FOXTON BEACH NORTH

STABILISATION REPORT

HOROWHENUA DISTRICT COUNCIL

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Herons resting in area

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1.0 Summary

The purpose of this report is to outline the current sand instability problems occurring at Foxton Beach North and recommend several options of overcoming the instability.

Foxton Beach North comprises of approximately 120 hectares of land and is located immediately north of the Foxton Beach township. It borders the Tasman sea to the west and Sim Brothers to the east. The area comprises of a complex of sand dunes and sand plains and is extremely dynamic. Associated with this area is approximately 2800 metres of coastline.

Of the 2800 metres of coastline it is estimated that 20 % is unstable. Of this, it is estimated that 80 metres requires major mechanical reshaping, and 475 metres requires rebuilding using sand fences or sand traps in order to become stabilized. The remaining 2445 metres requires a fertilizer and maintenance program for long term stability. Of the inland area it is estimated that of the total 110 hectares, approximately 55 hectares requires primary stabilizing using marram grass.

Three major factors have contributed to the instability of the area and include the lack of a periodic maintenance program, the effects associated with the use of off road vehicles in the area, and the lack of any secondary stabilization program. Addressing these three factors is the first step in assuring long term stability for the area.

2.0 Introduction

The coastal environment at Foxton Beach is extremely dynamic. Although typical of any lower North Island west coast beach, it lies within a section of coast that experiences some of the most active coastal dynamics of the west coast system.

The area of land controlled by the Horowhenua District Council north of the Foxton Beach township and surf club (referred as 'Foxton Beach North' hereafter) is shown in Figure 1. It comprises of a complex of sand dunes and sand plains and consists of approximately 120 hectares. The western boundary consists of approximately 2.8 km of foredune coast line.

The northern end of the property comprises of the Foxtangi Dunes RAP zone. This area has been recognized for its natural character and diversity of vegetation. Also associated with this RAP zone is an area of wet sand plains and its associated wetland species.

The beach at Foxton Beach North is presently accreting. At low tide, sand which is deposited on the beach is then available for wind erosion. Because the dominant winds are from the north-westerly direction, this deposited sand is then available to be blown directly into the foredune. Any gaps or blowouts present in this first line of defence causes wind to channel this sand through these blowouts and settle out on the leeward side of the foredune. Hence the development of drifting inland parabolic dunes. Also as both wind and sand are channeled through blowouts their erosive nature erodes the sides of the channel which enhances the blowout.

Figure 1. The area detailed in this report administered by the Horowhenua District Council.

3.0 Purpose of This Report

The purpose of this report is to outline the current sand instability problems occurring at Foxton Beach North and recommendations in terms of a management plan to:

1. rectify the current instability problems, and
2. outline several options available to achieve long term stability for the area

The options recommended does not outline a detailed program of works over a set time period. Such a detailed program would be financially driven.

Since the instability problems are isolated to the foredune and the inland dune system, only these areas are discussed in detail. Some references are made to the sand plains but only for continuity purposes.

4.0 Recognized Problems

At Foxton Beach North three major factors have contributed to the instability of the area. These include:

1. The lack of a periodic maintenance program
2. The effects associated with the use of off-road vehicles in the area
3. The lack of any secondary stabilization program

The effects from these three major factors include:

On-Site Effects	Off-Site Effects
• The burial of significantly recognized wetland areas leading to the reduction of species bio-diversity • The continual changing of the unique character of the landscape by flowing dunes. • The exacerbation of numerous small breaches of the foredune into larger blowouts. • The destruction of extremely sensitive primary stabilizing vegetation by off-road vehicles. The depletion of vegetation enhances blowout formations.	• The inundation of sand from Foxton Beach North into neighboring commercial forestry. Numerous complaints have been received from the Sim Brothers regarding several large sand blows flowing on to their land. • The continual sand blasting of residential properties at the southern end of the block.

Figure two shows the extent of the various problems occurring at Foxton Beach North.

Plate 1. The result of continued pressure from motor vehicles initiated a blow out in the foredune.

