



# STOP THE ROT

## Stabilisation of Historic Timber Structures

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INTERIM GUIDELINES



Department of Conservation  
*Te Papa Atawhai*

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# 1. INTRODUCTION

This manual describes operations that may need to be undertaken to prevent or slow down deterioration of old timbers in historic structures exposed to the weather.

The steps are described in a particular sequence which in most cases would be the ideal sequence. Practical considerations will often intrude, however, and it may be necessary to vary the sequence.

This manual takes a perfectionist approach to structural stabilisation. It will never be possible, and in some cases may not be necessary, to undertake every procedure recommended here. Hard decisions may have to be made, and the project manager must decide what is feasible and what isn't. Some heritage values may have to be sacrificed. The manual tries to define which operations are mandatory and which can be deferred or omitted, and lists many of the criteria for deciding these matters.

The guidelines are interim in the sense that better techniques and more appropriate chemicals may come to light in future years, in particular as more information is collected from the ongoing preservative trialing projects described below.

We are reasonably confident that the procedures described here do work and do not have significant adverse effects. However no stabilisation treatment lasts forever. Suggestions are made as to when re-treatment of any treated structure will probably be necessary. Use of the procedures and materials described here will not prejudice switching to better treatments and materials for future re-treatments.

The Department of Conservation (DOC) has already treated a number of structures using a variety of procedures and chemicals. Current research suggests that some of these treatments, especially those using low concentrations of TCMTB (i.e., Busan) have not been effective and should be replaced by the treatments recommended here. Other treatments are working quite well, and when re-treatment of these structures becomes necessary the original treatment may be repeated, if for no other reason than to expand our knowledge of the relative advantages of the different treatments.

This manual assumes that all the processes involved in stabilising a particular project will be treated administratively as a discrete project. Each such project will have a project manager, who will usually be a conservancy historic resources technical support officer.

The project was managed and funded by the Science and Technology Centre, Department of Conservation, Wellington.

## 1.1 EXPERIMENTAL AND DOCUMENTARY BACKGROUND

This manual is based on a wide variety of information sources including:

A set of trial treatments using various chemicals on an old Howe truss railway bridge built from durable eucalypt at Waikino, near Waihi. The trial panels were treated in 1999 and are being monitored at one year intervals by Dave Page in a project led by Mick Hedley of Forest Research on behalf of DOC.

A similar but scientifically less rigorous set of trials established by Owen Wilkes on a kauri driving dam in the Kauaeranga valley. Small scale trials are also underway on a variety of timbers including totara at Kawhia.

Personal involvement by Owen Wilkes in timber stabilisation on two other kauri driving dams in the Kauaeranga valley.

Inspection of a wide variety of other historic wooden structures on which DOChas attempted timber stabilisation, including truss bridges, suspension bridges, tramway sleepers, and slab huts. In some cases samples have been taken from these structures and assayed to determine the retention of preservative chemicals by the timber surfaces. The assistance and hospitality of DOChistoric resource staff is gratefully acknowledged.

Published information, including material from the New Zealand Forest Service and the New Zealand Timber Preservation Authority, and articles in overseas technical journals. The National Forestry Library at Forest Research, Rotorua, has been particularly useful as has Australian and Scandinavian research. Information about various chemicals has been supplied by manufacturers.

Consultation with various timber preservation practitioners, in particular Jack Fry of Conservation Supplies, Wellington.

An enormous amount of information and experience accumulated and readily shared by Forest Research, Rotorua, and conversation with Mick Hedley and Robin Wakeling at Forest Research. "Graveyard" trials of various preservatives at Rotorua yielded important insights.

Jack Fry has sold  
Conservation Supplies. Jack  
still lives in Wellington.  
Conservation Supplies is now  
in Auckland.

## 1.2 FURTHER INFORMATION

A good general textbook on prevention and treatment of fungal rot (although it is becoming out-of-date) is *Wood Preservation* by Barry A Richardson, 1978 (Construction Press, Lancaster, UK)

For information on hazards associated with timber preservatives see *Approved Code of Practice for the Safe Use of Timber Preservatives and Anti-sapstain Chemicals*. Occupational Safety & Health, Department of Labour, 1993.

