NZRF
LINE REMOVAL
GUIDE

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This document is issued by the New Zealand Roadmarkers Federation Inc. with formal endorsement
by the New Zealand Transport Agency

This document has been developed by the New Zealand Roadmarkers Federation Inc (NZRF).
The writer may be contacted with regard to document content by contacting
NZ Roadmarkers Federation Inc
PO Box 13-605
Onehunga
Auckland 1643
Phone 09 625 7470
Email alister@nzrf.co.nz

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1 Introduction and Need for the Guide

The revision of pavement marking layouts routinely requires the removal of existing markings with or without the re-application of markings at the revised location and pattern. Materials and/or line types may have an adverse affect on resealing operations, and the markings may need to be removed to enable effective seal application.

Although there are a number of methods that may be used to remove markings, the methods available for a particular application may be limited by the marking material and the pavement surface. In addition, the cost-effectiveness of particular treatments is dependent on the quantity of markings to be removed. This guide is aimed at providing a general description of the more common line removal methods, with a simplified method for the selection of an appropriate removal system for different marking types on particular pavement substrates. References to appropriate legislation are also provided.

Although the removal methods described in this guide are legitimate and practical, it is recognised that not all methods may be available in all locations. To assist RCA's we have highlighted the methods in most common use.

Following research undertaken with the University of Auckland School of Engineering in 2014 and 2015, removal standards that match the preview distances set out in Section 6.1 have been determined.

2 Scope

This document provides guidance to principals, contract specifiers, contractors and subcontractors on the methods used to remove pavement markings from paved surfaces.

The document is aimed at providing a useful minimum standard interpretation of current Road Controlling Authority requirements for line removal.

3 Application of the Guide

This document is limited to the process of line removal and does not specify the requirements for associated processes such as temporary traffic management.

It is intended that this document be used in conjunction with NZRF Safety, Health and Environment Guide and company procedures.

This document is limited to the removal of pavement markings applied for delineation. Methods used to modify or alter pavement surfaces themselves are not covered.

4 Definitions and References

4.1 References

NZRF Safety, Health and Environment Guide
NZRF Roadmarking Materials Guide
NZTA T 3 Standard Test Procedure for Measurement of Texture by the Sand Circle Method

4.2 Definitions

"Blacking Out"	The practice of covering up unwanted markings with a topcoat of material similar in colour to the road surface.
"Ghost lines/markings"	Markings that result from the line removal process. The degree of ghosting may vary from faint to sharp definitions, i.e. pavement damage.
"Line Removal"	The activity of permanently removing or obscuring (hiding) pavement markings
"Notification"	The advising of the local office of WorkSafe New Zealand of an activity deemed to be particularly hazardous.
"Residual markings"	the parts of the original markings that remain following the removal process.
"Strip sealing"	The application of a bituminous compound (usually about a metre wide) over unwanted markings followed by the spreading of fine aggregate over the bituminous coating.
"Reseals"	The activity of applying a coat of chipseal over an existing pavement surface. This activity requires the re-installation of existing pavement markings, the location of which can be established by the use of Reseal Tags and / or photographs / Reseal Plans.

5 Line Removal Principles

1. Redundant pavement markings must be obliterated so as to not function as a recognisable marking.
2. Where original markings are reflectorised, obliteration must include the removal of reflective elements.

5.1 Supporting Principles

1. Where line markings are removed permanently, that this is done in such a way that the chance of the motorist being confused as to position on the carriageway, particularly in wet weather and poor lighting conditions is minimised. Widening and softening the edges of existing markings may do this.
2. When arrows, letters or figures (for example speed limit symbols) are to be removed permanently (or temporarily "blacked out") that this be done in a rectangle or square pattern in such a way to minimise the motorist being confused, particularly in wet weather and poor lighting conditions is minimised.
3. Where permanent overlays or void concealment is used, the overlaid material is to be blended and / or shaped to minimise the difference in height and appearance
4. Unwanted markings are to be removed permanently, not "blacked out".
5. The line removal method(s) must not adversely affect or compromise the integrity of the pavement surface.
6. Prior to the commencement of work, the clients representative must approve the proposed method and determine acceptability standards
7. All line removal works must be carried out in accordance with the ordinances, statutes and laws relevant to the various jurisdictions.
8. All line removal works must be carried out in such a manner as to not endanger the health, safety or amenity of employees or the public in general.

6 Line Removal Standards

Effective line removal is a compromise between leaving "residual markings" creating "ghost markings" and causing damage to the pavement.

The risk of and the degree of damage to the pavement increases exponentially as the degree of removal increases, as does the risk of creating "ghost markings". When selecting the removal method consideration also need to be given to the number and age of the surfacing layers. There is an

increased risk of compromising the surfacings ability to waterproof the pavement when one or two layers are present, particularly when these layers are old.

Removal to recommended standards such that damage to the pavement is minimised requires trained operators working with care and attention to detail.

6.1 Residual Marking Acceptability Standards

The standard has been set by viewing the removed marking from the perspective of a road-user. Road-user preview times and extent of marking need to be taken into consideration when setting the standard of work. For example, the standard set for the degree of removal on an edge-line of a road having a chipseal surface and travel speeds of or in excess of 70kph, can be considerably lower than that for lane lines on a dense graded asphalt in an urban environment.

