles and strops that have WLL that exceed the expected recovery loads. NEVER use a tow ball as an attachment point. When a winch cable has been hooked up at both ends it must not be handled or stepped over.

Vehicles must avoid running over winch cables. A steel cable may become permanently kinked and weakened if it is deformed over a rock, a synthetic cable may be abraded or cut.

Before any winching commences the person in charge shall ensure that ALL people are moved out of the danger zones. A winch should not be operated whilst rigging is taking place. Slack in the system is only taken up when the Recovery Leader gives the all-clear.

If it is necessary for someone to assist with feeding the winch cable in (or out), then their hands should be kept clear of the fairlead (always more than 1 metre away from the fairlead) and be clearly visible to the person operating the winch controller.

### ***Winch Rope Dampener***

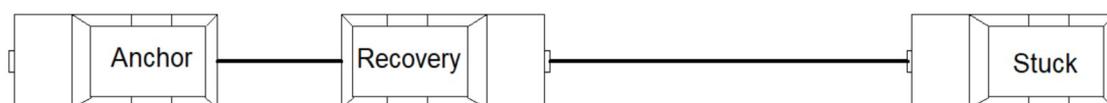
To try and slow down any recoil if a rope breaks, a commercially available winch dampener, sack, blanket or similar sized item should be draped over the midpoint of the cable to act as a drag parachute. This also acts as a flag to indicate where the (sometimes hard to see) winch rope is. Additional dampeners can be added at any joints in the rigging. Any repositioning of the dampener should only take place if winching has ceased and the person in charge of the operation gives the go-ahead.

### ***Fixed Anchor Points***

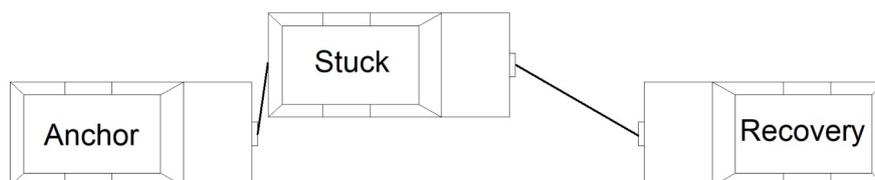
When using a tree as an anchor point, a non-stretch, wide strap (Tree Protector) should be used to prevent damage to the tree. Placing the winch line around the tree may ring-bark the tree leading to the death of the tree.

### ***Using Another Vehicle as an Anchor.***

Winching can be done from the stuck vehicle or the recovery vehicle depending on which vehicle has a winch fitted. Sometimes when winching from the recovery vehicle or when using the recovery vehicle as an anchor there is insufficient traction or holding force to prevent the recovery vehicle from moving towards the stuck vehicle. Consider digging holes for the wheels of the recovery vehicle or chocking the wheels with a log or rocks. Connecting one or more vehicles in tandem behind the recovery vehicle will increase the holding force, which may be sufficient to prevent the recovery vehicle from moving. Digging holes and chocking the wheels of the anchor vehicle will also help.

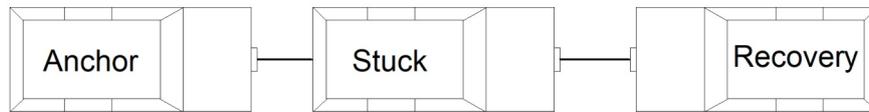


When you need to move a stuck vehicle sideways but only have access to the ends of the stuck vehicle due to the nature of the track, then anchoring one end of the vehicle while pulling on the other end will have the same effect as dragging the stuck vehicle sideways. This technique is very useful when a vehicle in the middle of a convoy drops a wheel off the side of a very narrow track on a mountainside.