There is a reference associated with commercial preservative disposal, probably only relevant to boron from the Ministry for the Environment, i.e., *Health and Environmental Guidelines for Selected Timber Treatment Chemicals, ME240*, 1997.

### 1.3 Scope

This manual is intended to provide guidance for stabilising historic timber structures in which the timbers of concern are exposed to the elements, rather than protected by roofs or by paintwork.

The structures of most concern are bridges, and most of these bridges will be made of durable eucalypt (often referred to as “Australian hardwoods”, - jarrah, ironbark etc.). Other types of structures and other timbers are mentioned in passing, and are dealt with more fully in appendices.

Totally waterlogged timbers such as those in submerged shipwrecks or Maori carvings recovered from swamps are outside the scope of this manual.

Following field tests a supplementary bulletin should advise on treatments for weatherboards, slabs, shingles, new poles and wood in concrete.

A follow-on research project should review treatments that provide protection against weathering which is particularly prevalent on north facing and horizontal faces. Some projects have applied a micocrystalline wax with a UV (ultra violet) filter.

### 1.4 THE NATURE OF TIMBER DECAY

Fungal rotting is the main cause of decay in timber, but other influences are also at work. Decay in typical New Zealand situations is caused roughly as follows:

- 65% Fungal rot - mostly caused by brown rot and white rot fungi. Soft rot is important on damper timber, and may be responsible for as much as one fifth of fungal rot.
- 25% Weathering - less important than fungi in New Zealand but may be important in structures that are relatively dry and contain sapwood. The preservatives recommended here are effective against fungi and insects.
- 7% Insects - generally not important in New Zealand, and the fungicides recommended here usually discourage insects.
- 5% Bacterial rot - operates very slowly, but may be dominant in very wet timber. Ignored in these guidelines.
- 3% Chemical rot - particularly around iron fasteners embedded in the wood, so can be locally important.

### 1.5 CHOICE OF PRESERVATIVE

Preservative formulations are all based on fungicides, but a good fungicide does not necessarily make a good preservative. There are many factors to be considered when choosing a preservative, including:

Fungicidal effectiveness - some fungicides are effective against a broad spectrum of fungi, others are more specific.

Water repellency - to slow down the entry of water into wood, while allowing free exit of water vapour.

Retention - the ability to lodge in or on the wood in sufficient amount to control rot.

Penetration - the ability to soak in as far as is needed to control rot.

Permanence - the ability to resist leaching out by water, degradation by ultraviolet, detoxification by micro-organisms etc.

Environmental impact, both during application and afterwards.

Worker safety, during application.

Visitor safety, subsequent to application.

Ease of application.

Historical appropriateness, aesthetic issues etc.

Cost.

No single preservative will excel in all these considerations, and different preservatives are needed in different situations. In particular, the control of surface rot requires a preservative which will fix permanently in the wood near the surface, while control of internal rot requires a preservative which will diffuse into areas where decay is active.

The requirements for remedial treatment are quite different from those for preventative treatment of, e.g., radiata pine used in building, and the copper-chrome-arsenic (CCA) preservatives used in pressure impregnation of radiata are not suitable. Most requirements for remedial treatment of historical structures can be met by four preservatives - copper naphthenate, creosote, boron, and "Busan" pole preservative gel. The interrelationships between these four are shown in fig. 1, and the detailed reasons for choosing them are listed in Appendix 1 which also contains details of various remedial treatment preservatives.

Some preservatives have not been recommended because they are likely to be less effective, e.g., Busan 30WB. DOC-sponsored research indicates that if this preservative is to be effective on historic structures, then it needs to be applied at ten times the concentration used in the past, and the treatment needs to be repeated every two or three years if it is to remain effective.

It is often asked why we can't use CCA (or "tanalising") treatments on historic structures, since it is so obviously successful for fence posts etc. The short answer is that CCA preservatives chemically bind to wood and will not diffuse through wood so will only penetrate wood when forced in under high pressure. There are also serious health hazards in any hand-application of chromate and arsenate salts.

### **1.5.1 Copper naphthenate**

Copper naphthenate performance was variable. This variability was associated with the substitution of naphthenic acid by other acids in the formulation. Recent formulations have been more consistent.