It is critical that this assessment takes into consideration all road conditions in that particular environment. Consideration must be given to but not limited to, day-light, wet-night, low incident light, change of lay-out, posted speed limits, consequences of possible driver confusion.

Line Type			
Edgeline			
Centre Line and Lane			
Centre Line and Lane Lines – Divided			
Edgeline			
Centre Line and Lane			
Centre Line and Lane Lines – Divided			
Intersection Markings			
Intersection Markings			

Based on the research undertaken in conjunction with the University of Auckland School of Engineering we have determined the following removal standards as matching the preview distances.

Viewing Point 50m 75% removed
Viewing Point 30 or 20m 85% removed

Pictorial standards are included at the last page of the Guide

Important Note:
On delicate surfaces - open graded asphalts, slurry seals, first coat and new chip-seals the surface may be destroyed before removal to a standard that can be achieved on sound surfaces, is met.

6.2 Evaluation on Completion

It is important that the completed line removal work is examined for the existence of “ghost markings” and / or damage to the pavement.

It is critical that this assessment takes into consideration all likely road conditions in that particular environment. Consideration must be given to but not limited to, day-light, wet-night, low incident light, change of lay-out, posted speed limits, consequences of possible driver confusion.

Important Note:
Driver confusion is likely in circumstances where the performance of replacement markings are at or fall to a level close to those that have removed, e.g. drivers will inadvertently follow a ghost line on a wet night if the new marking has a lower wet-night visibility.

7 Selection of Removal Method

There is no one single method of line removal that will work well on all of the various marking materials used on the many different pavement surfaces commonly encountered.

However, given an understanding of the marking materials used and the characteristics of the particular pavement types, it is possible to determine the method most likely to achieve a satisfactory end result. In particular circumstances, an effective result may be dependent on the utilisation of a combination of line removal methods.

A method selection matrix is provided below. The information supporting the decision rationale is provided in following sections.

It is strongly recommended that the supporting information is read and understood before selections using the matrix are made.

7.1 Selection Matrix

The following matrix is aimed at describing methods that may be appropriate for a range of marking types on a range of pavement surfaces. The key for the methods is as follows:

1. High Pressure Water Cutting / Milling
2. Grinding or Scabbling
3. Abrasive Blasting
4. Water Blasting – Sodium Bicarbonate System
5. Chemical Paint Removers
6. Heat Lance
7. Permanent overlay
8. Mechanical Destruction
9. Void Concealment ***following*** 1, 2, 3, or 4 above.

	Type of Pavement Surface				
Type Of Marking Material To Be Removed			Dense Graded Asphaltic Concrete		
Solvent-borne Paint			(1, 2, 3, 4)+9 (2+7)		
Water-borne Paint			(1, 2, 3, 4)+9 (2+7)		
Thermoplastic			1, 2, 3 (2+7) (8+1or3) (6+8 ATP)		
Preformed Thermoplastic			1, 2, 3 (2+7) (8+1or3)		
Cold-applied Plastic			1, 7		

Temporary Tape			6		
Permanent Tape			1, 2		

8 Pavement Marking Material Types

A wide range of materials are used by the roadmarking industry. Information on the use and characteristics of each of these materials is provided in the NZRF Roadmarking Materials Guide, available as a printed document or in electronic format on the NZRF Website - www.nzrf.co.nz

9 Pavement Characteristics

Pavement surfaces on roads are designed to provide a dust free, waterproof, skid resistant surface on which the motorist may travel safely. The characteristics that may be compromised by line removal are related to change in surface texture / chip loss and membrane integrity.

9.1 Pavement Texture

Effective obliteration of redundant markings is dependent on ensuring that the surface is restored as much as possible to that of the surrounding pavement areas.

The primary cause of the increase in texture depth resulting from many line removal processes on bituminous pavements is bitumen removal, where bitumen near the surface is removed, which can lead to stripping and a loss of water proofing.

In addition, the failure to adequately remove detritus from the pavement will severely degrade the draining ability of that pavement. In particular, blasting media and fines will clog open graded porous asphalts (OGPA)

A mismatch in macrotexture significantly increases the chances of “ghost markings” particularly during wet weather. Therefore, it is critical that the macrotexture, (i.e. the gaps between the stones) match that existing in the surrounding pavement as closely as possible.

Estimates of texture depth may be determined by laser based texture depth equipment or by the sand circle method, refer NZTA T 3.

9.2 Membrane Integrity

A key component in a chipseal pavement is the integrity of the waterproof membrane that is formed between the wearing course and the underlying basecourses. This membrane is particularly sensitive to damage from certain line removal processes and / or “over enthusiastic” line removal. The most common problem caused by a failure of membrane is the development of potholes either immediately, or over time as water gets into the pavement.

10 Pavement Types

A wide range of materials and structures are used on pavements in New Zealand. A critical component in the selection of the appropriate line removal method is an understanding of the pavement surface, its performance characteristics and how these characteristics may be adversely affected by the line removal operation.

Further information about pavement types is available on the NZTA website in specifications, manuals and Guides

A selection of the more common pavement types are as follows.