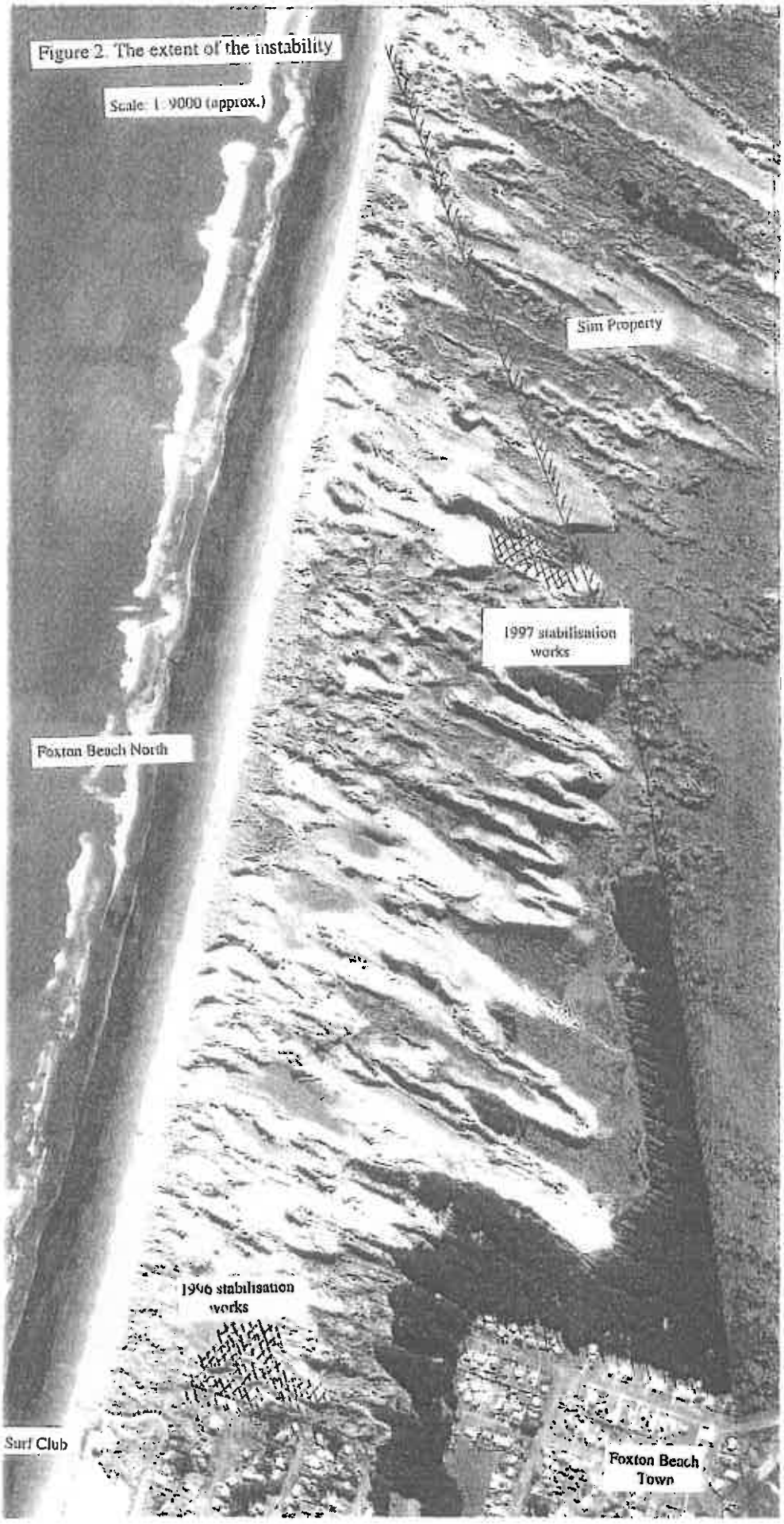
Figure 2. The extent of the instability
Scale: 1 : 9000 (approx.)
Sim Property
1997 stabilisation works
Foxton Beach North
1996 stabilisation works
Surf Club
Foxton Beach Town

5.0 Previous Works

In the past years there has been limited sand stabilization works undertaken in the area. Some primary marram plantings have been undertaken however these have not been maintained. Last winter approximately 2 hectares of marram was planted at the southern end of the property on several dunes that were causing severe aelion sand into the adjacent houses, as shown in Plate 2. The success of this work has been mixed due to prolonged equinoxial winds during the spring following planting. Associated with this planting was the establishment of approximately 1 hectare of marram nursery. Also, during the last two springs some nitrogenous fertilizer has been applied to the foredune area. This application has resulted in a significant increase in the amount of spinifex present, to the extent that it is now generally the dominant foredune vegetation.

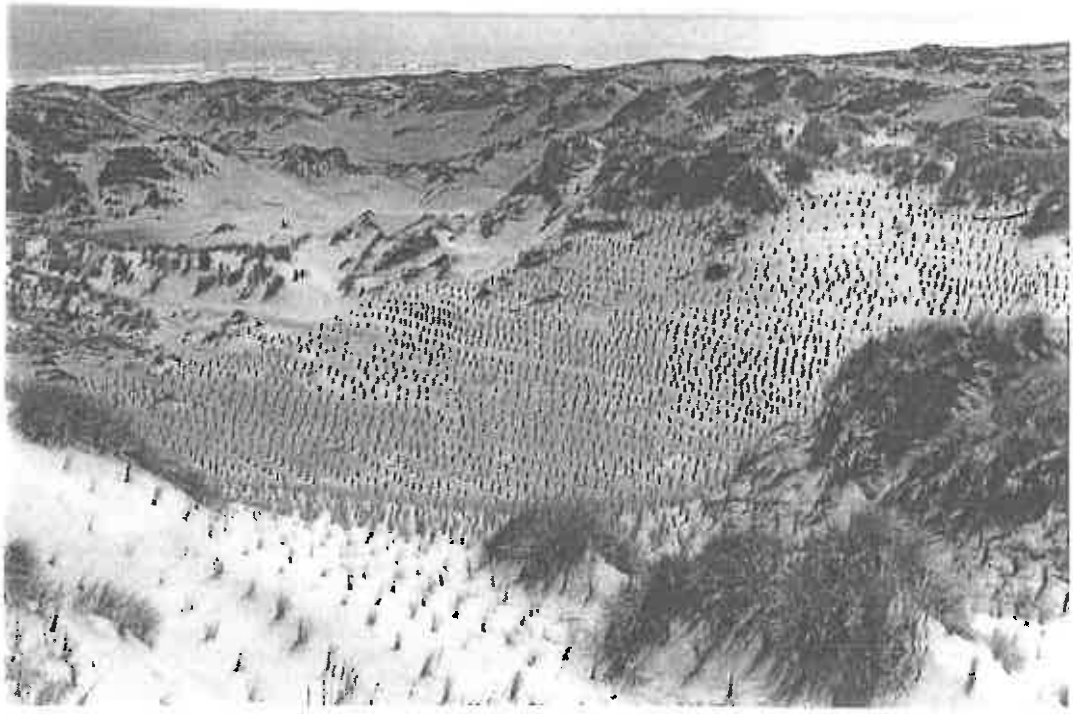

Plate 2. Stabilization works undertaken during the 1996 winter.