CN (copper naphthenate) is well established in New Zealand for remedial use, having been manufactured here since before World War II. There is lots of documentation on both its virtues and its faults. Contractors are familiar with it and comfortable working with it. It is a general-purpose spray-on brush-on surface preservative. Being oil-based it has some water-repellency. It is nearly

as safe to use as oil-based paint, and it is relatively cheap. It is effective against nearly all the rot fungi we are likely to have to deal with. It is available as an emulsion (CNE) especially suited to brushing-on, and as a liquid (CNL).

If environmental contamination with CN should occur it will have little biological consequence, except for fungi. Even if CNE gets onto soil or into water it is of relatively low toxicity to higher plants, fish, arthropods, birds and mammals.

On the negative side there is at least one variety of rot fungus (*poria* sp.) with the ability to detoxify CN. (But this hasn't been a big problem so far in New Zealand.) CN also loses some potency with time as it hydrolyses, leaving copper alone to provide fungicidal effect. The naphthenic acids used to make CN can vary and thus performance of CN is somewhat unpredictable from batch to batch. The bright green colour of copper naphthenate fades quickly to leave wood surfaces a slightly greenish colour.

### **CNE (copper naphthenate emulsion)**

CNE is formulated specifically for remedial treatment as a “bodied mayonnaise-type” (BMT) emulsion. When it is applied to a surface it demulsifies. The oily component containing the copper naphthenate begins to soak into the wood while the watery component forms a crust at the surface which prevents wash-off by subsequent rain etc. This maximises the possibilities for deep penetration and high retention, even in wood with fairly high moisture content. CNE can be spread on quite thickly (2 mm on side grain, 5-6 mm on end grain) and will slowly soak in over the next few days. The carrier oils remain in the timber for a long time, and have the ability to “creep” into checks (longitudinal fissures developed during weathering) or cuts which open up after treatment.

As a moderately viscous emulsion CNE can be applied easily and cleanly, with little risk of environmental contamination. It does not splash or drip. If a bucket of CNE is kicked over it will not spill. If a bucketful should be accidentally dropped into a waterway it will disperse only very slowly, allowing plenty of time for it to be retrieved. Workers are unlikely to come into contact with it providing impermeable gloves are worn.

CNE is thixotropic, which means that it becomes momentarily more liquid while being brushed on so that it is easy to apply. If it is brushed on across the grain the checks in the timber will fill up with emulsion. Over time the CNE will “creep” further down into the checks.

Timber recently treated with CNE has a rather garish azure green colour, but this disappears after a few days or weeks. As long as this colour is present anything which comes into contact with it will become stained by it, so temporary barriers to access may need to be set up.

### **CNL (copper naphthenate liquid)**

Copper naphthenate is sold as a 4% solution which can be further diluted. It is particularly suited to application by spray, using an ordinary horticultural backpack sprayer. It is widely available as a do-it-yourself preservative for home use. Our trials indicate it should be diluted 1:1 or 1:2 (rather than 1:3 as recommended by manufacturers), and it is better diluted with diesel than with mineral turpentine because the diesel confers additional fungal toxicity and some slight water repellency.

Application of CNL by spray poses some hazards not present with brush application of CNE. Workers risk blowback, so that respirators, protective clothing need to be worn, and goggles may be advisable, depending on wind conditions. Environmental contamination is also more likely, from spray-over, spray-drift, and dripping. CNL does release volatile organic carbon (VOC) into the atmosphere, with long term implications for global warming etc.

CNL can be applied with brush or roller, but there is likely to be lots of dripping. Brushing is not practicable on upside-down horizontal surfaces. If there are large areas to be treated, where spray-over can be avoided, then spraying of CNL is probably a quicker, more convenient and possibly cheaper option than brushing on of CNE.

If CNL is prepared using mineral turpentine rather than diesel as the carrier it is possible to later paint over the preserved wood.

CNL will probably work out to be cheaper than CNE. In general the same retention can be achieved with CNL as with CNE, but the penetration will probably be less particularly if the wood is damp.