10.1 Chipseal

Chipseal roads make up a large portion of New Zealand roads. Chipseal (or spray seal) is produced by spraying hot (160°C) or emulsified bitumen binders onto the prepared surface before applying selected aggregates which are rolled into the bitumen.

Chipseals may be produced using a range of aggregate sizes, which produces a relatively coarse texture. The resultant texture is dependent on the aggregate size(s), construction process, seal design and age. The texture depth range can vary between 1mm and 3mm when determined in accordance with NZTA T3.

The comparatively large macrotexture of chip seals, results in a tendency to "consume" significant quantities of marking material. The requirement of restoring the macrotexture without localised damage requires careful selection and management of the line removal process.

The issues relating to line removal on chipseals are stripping of aggregate, removal of aggregate, destruction of membrane integrity and the generation of ghost lines.

10.2 Open Graded Porous Asphalt

Asphalt is a mixture of coarse aggregate, fine aggregate, filler material and bitumen. The mixture is combined prior to delivery to the paving machine.

OGPA contains a lower proportion of fines such that the surface is free draining or "open". These pavements have a large percentage of air voids and rely mainly on particle interlock for stability. The draining of water from the surface is dependent on the interconnected voids within the structure.

The texture depth range is typically around 1mm when determined in accordance with NZTA T 3. The issue of line removal on open graded asphalt is primarily one of the clogging of the drainage courses, and as the aggregate has less bitumen holding it in position than in dense graded mixes, the surface can strip with overzealous water blasting.

Note; OGPA is the most sensitive pavement surface type and particular care needs to be taken to avoid damaging it by closing or blocking the air voids which drain the water from the pavement.

10.3 Dense Grade Asphalt

Dense or fine graded asphalts, although having a similar maximum aggregate size have a high proportion of fines, which produces a much lower texture depth to the open grades. The texture depth range is typically around 0.5 mm when determined in accordance with NZTA T 3.

The issue of line removal on dense graded asphalt is the removal of fine material components of the structure and / or the cutting of a trench in the top surface. Water consequently collecting in such trenches may create ghost markings at times of rain.

10.4 Slurry Seals

This is a material consisting of bituminous emulsion binders and aggregates screeded onto existing road surfaces. This overlay can be very thin, i.e. less than 10 mm, and has a comparatively fine surface texture similar to dense graded asphalt.

Slurry seals are relatively brittle when compared to the surfacing types described above.
The issue of line removal on slurry seals is the destruction of the bond between the slurry and the substrate and / or within the slurry itself.

10.5 Concrete

Although Portland cement pavements are common on roads in Australia and the United States, concrete pavements are not commonly encountered on carriageways in New Zealand.

Textures of the cement pavement surfaces encountered may vary significantly, but in general have a fine graded finish.

The issue of line removal on concrete is the loss of its finished surface or fines with water cutting, abrasive blasting or scabbler / grinder and spalling / scaling with heat lance.

Removal of markings on patterned concrete with coloured pigments and sealing compounds may result in the exposure of aggregate and a contrasting background colour, possibly requiring rectification.

10.6 Block Paving

Block paving is a commonly used decorative flexible pavement in shared or specialised roading pedestrian areas.

The blocks may be made from either fired clays, moulded concrete or stone The sand used to fill between the segments is an integral part of the pavement. The paving units may give varying reactions to line removal depending on the style of manufacture.

Concrete and dry pressed clay units can be porous, with wet extruded pavers more dense and glassy.
The issue of line removal on pavers is the maintenance of surface texture / appearance of the surface.

Line removal on these pavements can cause:
- Abrasion and pitting of surface
- Spalling of edges and cracking
- Loss of sand between segments allowing excessive movement
- Change of appearance of surface
- Change of colour of paver.

10.7 Specialist Coatings (Coloured & Antiskid)

These surfaces are specialist cold applied plastics, epoxies, polyurethanes or hot applied materials containing aggregates which sometimes have a high polished stone value, such as calcined bauxite. They are used to provide a high skid resistance and / or coloured surface to delineate stopping areas, bus lanes, etc.

It is unlikely that any line removal process would be successful on such surfaces without seriously compromising the surface characteristics.

11 Line Removal Types

11.1 Wet paint markings

Although this guide is aimed primarily at providing information on removal of markings that are set or dry, an explanation is provided of the methods and issues relating to immediate remedial actions or clean ups of inadvertent transfers or damage of painted markings.

Crushed glass, sand or similar powdered material may be used to absorb incorrectly marked pavements, provided it is applied immediately, and at such a quantity that it blots up all free solvents. This material is then swept up and disposed of in a controlled manner. Any remaining markings should be indiscernible to the motorist after light trafficking.

An alternative approach for small quantities is to wait for the paint to firm up before scraping off using a paint scraper. The remaining paint can be scrubbed off using solvent soaked rags and / or wire brush.

The removal of waterborne painted markings that are not totally dry constitute a significant environmental risk and must be dealt with caution. The resultant water and washings are ecotoxic and must be stopped from entering drainage systems, collected and disposed of in the correct manner.