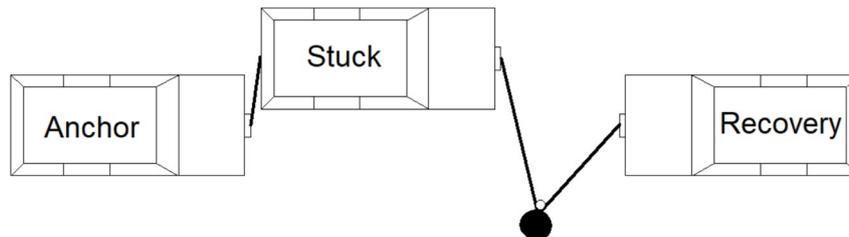


The winch will pull the front of the vehicle diagonally towards the recovery vehicle. The short rigid connection between the anchor vehicle and the stuck vehicle will cause the rear of the stuck vehicle

to move sideways in an arch as the vehicle is pulled forward, ending with the stuck vehicle centred between the recovery vehicle and the anchor.



Adding a pulley / snatch block in the winch line can increase the amount of sideways pull on the front of the stuck vehicle provided you have a secure anchor point to the side of the track.



You may need to add additional anchors at each end if the track is slippery. It is not recommended to dig holes in the track surface to stop vehicles moving as this will result in erosion of the track.

Simply pulling on one end of the stuck vehicle will not pull it back on the track. The other end will tend to swing in an arc due to gravity resulting in the stuck vehicle falling further off the track and even rolling over. This recovery technique is rather difficult to explain. A demonstration is the best way to appreciate the method and outcome.

### Kinetic Recovery (Snatching)

Kinetic straps and ropes are designed to stretch up to 20% of their length (i.e. a 6m strap will increase in length by as much as 1.5m) The strap behaves like a giant elastic band / energy accumulator. The recovery vehicle applies energy into the strap using momentum (mass X speed X speed). The strap will continue to stretch until the stored energy exceeds the holding force of the stuck vehicle (provided the recovery vehicle is still moving forward adding energy to the system) and then the strap will recoil pulling the stuck vehicle free. If the stored energy does not exceed the holding force when the recovery vehicle stops moving forward, then the stuck vehicle will act as an anchor and the strap recoil will pull the recovery vehicle backwards.

Ensure that there are no persons other than the driver in any vehicle directly involved with the recovery. Drivers should be secured with seatbelts on and have heads back against their headrests. The forces generated during a snatch recovery can be in the same magnitude as the weight of the vehicle, i.e. tonnes!

Clear any piled up debris from around the stuck vehicles wheels. A recovery vehicle is then hooked up to the stuck vehicle and takes up any slack in the strap between the vehicles. When the person controlling the recovery has checked that both drivers are ready and gives the go-ahead, the recovery driver moves off and attempts a simple tow (crawl). If this does not succeed then try again but this time with about two metres of slack in the strop. The tow vehicle moves forward at walking speed. If this fails try again but now with three metres of slack in the strop and a little more speed (jog). If there is still no success do some more digging around the stuck vehicle and try using a winch recovery. Only consider using multiple recovery vehicles in tandem if winching is not an option.

**REMEMBER: CRAWL then WALK then JOG!**

***Recovery Using Multiple Vehicles in Tandem.***

If one vehicle is unable to get enough traction to pull or snatch the stuck vehicle free then a tandem recovery can be tried. A normal tow strap is attached between the tandem recovery vehicles and a kinetic strap laid out as normal between the last recovery vehicle and the stuck vehicle. The big advantage of using tandem vehicles is the traction that can be achieved by having four extra wheels on the ground. ENSURE that the middle vehicle is in a straight line with the other vehicles, otherwise the middle vehicle can be rolled onto its side.

**Recovery Training**

Recovery techniques cannot be learned by just reading about them. It is important to seek practical hands-on training from experienced people. There is a lot to learn and master. Physics is not forgiving.

CCVC offers recovery training opportunities from time to time. Keep an eye on the Club Calendar and sign up for training trips whenever they are offered.