During the winter of 1992 a major planting program was under taken on the neighboring Sim property which consisted of secondary stabilization using Pinus radiata. Also associated with this planting was some primary marram planting on the Horowhenua District Council land at the northern end of the block in question. The success of this marram planting has been inadequate due to an unstable foredune environment feeding this planted area.

6.0 Background Information

6.1 Foredune Environment and Land Forming Processes

A basic understanding of the foredune environment and land forming processes is the first step in developing a management plan for overcoming the instability problems. Therefore the formation of blowouts, parabolic dunes and low mobile sand-sheets occurs by the following processes:

6.1.1 Blowouts

Blowouts form when strong nor-westerly winds erode a gap in the foredune. The wind blows through the gap sweeping sand from the beach and foredune in an inland direction. Where the foredune has been cut back by wave action leaving an non vegetated cliff of loose sand, strong onshore winds may initiate blow-out formation. Blowouts also develop in the foredune system where the stabilizing vegetation has been damaged or destroyed.

Unless the gaps in the foredune system are refilled by sand accumulation and colonized by stabilizing vegetation the blowouts increase in size and migrate inland under the influences of the prevailing onshore winds. Series of consecutive blowouts developed in an unstable foredune system often grade into parabolic dunes.

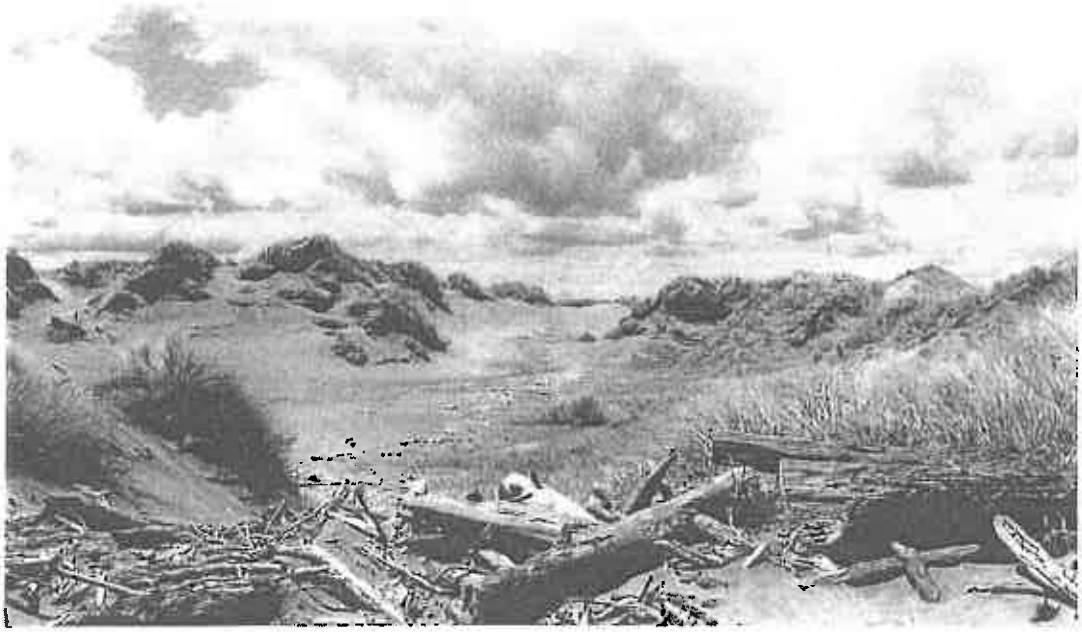

Plate 3. A typical blowout present in the foredune

6.1.2 Parabolic Dunes

Blowouts migrating inland under the influence of the prevailing winds have an advancing nose of loose sand and trailing arms of sand which have been partially fixed and stabilized by vegetation. In this way the blow-out develops into a parabolic or U-shaped dune.

The dunes retain a parabolic form as long as they remain partly vegetated so that the trailing arms are held back by vegetation. When the stabilizing vegetation is removed the parabolic form is lost and wind action produces large transgressive sand dunes. Transgressive dunes are dunes that have been driven in the direction of the effective wind over any surface except mobile sands.

6.1.3 Low dune mobile sand-sheets

Low mobile dunes are generally less than 30 m above sea level and partially aligned to the prevailing onshore winds. Wind reworking the foredune and/or narrow beach ridges causes the landward migration of mobile sand-sheets.

Formation of low dune mobile sand-sheets is initiated where the stabilizing cover of vegetation on the foredune and beach ridges is damaged or destroyed. They are highly unstable with many active blowouts. Vegetation cover is sparse and insufficient to trap and hold sand blown from the beach.