11.2 Markings that are set or dry

In addition to the temporary "blacking out" of markings, there are nine methods of "permanent" line removal:

1. High Pressure Water Cutting
2. Grinding or Scabbling
3. Abrasive Blasting
4. Water Blasting – Sodium Bicarbonate System
5. Chemical Paint Removers
6. Heat Lance
7. Permanent overlays
8. Mechanical Destruction
9. Void Concealment ***following*** 1, 2, 3 or 4 above.

11.3 Audio Tactile Profile (ATP) Markings

11.3.1 Removal of Obsolete Markings.

Removal of ATP generally requires the removal of the profile ribs first, followed by removal of the baseline or paint line (if present). Depending on the type of pavement surface the ATP is to be removed from, consideration should be given to grinding / impacting the profile ribs, followed by a second process determined from the removal matrix, to minimise the risk of damage to the road surface.

Thermoplastic
With thermoplastics, care should be taken not to generate too much heat during the removal process, as this may cause the material to soften to a point that inhibits its clean removal.

Cold Applied Plastic
Cold Applied Plastic profiles will have achieved a very strong bond with the road surface, therefore care should be taken to ensure the removal method will not result in damage to the road surface. E.g.

impacting the profiles may result in the material being removed with a corresponding section of pavement attached.

11.3.2 Removal Prior to Reseal

Removal of ATP markings should be considered prior to resealing of the road surface for a variety of reasons.

Resealing over the top of existing ATP markings may:
1. Inhibit drainage of the road surface
2. Result in a breakdown of some seal types (debonding) due to the extra stresses imposed on them by the nature of the profiles
3. Impact on the reinstatement of markings following the reseal.

Complete removal may not be required but must be sufficient to mitigate the potential problems mentioned above. Removal of any baseline is dependent on the degree of wear

Consideration should be given to; the degree of wear of the current markings, seal type, both existing and proposed and the layout and material to be used for the reinstatement of markings.

It may be practical to remove thermoplastic ATP by mechanical destruction, e.g. operating a roller or tracked machine to shatter the material and sweeping up the residue. Cold applied plastic however is unlikely to be removed by this method or it may result in damage to the substrate, therefore it would generally require grinding to achieve the desired outcome.

Note: Vic Roads Project Report 952 (undated) concluded that:
- 7mm reseals (Grade 5 NZTA M 6) over newly applied Vic Roads Specified ATP provided a reasonable audio and vibrational response
- 10mm reseals (Grade 2-3 NZTA M 6) will provide a medium response and thus this treatment is considered marginal and reinstatement of the ATP is recommended.

While resealing over recently applied / compliant ATP may offer an opportunity to reinstate markings at a reduced cost, it is not recommended.

The following matters should be considered:
1. The difficulty of marking paint or other marking materials to acceptable tolerances over the now obscured ATP line.
2. The lack of a robust measurement method for ATP which has been resealed over.
3. The possibility of a confusion of profiles if the sealed ATP proved ineffective. It is likely to be very difficult to match exactly the marking spacing.
4. The need to 'move' a profiled edgeline at some time in the future either to increase a lane width or install a different marking format. The separated centreline format, or installation of a median barrier could mean the ATP was in the wheel path on the left hand side. The cost to remove ATP prior to reseal is likely to be substantially less that the cost of removing a layer of seal and the ATP once it had been sealed over.
5. NZTA research report *Maintaining the effectiveness of ATP roadmarkings for their full lifecycle* will be published shortly. This Guide will be updated to incorporate the finding when they are published.

11.4 Raised Pavement Markers

As delineation is generally provided by a combination of raised pavement markers (RPM's) and pavement markings, removal of the markings may require the removal of affected RPM's.

The NZRF has published an RPM removal guide to assist contractors and other interested parties. It is available on the NZRF website.

Some damage is likely to occur where the adhesive is torn from the pavement. This damage needs to be repaired to ensure that the pavement strength and integrity is not compromised. The material used needs to match the pavement for strength, moisture barrier and appearance.

12 Temporary Line Removal

"Blacking Out" must be considered only as a temporary method of covering up unwanted markings.

"Blacking Out" should only be used in situations where line removal equipment is not immediately available or in work zones where permanent markings are to be installed after the completion of road works.

12.1 Advantages of "Blacking Out"

Expedites traffic delineation changes by allowing traffic to temporarily use the revised layout until permanent removal work can be scheduled at a later time.

Allows temporary traffic changes resulting from requirements of pavement repairs, etc.

Once other methods of permanent removal have been employed, to a point where the removal method causes minimal etching/damage of the substrate, it may be practical to apply black out paint to obliterate any residual markings in the voids; this would eliminate the need to continue with more destructive removal.

12.2 Disadvantages of "Blacking Out"

The blacked out area can appear to have a different colour and gloss from that of the pavement surface. This phenomenon is more apparent under certain lighting and weather conditions.

Where the lines incorporate the use of glass beads, masking of the line through blacking out is ineffective as the retroreflective effect of the glass is from the white/yellow paint that creates the 'mirror' around the back of the embedded glass. A black line can appear white or yellow at night and may give a brighter line than the replacement line.

The blacked out area can change in both colour and gloss as traffic erodes the coating. This has been known to cause problems, especially when sunlight reflects upon the "blacked out" markings at sunrise and sunset.