### **1.5.2 Creosote**

The alternative surface treatment for historic structures is creosote. It is a very effective preservative, probably better than copper naphthenate. It was formerly manufactured in New Zealand and widely used. Creosote penetrates well, and remains mobile within the timber for decades, so it can flow into checks which open up after treatment. It is effective against a wide range of fungi, including those active at the groundline. It is not water soluble and gives some water repellency.

Creosote is smelly and dirty, and if it gets on skin it stings and burns. The burning is accentuated by exposure to sunlight. These properties are particularly obnoxious with pressure-treated timber, because pressure-impregnated creosote unpredictably “weeps” back to the surface, so that fencers handling posts and linesmen climbing poles used to become contaminated by it. These problems are largely absent with brushed-on and sprayed-on creosote. Creosote treatment increases the flammability of timber for at least a few days after treatment.

In one sense the very obvious obnoxiousness of creosote is its best safety feature. Anyone who uses it will take great care to avoid contact with it. It is not likely to be seriously toxic in the quantities in which it is accidentally encountered.

New Zealand is one of the few countries in which creosote is no longer used, for historical reasons given in the appendices. Creosote is still widely available and used in Australia, the US, Britain, Japan and Scandinavia. In the 1980s Sweden shifted from CCA back to creosote for utility poles, largely on alleged health and safety grounds. Japan has banned CCA on alleged environmental and safety grounds, but still uses creosote for rail sleepers.

Creosote was formerly widely used in New Zealand, for sleepers, utility poles, fencing, piles, stockyards, farm outbuildings, crib-walling etc. Some county councils treated bridges with it. Farmers impregnated their own fenceposts by hot-and-cold soaking. As a do-it-yourself paint-on it was used for fence palings, post and rail fences, weatherboards etc. Creosote disappeared from the New Zealand market about 1998, and if it is to be used now it will need to be imported.

It is suggested here that it be used for surface treatment wherever it is historically appropriate, as in the situations just mentioned, and wherever its obnoxious properties will not impinge too forcefully on visitors.

Creosote is distilled from coal tar and today is produced as a by-product of coke making for iron and steel plants. In the past it has always been used as the liquid produced at the distillery. More recently a thickened emulsion analogous to CNE has become available in Australia.

Liquid creosote for remedial purposes is usually applied either by brushing or by spray. Because of its low viscosity it tends to splash and drip excessively. For application overhead spraying is the only way. Protective clothing, gloves, respirator and goggles may all be needed, and application should not be attempted in poorly ventilated spaces. Any splashes onto skin need to be cleaned off immediately with warm soapy water, especially in hot sunny weather.

In some situations the hot-and-cold-soak method may be appropriate - for example if there are a large number of moderate size, movable components to be treated, such as fence posts or bridge transoms. The timber pieces are put first into a bath of heated creosote for long enough to drive out air and moisture, and then transferred to a bath of cold creosote. As the timber cools a partial vacuum is created and creosote is drawn into the wood. Great care is needed to make sure the hot-bath creosote does not catch fire - indirect heating, e.g., with steam, is best.

Emulsified creosote has become available only recently, and there is no experience with its use in New Zealand, although it is widely used in Australia for the commercial and remedial treatment of wood. It is said to be as effective as run-of-the-distillery creosote, but with 80% of the smell removed. It should be much cleaner and safer to apply, and is probably the formulation of choice. We hope to undertake trials shortly.

### **1.5.3 Boron**

Boron is a very effective fungicide, and because of the smallness of its molecules, it diffuses readily through timber. It will diffuse right into the cell walls rather than remaining in the cell cavities as is the case with copper naphthenate. This means it can kill soft rot fungi which CN doesn't reach. Unlike copper and creosote it penetrates readily into damp timber - indeed it is dependent on there being at least 30% moisture content present before it will diffuse readily. This means it has a tendency to migrate within the timber to where it is most needed - to the dampest wood. If there is no damp wood, the boron remains immobile, and thus is not wasted.

In some respects boron is too mobile. It is likely to diffuse out of the wood as readily as it diffuses in. It is thus suited mainly to internal use, but may give limited protection in exterior situations when it is used in conjunction with a water repellent or paint coating.