6.2 Coastal Vegetation Present

The main vegetation present on the dunes includes marram grass, spinifex, and pingao.

6.2.1 Spinifex grass (*Spinifex sericeus*)

Spinifex grass is a native species and is common to the sand dunes around the coasts of New Zealand, Australia and New Caledonia. At Foxton Beach North it is generally found on the lower slopes of the frontal foredune.

It is identifiable by its rough or course grass appearance, silvery colour, and creeping runners that run down or across the dunes.

Other features include the large seedheads of radiating spikes (female, seed bearing inflorescence), which, once mature or ripe, blow free to roll about the beach until becoming lodged and releasing their seeds.. Spinifex also spreads by horizontal creeping runners which give out roots and side runners at each leaf junction.

Plate 4. Spinifex Grass on the front of the foredune.

6.2.2 Marram Grass

Marram grass is exotic to the New Zealand coastline and is the dominant vegetation on the inland dune system at Foxton Beach North. It is also present on the upper slopes of the foredune. Marram grass can be identified by its spiny postrate form and tends to grow in clumps. Its height varies according to the site and may extend to 1 metre. Marram grass spreads vegetatively by runners or by seed.

6.2.3 Pingao (*Desmoschoenus spiralis*)

Pingao is a native sand binding planting and was a prominent feature of New Zealand's dunelands. There are small isolated patches at Foxton Beach North and is mostly located either high up on the frontal foredune or immediately in behind the foredune.

Pingao is identifiable by tufts of course grass-like leaves which are of a golden colour and are borne on long, thick rope-like stems trailing across the dunes and is shown in Plate 5.

Plate 5. Pingao grass present at Foxton Beach North

6.2.4 Other sand association species

Other sand association species such as lupin, boxhorn, and numerous native species are also present and are located on the inland dune-sand plain system.

6.3 Ideal Foredune Characteristics

Stability research has shown that an ideal foredune has the following characteristics:

- The dominant seaward slope to achieve the maximum aerodynamics should be 1:5.
- The crest of the dune will be relatively flat in relation to its height.
- The land ward slope will be approximately 1:3.
- The dune will be completely vegetated.
- The dune is even longitudinally and contains no blowouts.

The objective of any reshaping program should aim to achieve the above characteristics.

6.4 Preferred Vegetation

The preferred primary sand stabilization vegetation for both the foredune and the inland environment are discussed below:

6.4.1 The Foredune Environment

Spinifex grass (*spinifex sericeus*) is the preferred primary stabilization plant on the foredune over marram grass. The primary reasons for this includes:

- Spinifex creates a lower more aerodynamic shaped dune system. Wind currents tend to pass over them in a less erosive laminar state. Marram vegetated dunes tend to create tall humocky dunes which are inherently prone to periodic blowouts if not managed correctly.
- Spinifex develops runners at the base of the seaward side of the foredune into the driftwood zone, where as marram will not. Hence spinifex dunes tend to build outwards rather than upwards as with marram grass.
- Spinifex vegetated dunes will generally recover more quickly from erosion by wave action due to the nature of their runners whereas marram vegetated dunes eroded by wave action often tend to form blowouts.
- Spinifex is endemic to New Zealand.

However the major problems with spinifex grass dunes is establishing them. Spinifex grass is very difficult and slow to establish manually when compared to marram grass. Spinifex is extremely sensitive to browsing animals such as rabbits and hares, especially during its establishment. The biggest problem with spinifex is its cost. Presently plants have to be sourced from outside commercial nurseries and last season the cost of planting material required for 1 hectare was around $12,000 when compared to marram grass, $2,500.

The Manawatu-Wanganui Regional Council is currently undertaking trials on establishing spinifex in this area and on how to improve the success rate. It is hoped that the results from these trials will reduce the cost of establishing spinifex.

Pingao as discussed earlier is also a good sand stabilizer of the upper and hind foredune slopes and inland dunes. It is however slow to establish and the current cost of the planting material needed for 1 hectare is similar to that of spinifex.

6.4.2 The Inland Dune Environment

Marram vegetated hind dunes are generally stable if (i) the foredune is stable and, (ii) the hind dune has a fertilizer and maintenance program. In the long term, complete stability will only be achieved through planting of secondary stabilizing species.

7.0 Stability Options

The primary objective of any management program adopted must be to eliminate the on-site and off-site problems associated with the instability of the area by primary stabilization methods. And to guarantee maximum long term benefit from these initial works, it is imperative that a secondary stabilization program is undertaken soon after the area is initially stabilized

At Foxton beach North the only option available for primary stabilizing the bare sand is intensive marram plantings. There are however a multitude of options possible for secondary stabilizing the area, and this report only outlines two. The first is a combination of protection and production forestry using the exotic species *C.macrocarpa* and *P.radiata*. The second option involves the establishment of a succession of native species from the foredune inland over the entire property. Each of these options is discussed in more detail in a latter section of the report.

Plate 6. A major sand drift flowing from Foxton Beach North into Sim's property

8.0 Recommended Program of Works

For a multitude of reasons total stabilization will not be achieved in one year. Therefore a stabilization program must be undertaken in the following sequence:

1. Establishment of a marram nursery
2. Stabilization of the foredune
3. Stabilization of inland dunes
4. Secondary stabilization program

It is however possible to undertake inland stabilization prior to completing the re-stabilization of the foredune. If this is undertaken it is imperative that the section of the foredune feeding the proposed inland dunes has been completely stabilized. Failure to do this will result in continued deposition of sand onto these inland areas, and with time these newly planted areas will become buried.