The blacked out area will eventually wear away to reveal the original unwanted markings.
Worn blacked out surfaces may exhibit a different skid resistance to the rest of the pavement surface; this may lead to skidding problems especially in wet weather,

12.3 Blacking Out Materials

12.3.1 Paint

Black road marking paints, both solvent-borne and water-borne, can be applied by brush, roller or spray, and offer a simple method of covering up unwanted markings. These paints are often tinted with white road marking paint in order to approximate the colour of the pavement surface. The use of water-borne paint is generally considered to be more effective than solvent-borne paint due to superior wear characteristics. Crushed aggregate up to 1.0 mm should be surface applied to attain a lower gloss level, improve skid resistance, more closely match the pavement colour and texture and for greater durability.

12.3.2 Black Tape

Removable black line masking tapes are designed to provide a short-term obliteration of pavement markings. These offer a fast way of creating temporary lane changes during road maintenance and on construction sites. The traffic flow can be restored to normal when required by removing the black masking tape to reveal the original markings. The ease of removal is dependent on degree of trafficking.

13 High Pressure Water Cutting / Milling

This is the usual removal method used in NZ. There is reasonable access to plant and removal can be carried out on a cost effective basis.

High pressure water cutting or milling uses water pressurised at up to 280,000 kpa (40,000psi) in conjunction with rotating blasting heads. These devices can deliver pressure at the rotating head of up to 138,000 kpa. The sheer force of the water delivered literally “knocks” the markings off the pavement.

Typical flow rates used are 4 – 24 litres per minute. Removal rates can be in the order of 1km/hr.
The more sophisticated systems have the heads mounted on a trolley. The nozzle orientation, height from the surface and the travel speed of the cleaning heads over the pavement can be well controlled. This system also involves the vacuum removal of the water and removed materials. The recovered water and material are then recycled through a filtering process which removes the paint and other material before reusing the water.

Alternatively the head orientation, height and travel may be controlled manually by the operator. Such systems may or may not include vacuum removal of the water and removed materials.

13.1 Advantages of High Pressure Water Cutting / Milling

When operated by skilled operators, the trolley mounted process is capable of consistently removing most types of road marking products without significantly damaging the road surface.

13.2 Disadvantages of High Pressure Water Cutting / Milling

With the manually directed head units, the results are highly dependent on the pavement surface conditions, the controllability of the machine, the skill of the operator and the cleanup methods used. This method may damage surfacing with loosening or removal of larger aggregate.

Failure to remove fines as an integral part of the line removal process may lead to the clogging of open graded asphalt surfaces.

14 Grinding or Scabbling

Grinding is achieved by the use of motorised, high-speed rotation of hardened steel or tungsten carbide cutters. The orientation and pressure on the cutter head and the depth of grinding is continuously adjusted during operation to achieve optimum results. The device is commonly mounted on a specialist multi-purpose rubber tyred machine e.g. a Bobcat.

A push-along grinder is a comparatively inexpensive item of equipment that can effectively be operated by a single operator.

This method of line removal results in detritus that includes marking material and particles of surfacing material, which must be cleared from the site using vacuum brooms.

More elaborate versions of self-propelled and ride-on grinders complete with dust collection systems are better suited where long distances or where large areas of markings are to be removed. Some of the smaller grinding units may also have the option to include a dust collection system, thus providing a dust free working environment.

14.1 Advantages of Grinding or Scabbling

Grinding is one of the most cost-effective methods of removing high build pavement markings off fine textured pavements.

14.2 Disadvantages of Grinding or Scabbling

The effectiveness of grinding is dependent on the pavment surface being flat in both a horizontal and longitudinal aspect, and that should be evaluated when grinding is being considered.

Grinding or scabbling cannot be carried out on most chipseal surfaces or open graded asphalts without compromising seal characteristics, destroying the seal and / or producing significant “ghosting”.

“Ghost lines” often result as a consequence of a rough surface profile or channel having been created by the grinding process. However, when used in conjunction with the subsequent application of bituminous compounds, e.g. strip sealing, this effect can be minimised.

The results are highly dependent on the pavement surface conditions, the controllability of the machine, the skill of the operator and the cleanup methods used.

15 Abrasive Blasting

Blasting is one of the most widely used techniques in surface preparation. The blasting media is accelerated and propelled at great speed and tremendous force using compressed air.

Experienced operators can select the appropriate blasting media and regulate the blasting pressure to remove redundant markings without significant damage to the pavement surface.
Markings are removed by being either shattered, broken loose and / or removed by abrasion by the particular blasting media striking the surface.

Occasionally, for expediency and in order to speed up the effectiveness of the blasting process, the top surface of the unwanted thermoplastic markings can also be broken up by
physical means (e.g. by brick bolster, chisel etc) before being abrasive blasted.

While lines are typically removed in an open environment, it is possible to build mobile blast booths that control noise and dust.

15.1 Advantages of Abrasive Blasting

Can be carried out by roadmarking operatives during periods of inclement weather.
With care, many pavement surfaces can be restored to near original condition.