There is little experience with remedial use of boron in New Zealand, although boron diffusion has been used for H1 radiata treatment since the 1950s, and New Zealand is a world leader in this technology. Overseas there is burgeoning interest in boron for both commercial treatment of building timbers and in remedial treatments.

Boron is by far the safest preservative available. Boron has very low toxicity for mammals and most other forms of life. It is however very toxic to arthropods, particularly insects, so care should be exercised if there is concern about, for example, rare giant wetas. Boron is essential to most forms of life, and it is everywhere present in low concentrations in soil and water, it is not bio-accumulative. If it is accidentally released into the environment it dilutes and disperses readily.

Boron needs to be inserted into the wood rather than applied to the outside. Holes are drilled into the timber at carefully chosen locations, and these holes are filled with rods of fused boron and/or boron paste. The paste diffuses more rapidly than the rods and may be more suitable for wood that is relatively dry. Rods deliver more active ingredient for the same volume when compared to the paste but they need a relatively high moisture content in the wood to dissolve them.

Boron is also available in foaming form. The foam has the consistency of whipped cream, and can be injected into voids in timber, where it expands to fill the void and subsequently collapses against the walls of the void, so that the boron is transferred to the adjacent timber. Foamed boron has been used extensively overseas as a way of applying preservative to surfaces in inaccessible spaces such as those between the internal and external cladding of house walls, as well as in the bilge spaces of historic ship hulls. Approval to use foam in New Zealand, if required, is now given by ERMA or under hazardous substances legislation. (Details about boron foams. This needs to be checked with Jeanette Drysdale and potential suppliers. Basic questions about concentration, application and availability need to be answered before we can recommend its use.)

Cavities treated with boron foam can later be permanently filled with polyurethane foam. This is a technique used extensively in Hawaii and North America for renovating utility poles that have been hollowed out by termites or woodpeckers.

#### **1.5.4 Pole preservative gel**

Polegel, as it may more conveniently be referred to, combines an organic fungicide, TCMTB, with a penetrant chemical called DMAD, to give a preservative which will penetrate timber to a greater extent than CN or creosote, but which is not as mobile as boron. It is supposed to be as effective in damp wood as in dry, and in wood below 30% moisture content it may be more mobile than boron. Like boron it will penetrate cell walls. It is not very effective against brown rot/white rot, but is very effective against soft rot, and therefore is particularly useful at the groundline of timbers which rest on or are embedded in the soil, where soft rot is particularly active and otherwise difficult to control. A technique for applying preservative in bandages was developed by the CSIRO in Australia and is widely used in New Zealand for remedial treatment of power poles. (Check efficacy of TCMTB against brown and white rots.)

Polegel is provisionally recommended here for bandaging piles, posts and poles at the groundline. It is recommended with some reservations. Polegel was developed to protect against soft rot in poles which had already been treated with CCA against brown rot/white rot. There are more sophisticated formulations under trial overseas for groundline control, and it is likely that one of these will in the

future be found more suitable for remedial historic purposes than Polegel.

Polegel as a thickened gel used in small quantities and isolated by impermeable bandage is unlikely to cause environmental problems. It is not particularly toxic but it does cause a severe skin allergy with some people, with symptoms like severe sunburn.

Polegel is the most problematical of the four recommended preservatives. It is not widely used outside Australasia, and there is little information about it. It is very expensive on a per litre basis, and it is very expensive to test for.

## 1.6 OUTLINE OF OPERATIONS

(The numbers here correspond to the section numbers of the relevant text)

### **3. Initial assessment**

Is the structure important enough to warrant stabilisation?

Is it feasible?

Is it more urgent than other historic structures??

### **4. Cleaning the structure**

Before detailed assessment or stabilisation can begin dirt, moss, lichen, and completely rotted wood needs to be cleaned off. Waterblasting will generally be the best technique.

### **5. Preparation of plans and elevations**

This allows detailed assessment and operational planning to begin. Later on it will facilitate regular maintenance and management.

### **6. Detailed inspection and assessment**

At this stage every wooden component needs to be inspected, and decisions made about which components can be stabilised and which need to be replaced.

### **7. Repairs**

Repair or replacement of structurally vital wooden components now takes place. Perhaps metal fasteners etc., will also be replaced at this stage.