The highest priorities for any primary stabilization works must be:
1. stabilizing the three main sand blows flowing into Sim's property
2. blanking the plantings undertaken during the 1996 winter to enhance its stability

8.1 Marram Nursery Establishment

A small marram nursery was established during the 1996 winter on an area of high sand plain at the southern end of the property. It would be beneficial to undertake similar plantings on an annual basis to ensure the quality of material, guaranteed supply, the avoidance of paying royalties, and its convenience. It should also reduce costs. Generally a marram nursery requires minimal labour input during the year and is always planted on an area that requires stabilizing.

Often marram nurseries are sited on the flat leeward side of an inland dune that require stabilizing. This removes the need for stabilizing this area in the future. Ideally a marram nursery is best sited on a moist sand plain which is sheltered from the prevailing winds and is easily accessible under all conditions. At Foxton Beach North there are numerous suitable sites for such a marram nursery.

The area required is dictated by the amount of material required. One hectare of marram nursery should adequately supply enough planting material for approximately two to three hectares depending on the age of the material being pulled. Generally planting material is pulled after two years, however pulling may occur after only one year, but at lower yields. Obviously yields are improved immensely by fertilizing. It is recommended that at least one hectare of marram nursery is established annually.

In establishing the nursery the initial spacings should be 1m x 1m and absent of other vegetation. They should also be located where they will not be inundated with drifting sand.

The fertilizer program required for nursery establishment and maintenance is discussed in a latter section.

8.2 Stabilization of the Foredune

The areas of the foredune have been segregated according to the techniques needed to achieve stabilization. These segregated areas are shown on plate 5 and includes:

1. areas which require major reshaping,
2. areas of the foredune requiring rebuilding, and
3. areas that can undergo a maintenance program.

The methods required for stabilization include:

8.2.1 Foredune stabilization requiring major reshaping

Approximately 80 metres of foredune requires major mechanical reshaping. The estimated area in total is 0.5 hectares.

Typically, this area is characterized by:

- numerous blowouts present,
- the dune height is generally excessive,
- the slope of the windward side of the dune is excessive and encouraging erosive turbulent wind conditions,
- the vegetation present is inadequate and any fertilization program would not promote a complete vegetative cover in the long term, and
- there is sufficient sand present at the recognized areas to reshape the dune system to an ideal slope and shape.

The main objectives required when reshaping the foredune using machinery must be:

1. to achieve the ideal foredune characteristics as discussed earlier. This will ensure that the erosive nature of any winds are minimized especially during the period when the vegetation is becoming established.
2. A complete vegetation cover must be achieved as quickly as possible to ensure the long term stability of the area.
3. Where practical, any spinifex vegetation present on the front of the foredune must be retained if possible. The long term of any foredune management plan is to achieve a spinifex dominated dune system due its improved long term stability. Having spinifex partially present will enable this process to be quickened.

The reshaping process recommended includes:

1. Using D7 or D8 bulldozers the proposed area is reshaped by infilling the excessively high dunes into the blowouts immediately adjacent to them. The cost in reshaping increases exponentially as the distance of sand to be pushed increases. Also, often two bulldozers working in tandem will push 50% more sand than two bulldozers working separately.