15.2 Disadvantages of Abrasive Blasting

Abrasive blasting is not effective in removing elastomeric marking materials such as cold applied plastics.

Abrasives are likely to clog open graded porous asphalt pavements.

Blasting is by nature a noisy operation, and may prove to be an unacceptable option at certain locations or times of the day, especially in built up areas.

The blasting media may generate considerable quantities of dust and particular media requires the injection of water to limit the dust hazard.

Abrasive Blasting is “Notifiable” under the Health and Safety at Work Regulations 2016. In addition proof is required that all sand used has a silica content below 5%.

All spent abrasives must be removed from the pavement surface, as these adversely affect drainage and other surface characteristics.

Abrasive blasting using steel shot as a media causes significant damage to open graded asphalt surfaces.

15.3 Abrasive Blasting Using Sand as the Media

Sand shatters as it strikes the markings, therefore generating dust in the process. This presents health hazards (the lung disease Silicosis and an acknowledged carcinogen) to operators, and pavement users. Water must be introduced to minimise dust, but care is still required during operation.

15.4 Abrasive Blasting Using Garnet or Copper Slag as the Media

Garnet and copper slag are much harder than sand and as such, more effective in removing both painted and thermoplastic pavement markings. The choice of the media is often made on the basis of availability/cost.

Spent media is swept or vacuumed up. Small quantities of garnet or slag left on site present considerably less risk to road-users and / or the pavement surface.

The use of this media does not generate much dust especially if moistened copper slag is used. Blasting with garnet or copper slag is cost effective; skilled operators are capable of removing several hundred square metres of pavement markings per day.

15.5 Abrasive Blasting Using Steel Shot as the Media

The steel shot blaster method is a dust free enclosed operation. A dust collector vacuum is operated in conjunction with the blaster.

When accelerated steel shot strikes the surface, pavement marking materials are broken loose. Shot and dust rebound up the chamber where they pass through an air stream which draws out the impurities into the dust collector vacuum. The shot is then recycled and continues to be reused. The debris collected in the dust collector is emptied as needed.

Even though an experienced operator may be capable of removing several hundred square metres of markings per day, this is an expensive system, requiring daily maintenance and the use of blast wheels having a relatively short life cycle.

16 Water Blasting -Synthetic Media System

In this removal method corn/wheat starch, sodium bicarbonate, or dry ice is mixed in a special blasting head with a high-pressure water jet. These "soft" abrasives avoid damaging the underlying material.

Sodablasting uses baking soda (sodium bicarbonate) which is extremely friable. The micro fragmentation on impact explodes surface materials without damage to the substrate.

16.1 Advantages of Water Blasting – Sodablasting System

Sodium Bicarbonate is claimed to be a relatively benign chemical, and easily disposed of, as it dissolves readily in water.

16.2 Disadvantages of Water Blasting – Sodablasting System

While it is claimed this method can remove all types of marking materials in an environmentally friendly manner with minimum damage to the pavement surface, trials indicate that this method has little success in removing waterborne, thermoplastic markings and cold-applied plastics.

As with all blasting systems the effectiveness of the method may well depend upon the skill of the operator.

17 Chemical Paint Removers

Several types of chemical paint removers are commercially available:

(a) those based on methylene chloride or similar solvents.
(b) those based on alkalis.
(c) those that contain no caustic or chlorinated hydrocarbon solvents. Only type (a) and (c) materials should be used for removal of pavement markings.

Methylene chloride is a strong solvent that softens and swells the markings allowing them to be removed using water jetting and/or stiff bristle brooming.

In order to keep the solvent (which is very volatile) in contact with the marking for as long as possible, the remover is usually thickened and paraffin wax included to retard evaporation. The paint remover which is usually of a 'gel' like consistency, should be liberally applied to the marking by brush or broom, left for the period recommended in the manufacturers specifications, and then removed by brooming or water jetting.

When using chemical paint removers, the manufacturer’s material safety data sheet must be carefully read and all precautions observed.

Companies specialising in the removal of pavement markings by chemical means generally use several chemical formulations, and by varying the ratio of chemicals are able to effectively remove pavement

markings. Due diligence is required to handle and dispose of used chemicals and removed markings in a safe and environmentally acceptable manner.

17.1 Advantages of Chemical Paint Removers

Method is relatively simple, inexpensive and appropriate for small areas.

17.2 Disadvantages of Chemical Paint Removers

The use of chemical paint removers can be time consuming and labour intensive. It is generally cost effective only when a small area of pavement marking is to be removed.

The materials used are hazardous and adequate precautions must be implemented to ensure that all materials are collected and prevented from polluting waterways. Skin as well as eye contact and the breathing of vapours must be avoided. Measures must be introduced that ensure the prevention of inadvertent contact by members of the public.

Multiple applications of remover may be necessary in order to remove heavy film builds of pavement marking material.

Paint removers will also soften bitumen and asphalt. Application to the markings must therefore be carefully controlled in order to minimise contact with bituminous surfaces.

Chemical paint removers are neutralised by water, therefore removal can only be accomplished in dry conditions.

18 Heat Lance

Heat lances use a mixture of propane gas and compressed air to produce a concentrated, powerful, high velocity flame. The air pressure and flame is regulated to achieve the desired heat.