### **8. Controlling surface rot**

Stopping rot on the timber surfaces. This is the biggest, most important, and probably most expensive part of the project. It often requires rescheduling and waiting to get optimal weather conditions.

### **9. Controlling internal rot**

This is a much more fiddly operation, but at least it is not weather-dependent. Holes may have to be drilled for insertion of boron rods.

There are preservatives other than boron rods that can be used for internal treatment i.e., Boron pastes, Polegel, CN emulsion.

#### **10. Controlling groundline rot**

Rot on piles where they enter the ground poses different problems from rot anywhere else on a wooden structure. Groundline bandaging may be the answer.

#### **12.2 Consolidation**

Hardening of surfaces already softened by rot.

#### **12.3 Obstructing entry of water**

Water repellent treatments will hinder entry of water while allowing exit of water vapour. Other ways of hindering water entry also need to be considered.

#### **14. Subsequent care & maintenance**

Any treated structure needs to be inspected about once a year. Preservative chemicals eventually leach out of timber, and at some stage re-treatment will be necessary.

## 2. ON-SITE SAFETY ISSUES

This manual does not deal with safety issues connected with use of ladders, scaffolding, safety lines, or abseiling gear, or with use of chain saws and other power tools. Minimum protective clothing requirements are gloves, overalls, safety glasses, and the use of others may be required in particular circumstances e.g., respirators and crampons. Wet timber is often more slippery than dry timber, but may be safer to walk about on after algal slime etc. has been removed by waterblasting. Timber recently treated with oil-based preservatives (e.g., CNE) is even more slippery than wet timber. You may find instep crampons useful for moving about on such timber. Tarpaulins placed on the ground which have become covered with a fine mist of preservative from spraying overhead can also be very slippery.

If you are unused to using a powerful waterblaster, get acquainted with it at ground level before venturing up high. There is a quite powerful recoil in the hand piece, and spray suddenly ricocheting off timber right into your face can be very disconcerting!

If preservatives are being sprayed on, it is suggested that not more than two people do spraying at any one time, and that they keep well away from each other, to reduce the chances of one person's overspray drifting into the other person's face. Respirators with appropriate filters should be worn when any liquid is being sprayed.

The preservative chemicals recommended here are not known to be particularly toxic, corrosive or dangerous. Particular safety issues concerning specific chemicals and application techniques are mentioned at the appropriate locations through the rest of the text. More detailed safety information is available in the form of "Material Safety Data Sheets" (MSDS) from the various suppliers. These prescribe suitable antidotes for accidental ingestion etc. Note also: Although the active ingredient in CNE and CNL is of low toxicity the hydrocarbon carriers may cause skin irritation.

Products containing TCMTB, e.g., Polegel, are of low toxicity if swallowed, but can be corrosive to skin (effect is similar to sunburn!), eyes, lungs and intestinal tract (bad heartburn!).

Polegel, because of its viscosity, is fairly safe to use, but it still has a habit of oozing out of the caulking gun right when you least expect it. Take care when driving plugs into insertion holes to ensure that Polegel doesn't get squirted into the face or eyes.

Boron rods are quite safe. The boron compounds in them have about the same toxicity for mammals as common salt.

Solvents used in CNL are highly flammable. Creosote is also highly flammable, and its application considerably increases the flammability of timber for at least several days after application.

Fumes are unlikely to be an issue with the chemicals recommended here, especially out in the open. In confined spaces ventilation needs to be provided when using creosote or CNL. Respirators with appropriate filters need to be worn when creosote is sprayed, and should be available when CNL is sprayed.

Potential dangers with any chemical supplies should be explained to anyone connected with their transport, especially boat skippers and helicopter pilots. Even if you think your chemicals are perfectly safe it is courteous to explain what they are - and the transport operator may be aware of transport-related hazards unknown to you (e.g., lids popping off paint tins at higher altitudes!).