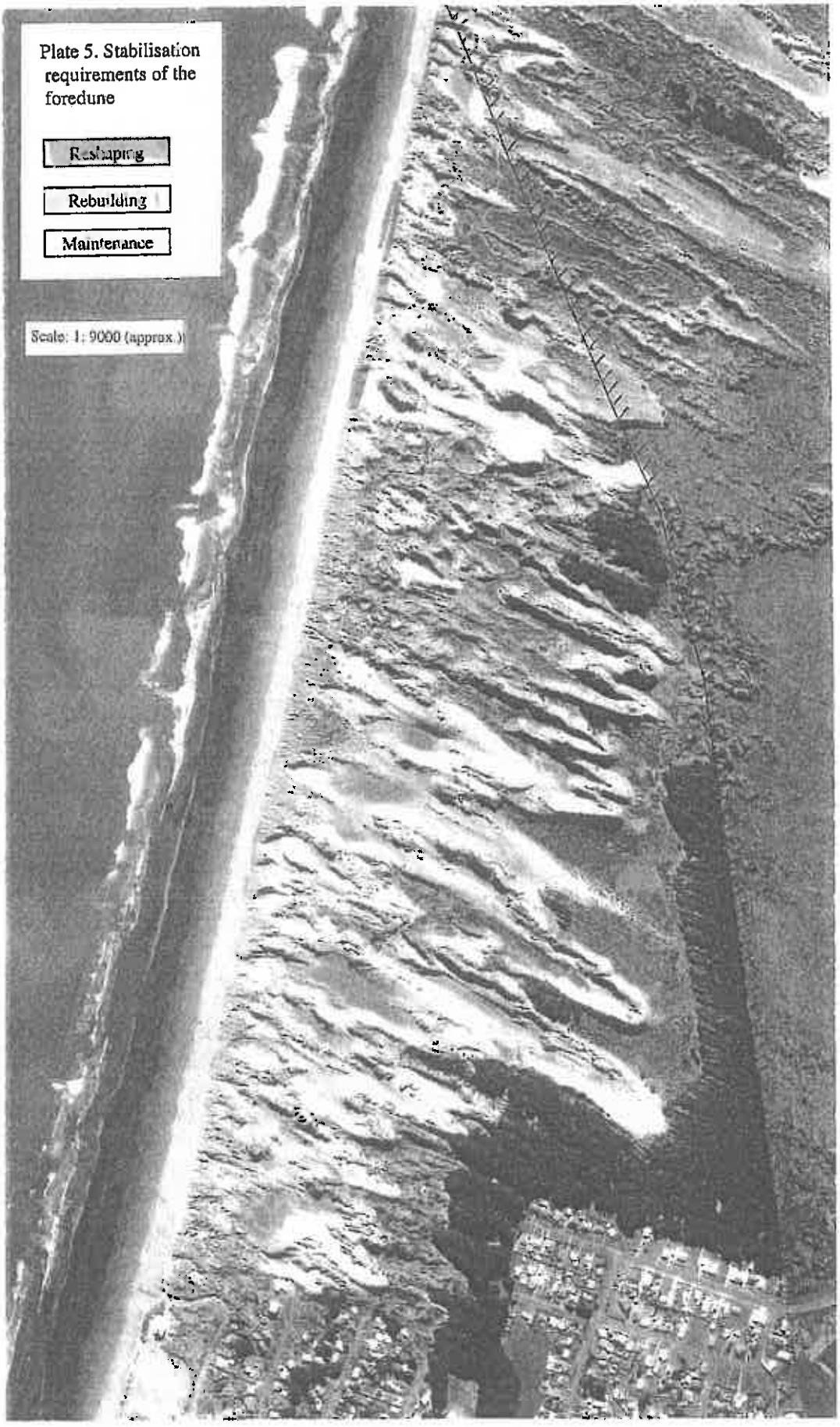
Plate 5. Stabilisation requirements of the foredune
Reshaping
Rebuilding
Maintenance
Scale: 1: 9000 (approx.)

2. Any reshaping must achieve slopes of 1:5 on the windward side of the foredune and 1:3 on the leeward side of the foredune. It is important that any changes in slope do not occur abruptly. Abrupt slope changes enhances the erosive native of the wind across that point.
3. All reshaping works should aim to be completed by mid June of any one year.
4. As soon as the area achieves the desired characteristics the planting program must commence. Using marram grass, it is planted across the slope at 80 cm spacings within the row. The distance between rows should be no more than 1 m. Marram planting must be completed by early to mid July to ensure adequate establishment is achieved prior to the strong spring winds and hot dry summers.
5. Any areas which fail to adequately establish must be blanked the following year.

Continuation of dune reshaping in subsequent years involves marrying in the new works with previous works using the same slopes and heights.

It is common to place a straw mulch between marram plants on the front of the foredune at the planting time. This practice enhances the establishment by providing protection for the marram plants, inhibits the erosion of sand from between the plants, provides organic matter and nutrients, and serves as a moisture reservoir for the marram during establishment. This practice however increases the cost of the job considerably and is usually only undertaken on areas where land or properties on the leeward side of the dune can not afford to be inundated with aeloin sand.

8.2.2 Foredune Rebuilding

Foredune rebuilding is required on approximately 475 m of foredune and involves an estimated area of 2 hectares.

Typically this area is:

- devoid of sufficient sand reserves for mechanical reshaping or the blowouts are presently small enough where some sort of sand trapping system would rebuild the area, and
- often there is spinifex grass present immediately adjacent on the seaward side of the blow-out.

The rebuilding process would involve:

1. The placement of brush material over the bare sand areas so as to prevent further erosion of this sand, and secondly act as a sand trap for sand coming from the beach.
2. On wide blowouts large logs can be placed across the blow-out and backed up with brush material. Together these will act as a sand trap. Often the sand does not build up initially on the logs but does often on the leeward side of the logs where a change of wind speed occurs. Hay bales placed across the blow-out in a solid barrier can also achieve similar results to the log placements. A semi-permeable barrier (50% permeability), such as a low slat timber fence or wind cloth, is often far more effective in trapping sand for rebuilding purposes. A semi-permeable barrier reduces the amount of wind flowing around the ends of the solid barrier. If

the wind flow is shifted to the ends of the barrier so is the point of erosion. The time period needed to achieve suitable sand deposition is dependent on a multitude of factors and several barriers may be required for the greatest effect.

3. The placement of brush material may need to be a continuous process until a small dune parallel to the coastline forms. Once this dune forms it should be planted using marram grass with rows running parallel to the coast line and planting spaces within the rows 80 cm apart. The distance between rows should not exceed 1.0 m. This vegetation will also serve as a sand trap and will be much more effective than just brush and logs. The planting must be completed between May and July to ensure good establishment prior to the spring winds and dry summer months.
4. All marram plantings must be fertilized to aid establishment.

Material suitable for brush includes prunings from pine trees. The laying of brush material involves the placement of branches in parallel rows across the main wind direction with the distance between barriers being no greater than 6 to 8 times the height of the brush barrier. Brush barriers are however very labour intensive but their construction may be undertaken at any time of the year.