Originally designed for burning off unwanted thermoplastic and painted markings, this method is also effective in the removal of temporary marking tape. Heat from the flame softens the adhesive of the marking tape, which can then be peeled off with relative ease.
A heat lance can also be used to soften the raised ribs of profile thermoplastic markings, which can then be easily scraped off leaving just the base line.

18.1 Advantages of Heat Lance

A heat lance may also effectively be used as a drying burner; an effective method of negating a wet or damp surface when road marking. The hot compressed air from a heat lance can be directed to remove loose or flaked thermoplastic and paint, dirt and sand when remarking.

18.2 Disadvantages of Heat Lance

The lance generates a considerable amount of noise and fumes when working. The method may require specific precautions due to the noise emitted when operating.

Due to the noise and the likelihood of fumes / smoke, Regional / District Council Consent may be necessary.

Particular marking materials, e.g. Cold-applied resins and coloured thermoplastic when heated/burnt change state and may alter the colour and or texture/structure of bituminous substrates.

The equipment is relatively expensive to purchase and operate. Operation of the plant needs to be carried out by operators having appropriate training and / or under adequate supervision.

As the fumes given off by the superheated materials and road surface contaminants may be toxic, appropriate protective equipment may be necessary.

Fumes from superheated cold-applied resins are likely to be toxic.

19 Permanent Overlays

Permanent overlays have application where it is either difficult to remove the particular marking type from that particular substrate or where the line removal method is either not cost-effective or practical. The overlays used need to be long-life. These may be bituminous, thermoplastic or resin bonded systems.

19.1 Advantages of Permanent Overlays

These can closely match the pavement surface / road environment and are less likely to compromise the integrity of the membrane on bituminous pavements.

This method is especially useful for eliminating “ghost images” that occur when grinding and blasting removal methods are used in the removal of unwanted markings.

19.2 Disadvantages of Permanent Overlays

Relatively high material cost. Although permanent, costs of particular overlays, e.g. cold applied plastics, may be prohibitively high.

Typically “black”, hence only appropriate on bituminous surfaces.

Must be applied with caution to ensure that markings do not exhibit characteristics of the markings being overlaid in particular circumstances.
May contribute to high build markings and therefore should comply with NZTA P22, clause 13.2, as shown in the table below:

Description	**Requirements**
New markings	2.0 -2.5 mm asphalt 2.0-3.0 mm chipseal
Remarking over existing long-life	4.0 mm maximum
Joins and overlaps on lines	4.0 mm maximum
Joins and overlaps on letters and symbols	4.0 mm maximum

On continuous, high build markings the black thermoplastic or cold applied plastic overlay should be omitted so as to coincide with any existing drainage gaps.

Skid resistance of permanent black overlay should comply with NZTA P22. The dry film thickness would be determined by the total of the dry film thickness of *both* the existing marking and the proposed overlay.

19.3 Permanent Overlay Types

19.3.1 Bituminous Compounds

A bituminous compound is applied (usually at about a metre wide) over the unwanted marking and crusher dust or sand is then spread over the bituminous coating. The crusher dust or sand serves to lower the gloss level and improve skid resistance.

"Asphalt rejuvenators", a mixture of bitumen emulsion, water and sand which are cold applied can provide a relatively cheap and easy cover.

This method is very effective on spray / chipseal surfaces but is less effective when used on asphaltic concrete or concrete surfaces.

19.3.2 Thermoplastic

Black preformed thermoplastic applied with the use of a blowtorch is a relatively easy method of masking small quantities of unwanted markings. The black thermoplastic must, by necessity, be free of reflective glass beads.

Alternatively black thermoplastic (free of glass beads) may be applied by screeding, extruding or spraying to larger areas.

19.3.3 Resin Bonded

Resin bonded systems use polyurethane, epoxy or methyl methacrylate to bond a suitably coloured aggregate to the pavement. These are applied by trowel, roller, brush or cardboard then dusted with the aggregate.

Resin bonded overlays are considered to be the longest wearing of the permanent overlay materials and are semi-permanent, second only to the complete removal of unwanted markings.

19.3.4 Raised Pavement Adhesive (for RPM Removal Repair)

Any small void created during removal of raised pavement removal can be filled with raised pavement adhesive to which a suitable quantity of the appropriate grade road chip is applied and compacted

20 Mechanical Destruction

Mechanical destruction may be used to assist in the removal of certain materials such as thermoplastics. Removal is achieved by use of machinery or equipment to impact the material, causing it to de-bond from the substrate.

Typical solutions are; suitable machines with rollers, tracks or blades driven over the markings, or handheld masonry breaker, scabbler, needlegun scaler, air chisel, brick bolster or axe.

20.1 Advantages of Mechanical Destruction

This method is particularly practical for resealing contractors where removal of thermoplastic markings is required prior to resealing.

It is also a quick, cost effective method to remove the bulk of the material prior to the residual markings being removed by high pressure water or abrasive blasting.

Handheld masonry breakers, air chisels, brick bolsters or axes are very effective when the substrate is concrete.

20.2 Disadvantages of Mechanical Destruction

Should not be used on open graded porous asphalts due to the tendency to close or block the pores in the pavement.