- When mixing two liquids always pour the more dangerous liquid into the less dangerous one (unless otherwise specified by the supplier).
- All chemical containers should be clearly labelled, and ex-food containers should not be used to hold chemicals. (Quite apart from the safety issues, some food containers including plastic milk bottles and icecream containers are soluble in organic solvents.)
- In general, brush-on application techniques are safer (and less environmentally contaminating) than spray-on ones. Boron rods are relatively safe.
- When application of any chemical is underway it is always a good idea to have nearby, as a minimum, a labelled bucket of clean water, a cake of soap and some rags, just in case someone needs to wash themselves down in a hurry. Ordinary mineral turpentine is useful for cleaning up spills of CNL and creosote.
- When using any product the manufacturer's recommendations relating to protective clothing and other safety precautions

### 3. INITIAL ASSESSMENT

Before undertaking any stabilisation work you should do a rough assessment of all aspects of the proposed project, looking at such issues as importance, urgency and feasibility:

- a) Is the structure important enough to be worth trying to stabilise?
- b) How feasible is it to stabilise the structure? Perhaps it is already too decayed to be worth trying?
- c) How urgent is it that stabilisation procedures be undertaken on the structure in question? Are other structures more urgent?
- d) If it is decided to go ahead then some thought needs to be put into issues such as estimating how big the project is likely to be - is it a one year project or a multi-year project?
- e) Deciding on the sequence in which the various operations are carried out - looking at such questions as whether it is necessary to waterblast the structure before detailed inspection is carried out.
- f) Getting a rough idea of how much of the structure can be preserved, and how much needs to be replaced.

The initial field assessment will be carried out by making a visual inspection of the structure. An ordinary screwdriver (not a Phillips head one) makes an excellent probe for getting a rough idea of how extensive and how deep the rot is. You should attempt to identify the timbers involved to be sure that they have sufficient potential durability to be worth trying to preserve.

One important aspect to think about at this stage is access to all parts of the structure. Can all components be reached from ground level or by standing on the structure itself? Or will it be necessary to use ladders and/or scaffolding? Ladders need to rest on something firm and lean against something firm. Scaffolding is expensive to hire and difficult to transport to remote locations. By law it has to be independently inspected every week.

If work needs to be done well above ground level it may be necessary to rig handlines, or use safety lines and a body harness. If the structure is in a deep narrow valley it may be simpler to rig a line across the valley above the structure, and employ abseilers to carry out the work. Abseilers enjoy a three-dimensional ability to move around and over a structure which is hard to appreciate until one sees them in action.

At this stage it may be necessary to get some assurance from a qualified engineer that stabilisation is feasible, and that after repairs and preservation treatment there will be enough fabric left in the structure for it to remain standing, and for it do so without posing unreasonable risks to staff working near the structure or to visitors viewing it. (At the end of the project DOC will require signing off by an engineer anyway, so one might as well be involved from the beginning.)

Potential natural hazards to the structure need to be assessed. Are there large trees that might fall on it? Are rock falls or soil slumps likely to bury it? Could a flood wash it away?

The structure's appearance will be changed forever once waterblasting commences, so take lots of photos beforehand. Some components may be so thoroughly rotted that they will not survive the waterblasting.

### 3.1 ARCHIVAL RESEARCH

Initial assessment will be more realistic if archival research is done now. How old is the structure? How many times was it rebuilt or repaired? What natural disasters (floods especially) have affected it? Was it ever affected by fire?

Original specifications can be fascinating. What timber was originally specified for its construction, and what treatments were specified for the timber? Often the specifications were quite specific. For many structures coal tar was to be boiled for 6 hours, then mixed 2 parts of coal tar to 1 part Stockholm tar, for application to end grain and lap joints. The Railways originally specified red lead primer in joints, and later red oxide/linseed oil paint for end grain.

Original engineering drawings may still be in existence, and are useful for finding out what the original dimensions of components were, and what components have entirely disappeared.

The date when the structure went out of service (i.e., when the railway branch line closed or a modern road bridge was opened) is important as it indicates how long the structure has gone without maintenance. This gives a preview of just how grisly the rot and other mayhem is likely to be.

## 4. CLEANING DOWN

Most structures that have not been subjected to any previous stabilisation treatments will probably be largely covered in dirt, moss, lichen, algal slime and rotted wood. Cleaning down is not absolutely necessary, but surface accumulations can prevent preservative chemicals from penetrating to sound wood. Cleaning down will reduce the amount of preservative chemicals needed to treat the structure.