8.2.3 Areas Requiring a Maintenance Program

The foredune presently requiring a maintenance program occurs on approximately 2250 m of foredune and involves an estimated area of 9 hectares.

These areas are typified generally by a complete vegetative cover and slope characteristics not dissimilar from the ideal situation discussed earlier. There are however some small non vegetated areas that if left will develop into major blowouts.

The recommended program for this area includes:

1. Immediate blanking of all bare sand areas using marram grass planted at 80 cm spacings. All plantings should be undertaken between May and July to enhance establishment.
2. The commencement of a maintenance fertilizer program at the rates discussed in a later section on fertilizer programs.
3. Some small blowouts within this area shown on the attached aerial photograph may require brushing prior to replanting. The purpose of this would be to create a uniform foredune for long term stability.

The fertilizer program for the foredune will, in the long run, ensure long term stability for the area. A fertilizer program promotes complete vegetation cover and therefore reduces the incidence of blow-out formations. Vegetation recovery is also quicker when the plants are healthy.

8.3 Inland Dunes

The inland dunes have been differentiated according to their current stability and require different management practices.

8.3.1 Inland Unstable Dunes

Inland unstable dunes occupies approximately 55 hectares of land. They are usually associated with immediately adjacent unstable foredunes, however there are several large areas further inland which are currently bare.

A recommended program for these areas includes:
1. Marram planting at 1.0 m x 1.0 m spacings over all exposed areas.
2. The introduction of a fertilizer program for new plantings at the rates discussed in a later section on fertilizer programs.

An inland dune should not be planted if the adjacent foredune feeding the dune is unstable. All planting must commence from the coastal end of the dune. The reason for this is to prevent the burial of future new inland plantings.

Some of these planted areas can be used for a marram nursery for future plantings.

8.3.2 Inland Stable Dunes

These areas are presently completely vegetated and to ensure the maintainment of the vegetative cover a maintenance fertilizer program should be undertaken. Eventually these areas will be planted using secondary stabilizing species.

8.4 Secondary Stability Program

A secondary stabilization program is essential to achieve long term stability for the area. Generally marram grass has a life expectancy of between 7 and 12 years depending on fertilizer and maintenance inputs. Marram tends to become 'woody' with age and prefers flowing sand over it for the regeneration of young material. A natural way of marram ensuring this is to become woody and die out causing further sand blows. Consequently primary stabilization has a limited life expectancy and to ensure long term stability of the area a secondary program must commence will in advance to marram becoming old and woody.

The inland secondary stabilization program may only commence once the foredune system protecting the inland dunes to be planted have been primary stabilized. Outlined below are two possible secondary stabilization options.

8.4.1 Option 1

This involves a combination of protection and production forestry.

The Protection Zone

A protection zone recommended must be between 100 and 120 metres wide and situated immediately behind the foredune for its complete length. The twelve rows should comprise of *C.macrocarpa* planted at 1800 stems per hectare (2.0m x 2.7m). The area immediately to the east of these plantings should comprise of approximately 32 rows of *P.radiata* planted at 1800 stems per hectare (2.0 m x 2.7 m).

The cost of establishing 1 km (which is equivalent to 12 hectares) of protection plantings is approximately $10,800 and includes the cost of seedlings, planting labour, pest spray at planting, and release spraying.

Production Forestry

Production species, such as *P.radiata* or *C.macrocarpa*, may be planted 2 to 3 years following the establishment of the protection zone. Both these species have been and are still being successfully grown at Waitarere and Santoft forests, and at Sextons property along the coast line.

The recommended stocking rate for planting is 1250 stems per hectare. This is generally high due to the level of rabbits and hares present. There will be some difficulty in establishing both these species on the wetter sand plains due to the frequently high water table. Generally these areas do not pose a serious erosion problem and could be left to naturally regenerate. Management of any commercial trees should be for a pruned log regime so as to optimize the potential returns of the block.

The advantage of *P.radiata* over *C.macrocarpa* is that the cost of seedlings are one third the price and maturity for harvest can be up to ten years sooner. However *C.macocarpa* is much more salt tolerant than *P.radiata*. The establishment of a protection zone between the coast line and the production forestry should however reduce the effects of salt laden winds. In terms of net returns, well managed P.radiata on 1997 prices should be in excess of $45,000 per hectare after 30 years. Similar returns can be expected from *C.macrocarpa* after 35 to 40 years. Also generally the costs of silvicultural works for a stand of macrocarpa is significantly more expensive than *P.radiata* due solely to the higher degree of branching.

The cost in establishing a crop of *P.radiata* and *C.macrocarpa* is approximately $650 and $1450 per hectare respectively. These figures include the cost of the seedlings, planting labour, pest spray at planting, and release spraying in the spring.

8.4.2 Option 2: Native Revegetation Program

Generally a native re-vegetation program would concentrate on one area at a time and must only commence in an area once it is primary stabilized with sand binding plants. A succession of species would be required to achieve the final secondary stabilization objective. Generally initial plantings of low shrubby species would be used as nurse crops for much taller species planted at a latter date. The planting density for natives varies considerably depending on the species used, as does the cost of planting material. The cost of native species planting material is however three to five times greater than that for *C.macrocarpa.*

Shrubby species which are already present in the area and would be suitable for a nurse crop include *Coprosma acerosa* (sand coprosma), *Pimelea arenaria* (sand daphne), *Cassinia leptophylla* (Tauhinu), and *Kunzea ericoides* (Kanuka). Species which can be planted within or between these nurse crops may include *Olearia paniculata* (Akiraho), *Phormium tenax* (coastal flax), *Coprosma repens* (taupata), *Cordyline australis* (cabbage tree), *Myoporum laetum* (ngaio), *Olearia avicenniaefolia* (akeake), *Podocarpus totara* (totara) etc.