## RECOMMENDED EQUIPMENT LIST

Equipment that you should consider having in your 4WD vehicle:

- **Drinking Water**, refreshments and spare clothing
- **First Aid Kit\*** and essential personal medication
- **Fire Extinguisher\***, 1 Kg (minimum) dry powder
- **Tool Kit\***, general tools plus specialist tools that your vehicle may require for roadside repairs.
- **Spare wheel, jack and tools\*** to change a tyre
- **Shovel or Spade\***, preferably with a steel handle.
- **Cargo Net / Tie Downs\*** to hold down all your safety equipment and spares
- **Kinetic Recovery Strop / Rope\***
- **Radio**, club radio (VHF) preferred, otherwise UHF PRS radio
- **Tyre Pressure Gauge**, to check pressure after deflation or re-inflation.
- **Gloves**, for handling wire winch ropes, rocks and logs.
- **Plastic Rubbish Bag**, to hold wet, muddy recovery strops and gumboots or put on floor of vehicle to save carpet when your boots are muddy.
- **Torch**, with good batteries and working!
- **Maps** of the area being visited
- **Tyre Deflation Tool**, very useful for quickly reducing tyre pressures precisely
- **Air Compressor**, of a reasonable size to re-inflate tyres after being off road. Some people adapt a dive tank for an air source.
- **Recovery Strops**, at least one short (for use as a bridal or tree protector) and one long.
- **Strop Joining Sticks**, at least two.
- **Rated Shackles**, at least two rated at  $4\frac{3}{4}$  ton
- **Snatch Block (Pulley)** if vehicle fitted with winch
- **Rope**, to fit snatch block
- **Trouble Lamp**, with a lead long enough to reach the rear wheels.
- **Bow or Pruning Saw**, a hand saw with coarse sharp teeth suitable for cutting small logs.
- **Chainsaw (& safety equipment)** if you travel on forest tracks a chainsaw can be handy.
- **Water depth gauge**; a stick to measure the depth of water holes.
- **Spark Arrester**, a gauze spark arrester on exhaust to prevent a bush fire (mandatory in some forests).
- **Vehicle Spares**, as required e.g. spark plug & lead, radiator hoses, hydraulic oil, fan belt, fuses etc.
- **PLB**, Personal Locator Beacon, highly recommended if travelling into remote areas.

**Note:** Equipment marked with \* are required on Shiny 4X4 trips and above. This equipment must also be present when vehicle is presented for inspection.

## FURTHER READING & INTERNET VIEWING

### Books and Publications

- 4WD North Island, 102 Off Road Adventures by Andy Cockcroft (ISBN 1877251178 )
- 4WD South Island, 107 Off Road Adventures by Ken Sibley & Mark Wilson
- [Four-Wheel Drive: The Complete Guide by Andrew St Pierre White](#)
- [Snatch Straps 4WD Industry Guidelines - March 2008](#)

### Websites

- **Some good information here:** <https://www.4-wheeling-in-western-australia.com/>
- **Explanation of tyre terms:** <https://www.tyresizecalculator.com/tyres/tyre-terminology>
- **Tyres:** <https://l2sfbc.com/is-a-narrow-or-wide-tyre-best-for-a-4x4/>
- **Hi-Lift Jack Instructions:** <https://hi-lift.com/resources/instruction-manuals/>
- **Snatch Straps:** <https://www.four-wheel-driving-australia.com/4x4/snatch-strap/>
- **Winching instructions:** <https://international.warn.com/product-literature>
- **Tread Lightly:** <https://treadlightly.org/learn/recreation-tips/4x4/>
- **4WD Routes:** <https://www.4x4explorer.co.nz/>

### Youtube Playlists

- [L2SFBC - Robert Pepper: Tyres](#)
- [L2SFBC - Robert Pepper: 4X4 Recovery](#)
- [MadMatt 4WD: 4X4 Recovery](#)
- [MadMatt 4WD: Winching](#)
- [Ronny Dahl 4WD WA: 4x4 off-road beginners tips](#)
- [Southern Four Wheel Drive Association: Educational Videos](#)