If the structure is reasonably free of dirt, moss etc. it may be possible to dispense with cleaning down - this will apply particularly to structures exposed to plenty of sun and wind.

Cleaning down need not be too thorough. A few millimetres of weathered or partially rotted permeable wood will help to retain an effective coating of preservative over the sound wood beneath.

### 4.1 WATERBLASTING

Waterblasting is the best method of cleaning timber down to moderately sound wood. Waterblasting is also a marvellous way to discover previously unsuspected areas of rot and other structural weaknesses.

It will generally make more sense to use a petrol waterblaster rather than an electric blaster running off a portable generator. The two most important characteristics of a waterblaster are the water pressure at the nozzle, and the volume per minute delivered. Pressure is usually adjustable, but throughput is not.

Water pressure determines how powerful the water jet is. In general a pressure of 500-1500 psi will readily remove dirt, moss, lichen, and completely rotten wood. Higher pressures are likely to weaken the fabric of sound wood. Experience will indicate what pressure is best - if it is too high an observant operator will soon notice that sound wood surfaces are acquiring a furry texture as individual wood fibres are loosened from their matrix.

Throughput determines the speed at which cleaning down can be performed. Electric-powered domestic water blasters may have sufficient pressure but agonisingly slow throughput. Commercial waterblasters will clean a timber surface in about one fifth of the time needed with a domestic blaster.

Waterblasting is good fun, but it is amazing how soon one becomes chilled by the more or less constant fan of high-velocity water ricocheting off the surfaces being cleaned, even on a hot summer day. At a minimum the operator needs plenty of warm clothing and PVC parka and overtrousers. Wet suits are ideal for protracted operations.

A clean water supply is necessary for waterblasting, to prevent wear on the pump and blockages in nozzles etc.

Most waterblasters have provision for adding detergents or other chemicals to the water flow. For our purposes there is little advantage in doing so, and, given

the large amount of water passing through the waterblaster, any chemicals added at this stage are a potential cause of environmental pollution.

The one big disadvantage of waterblasting is that it injects a substantial amount of water into the fabric of what might otherwise be a reasonably dry structure. Since high moisture content in wood inhibits uptake of most preservative chemicals it is important to schedule waterblasting as early as possible in the overall operation to allow as much time as possible for subsequent drying out.

#### 4.2 OTHER METHODS OF CLEANING DOWN

Cleaning down can also be done using more laborious dry techniques, in particular by brushing down with hard-bristled (and usually long-handled) brooms. It is worth experimenting with a variety of brooms for this. Some brooms clog up amazingly easy with mushy rotten wood. Wire brushes may be useful, but are even more prone to clogging.

Some scraping may also be necessary, using a painter's flat-bladed scraper, especially to remove patches of moss or lichen. A gardener's push-hoe with well-sharpened edge may be effective for scraping larger areas.

Another possibility, particularly for removing dirt and completely rotten wood from fissures, could be a workshop air compressor with hose and nozzle. (If anyone tries this we would be interested to hear how effective it was.)

Dry methods of cleaning may present some minor hazards to the operator by producing clouds of dust. Some early structures, particularly bridges, were coated in red lead primers. These have generally weathered away by now, but red lead may still be present where timbers are in contact with each other. White lead primer is less obvious but just as dangerous. Lead can be detected with sodium sulphide solution (if lead compounds are present the surface will immediately go black when the solution is applied.) If lead is present in quantity respirators with particulate filters should be worn. If there is concern about red lead or other dusts contaminating the environment an ordinary vacuum cleaner can be used.

Other useful tools are secateurs, a tree lopper, and a pruning saw. You may need a spade, shovel, mattock, or crowbar.

#### 4.3 OTHER WORK

Vegetation should be cut back around the structure at this stage to let in as much sun and wind as possible so the timbers have an opportunity to dry out before preservative application begins.

Accumulations of earth, landslide debris, flood silts or gravels should be cleared away from timbers to promote further drying out.

Deal to places where water is ponding on timbers, and where runoff is flowing onto timbers.

Spray penetrating oil on nuts and bolts now in case you need to undo them later.