9.0 Fertilizer Program

Coastal sand dunes have low levels of plant nutrients and are usually deficient in nitrogen, phosphorus and potassium. Fertilizer application will improve the establishment and growth of dune vegetation.

At Foxton Beach North the following fertilizer program is recommended:

9.1 Nursery

Successful marram nursery establishment and maintainment requires three fertilizer dressings annually as shown in the following table.

Timing	Rate (per hectare)
Spring (September/October)	• 10 kg phosphorus (usually applied as cropmaster at a rate of 65 kg per hectare) 50 kg nitrogen (usually applied as 100 kg of urea and the remaining nitrogen coming from the cropmaster)
Early Autumn (March)	• 10 kg phosphorus (usually applied as cropmaster at a rate of 65 kg). • 25 kg nitrogen (usually applied as urea at rate of 40 kg with the remaining nitrogen coming from the cropmaster).
3-4 weeks prior to pulling (May)	• 25 kg nitrogen (usually applied as 55 kg of urea)

Fertilizing a marram nursery can easily be undertaken by hand and the timing should be in conjunction with light rain.

9.2 For Establishing Complete Vegetation Cover

The annual fertilizer requirements for the establishment of vegetation are as follows:

1. 100 kg nitrogen per hectare split evenly into two or three dressings. The first dressing should be applied at planting, the second at the start of the spring, and the third during the autumn. Once the vegetation is established, two dressings (spring and autumn) will be sufficient. Nitrogen is usually applied as urea, ammonium sulphate or calimonium nitrate. The reason multiple dressings are required is that

nitrogen is extremely easily leached. Slow release forms of nitrogenous fertilizer can be used however they are much more expensive.

2. Phosphorus fertilizer should be applied at a rate of 20 kg P per hectare per year as a single application at planting and then re-applied at the start of the growing season (spring). Phosphorus is usually applied as superphosphate or cropmaster.
3. Potassium requirements should be satisfied by the amount of K present in superphoshate or cropmaster.

9.3 Maintenance Fertilizer Requirements Once Complete Vegetation Cover Achieved

Maintaining an annual fertilizer program once the vegetative cover becomes established is the most effective method of retaining long term stability of the dune system. Retaining a vegetative cover reduces the need for extensive planting programs, or at worst expensive reshaping. It is therefore recommended that the following maintenance fertilizer program be adopted:

One dressing applied in the spring containing 80 kg of nitrogen, 20 kg phosphorus, and 15 kg of potassium. The phosphorus and potassium would normally be applied as superphosphate or cropmaster while the remaining nitrogen would be applied as either urea or ammonium sulphate.

It is recommended that only the dune areas are fertilized. Generally the sand plains pose less of a problem if they become devoid of vegetation. In the past it has been found that the most efficient and effective method of applying all fertilizer requirements has been by helicopter.

10.0 Maintenance Program

A annual maintenance program must include the following:

1. A maintenance fertilizer program as discussed earlier.
2. Annual marram blanking of bare exposed areas of sand.
3. Minor reshaping (in the planting season) of the toe of foredune as blowouts occur.
4. If blowouts occur out of the planting season, these areas can be immediately mulch covered to prevent the erosion intensifying and replanting the next planting season.
5. A blanking program for the secondary stabilizing species.

11.0 Other Considerations

Two other issues must be considered when developing a management plan and include vehicle traffic and resource consent requirements.

11.1 Vehicle traffic

Motor bikes and dune buggies are causing severe detrimental damage to the vegetation along the coastal system. If the area at Foxton Beach North is to be stabilized then:

- Vehicle traffic in this area should be prohibited especially during the primary stabilization phase and the initial secondary stabilization phase. If this is not possible they must be restricted only to the sand plains and specific tracks over selected parts of certain dunes.
- Vehicles must be totally prohibited from the foredune. No exceptions. This area is the primary defence or protection area and its vegetation is extremely sensitive.
- It is recommended that vehicles using any land administered by the Horowhenua District Council should be registered with the council and display an identification number. The purpose of this is for easy identification of those vehicles causing adverse effects on areas they are not permitted.

11.2 Resource Consent

Any mechanical reshaping of the foredune will require a land resource consent from the Regional Council under their Transitional Regional Plan.

12.0 Recommendations

It is recommended that the Horowhenua District Council:

- recognize that the area at Foxton Beach North is significant and the resource is not being utilized to its full potential
- recognize the on and off site effects occurring from the current instability problems
- recognize the need for a long term management plan for the reserve and that any management plan deals with the current instability of the area
- recognize the need for a systematic approach for achieving stability of the area, and the importance of a fertilizer and maintenance and secondary stabilization programs

It is appreciated that the stability works outlined in this report can not be achieved over one or two years but require a number of years.

Lachlan Grant

Soil Conservator

Manawatu-Wanganui Regional Council

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