In almost all instances, other than removal for reseal operations, a second method must also be employed in order to remove any residual or underlying markings.

21 Void Concealment

This describes the practice of using black paint to conceal any residual markings deliberately left in the voids of the road surface to minimise the damage caused by the initial removal method.

Once the obsolete markings have been removed from the surface of the road it is often practical to obliterate any residual markings in the voids by using a squeegee to skim black paint into the texture of the surface. This method of application ensures a minimal dry film thickness of black paint is applied to the surface of the road and will be trafficked off almost immediately, whilst the black paint in the voids will remain protected from traffic wear and as such may be regarded as semi-permanent.

21.1 Advantages of Void Concealment

Minimises damage to the substrate by reducing the amount of removal required.

21.2 Disadvantages of Void Concealment

This method is not suitable for all seal types.
The black paint may eventually deteriorate due to, UV degradation, age embrittlement or weathering.

22 Legislation & Guidelines

The following legislation and guidelines have application to the practices described by this document:
The Health and Safety at Work Act 2015, and its subsequent amendments
The Health and Safety at Work Act Regulations
The HSE Pressure Equipment, Cranes and Passenger Ropeways Regulations 1999
The Clean Air Act 1972
The Resource Management Act 1991
NZRF Safety, Health and Environment Guide

23 Obligations & Responsibilities

The legislation details specific requirements for particular operations and both Principals and Contractors are advised to familiarise themselves with those requirements.

23.1 In general

All Line Removal works must be carried out in such a manner as to not endanger the health, safety or amenity of employees or the public in general. All line removal operations are potentially hazardous and as such require hazard analysis prior to the commencement of work. Appropriate personal protective equipment must be supplied and regular checks made to ensure that these items are correctly fitted and worn.

As with all operations carried out on roads, the safety of the worker and the public is of paramount importance.

When removing markings in or near built up areas, the possible adverse effects of noise pollution and dust must be considered when selecting a removal method. Consents may be required, either for each exercise or as required by the Regional Council.

The removed markings and blasting materials must be contained, collected and disposed of in accordance with legislated environmental guidelines. It is recommended that traps be utilised to prevent dislodged marking materials from entering into the storm water drainage system. Markings removed by this process are either swept or vacuumed up at the end of the operation and disposed of in accordance with environmental guidelines.

23.2 Specific Requirements

Worksafe New Zealand must be "Notified" of any and all Abrasive blasting operations prior to the commencement of work. If sand is used as a blasting media, written proof that the silica content of the sand is below 5% is required. Regular operators of such plant must have regular health checks.

Due to the likely "dust nuisance", wet and dry abrasive blasting are in general, specifically addressed in Regional Plans as "Restricted Discretionary Activities" and as such require Resource Consent from the appropriate Regional Council

Water blasting results in a likely discharge of contaminants to land or water and therefore is likely to be specifically addressed in Regional Plans. This activity is generally dealt with as a "Permitted Activity" with conditions attached.

Similarly, where a "noise nuisance" is likely, Consent is required from the appropriate Regional / Local Council.

Line removal activities on roads and public thoroughfares are required to be carried out within closures established in accordance with the RCA requirements for temporary traffic management.

Information on the operational requirements of the related legislation may be found in the NZRF Safety, Health and Environment Guide.

24 Training & Competency Assessment

Principals and Employers are obliged under the respective legislation to ensure that all operatives have been appropriately trained and / or supervised for the task that they are assigned to.

There are a number of Unit Standards registered on the NZQA Framework which relate to the practices as described by this document, i.e.

17522 Abrasive Blasting	Apply quality concepts to abrasive blasting
17523 Abrasive Blasting	Demonstrate knowledge of abrasive blasting materials
17524 Abrasive Blasting	Demonstrate knowledge of wet blasting
17525 Abrasive Blasting	Operate blast pot
17526 Abrasive Blasting	Operate low-bar water blaster in abrasive blasting environment
17547 Blaster Coater Operations	Demonstrate knowledge of health and safety in a blaster coating environment

Assessors registered by the relevant Industry Training Organisation may assess competency against the appropriate unit standard.

25 Industry Review and Improvement

25.1 Document Development

The content of this document has been developed on the basis of industry participation and consultation. The development group has endeavoured to provide clear interpretation of the information gained during consultation and an understanding of industry collected knowledge.

25.2 Submissions for Change

Submissions for change can be separated into three categories in relation to their importance and complexity; i.e.

1. Critical and Urgent – Make submission to the NZRF Executive Director
2. Formal Submission – Make submission to the NZRF Executive Director
3. Informal enhancement/discussion point – Make submission through Industry Representatives/Review Group Members.

25.3 Line Removal Guide 2017 Review.

The following people are acknowledged for providing valuable insight and information during the 2017 review of this guide:

Hamish Coop	Aquamax
Chris Mackenzie	Aquamax
Lance Wright	Coastline Markers
Steve Borrie	Potters Industries
Graham Sims	TSL
Robert Busuttil	NZ Transport Agency

25.4 Notice of Amendments

A control copy of this document and the attachments are available on the NZRF website.

Pictorial Standards

75% removal

85% removal