GOLF COURSE DESIGN

A major design study submitted in part fulfilment of the requirements for the Diploma in Landscape Architecture at Lincoln College, University of Canterbury

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"Golf is deceptively simple and endlessly complicated. A child can play it well and a grown man can never master it. Any single round of it is full of unexpected triumphs and perfect shots that end in disaster. It is almost a science, yet it is a puzzle without an answer. It is gratifying and tantalising, precise and unpredictable; it requires complete concentration and total relaxation. It satisfies the soul and frustrates the intellect. It is at the same time rewarding and maddening - and it is without doubt the greatest game mankind has ever invented."  - Arnold Palmer
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OBJECTIVES
1. To investigate the design of golf courses.

2. Use these research findings to develop a design proposal of a private 18-hole championship golf course for a specific site.
METHOD
Fulfilling the intended objectives of developing a design proposal for an 18 hole championship golf course, involves several stages of investigation. It is intended, firstly, to research the physical requirements and criteria for golf courses, especially those of a championship standard, and this knowledge will be essential for developing the design programme.

A specific site has been chosen by intuitive means (shape, size, location and terrain were considered suitable) in which to impose a design upon. It is not of critical importance to select the "ideal" site for a golf course because considerable change of the site can take place with excavation, tree planting and artificial control of the water and soil. By these means a site considered almost unsuitable initially, can be transformed into a functional and successful golf course. An investigation of the physical, cultural and visual factors of the site will be undertaken so as to become aware of the existing character of the site and its environs. These factors will be evaluated in terms of the site's projected use. A design will follow from the evaluation whereby information will be synthesised so as to determine
the location of elements on the golf course. A refinement of the programme will lead to a detailed design proposal of the 18 holes and clubhouse complex.
The game of golf consists of playing a ball from the teeing ground into a hole by successive strokes in accordance with the rules. It is a game played world wide by people of all ages, and nationalities, watched - indirectly, for many, and provides a source of income for a privileged few. It brings enjoyment and elation to those who master its skills yet frustration and exasperation to so many.

Golf is such a complex game and success is not just achieved by practice, experience, a knowledge of the game and natural aptitude. Self discipline, temperament, mental attitude, diligence and courage are all factors which combine to form an important part in the makeup of a successful golfer.

The basic items used to play golf with are clubs and balls. The rules of golf limit the number of clubs a player may carry on any round to 14, although a set sufficient for normal play will include only eight.

There are two main types of clubs, known as "woods" and "irons". Four woods and nine irons all graduated in loft, a sand wedge for chipping out of bunkers, a pitching wedge for approaches onto the green, and a putter for greens comprise the golfer's set of clubs. The
degree of loft of the club face of woods and irons varies progressively from about $11^\circ$ on the number one wood to $59^\circ$ on the sand wedge.²

There are two types of ball in general use - the traditional British ball with a diameter of 41 mm and the slightly larger American ball which is reputed to induce a higher standard of play. For the average golfer however, he will notice little difference between the two balls. The ball itself is hard and elastic, owing this quality to its composition, and is normally white although it has been known that fanatics have used dark balls in snow conditions!

The tee is a necessary item of equipment. It is a small plastic or wooden support on which the ball is placed prior to playing it from the teeing ground (also known as the tee) and is coloured so that it can be easily recovered after the ball is played.

These items - clubs, balls and tees - are carried around the course in a large bag and it is normal to place this bag on a two-wheeled trolley.

Players wear spiked shoes to give better support during their swing and a right-handed player will wear a glove on his left hand for better grip of his club. Other items he may carry in his bag are towels, rags, rule books.
and wet weather gear.

The basic technique of the game is quite simple - to stand still and hit a stationary ball in a chosen direction. However, the execution of this task is quite difficult because so many variables are involved, and perfection (ability to play a course in par figures) is often never attained by many who have played the game throughout their life.

Clubs are designed to fit particular situations in which a golfer may find himself, but the flight of the ball depends on the manner in which it is struck. It is the action of the golfer which determines the success of his shot.

REFERENCES

2. Tyler, M. pp 23.
GOLF COURSE DEVELOPMENT
1. AN HISTORICAL ACCOUNT
The origins of golf are misty. Many believe that the game began on ice in Holland and that it transmigrated across to Scotland where round pebbles and sandy wasteland were used instead of picks and ice. The other theory propounded is that the game originated along the coast of Scotland. Perhaps golf evolved in two different places simultaneously - one will never know.

The first official evidence that golf was played in Britain comes from Scotland where, in 1457, a statute prohibited the exercise of golf on the grounds that it was interfering with the practice of archery. For such a step to have taken place the game must have had a firm foothold in Scotland as early as the beginning of the 15th Century. It was not until the 16th Century that the first formal course, St Andrews in Scotland, came into existence, thus being recognised as the home of golf. Mary Queen of Scots is even reported to have played there in 1563, and then later her son, James I, took the game to Blackheath.

The original sites chosen for the game were on linksland by the sea. This was a strip of sandy wasteland, fashioned into numerous furrows and ridges during a receding sea after the last ice
age. Courses such as St Andrews, Prestwick, Carnoustie and Dornoch were imposed on this land and it was from these that golf courses throughout the world have evolved. Even today these courses are models for newly designed ones.¹

On these linksland courses of Scotland, and later Ireland, little needed to be done to establish and practise the sport except for the purpose of teeing off and holing out*. There were certainly no fairways*, greens and tees as we know of today. This allowed for limitless opportunity to make up rules as play progressed from one spot to another, players hitting their pellets across sandy wasteland and then holing out in some smoothed and tidy hollow. "It was like playing across country with no main thoroughfare. The player had to use his own judgement without the aid of guide posts or other adventurous means of finding his way in order to complete a round".²

The rugged expanse of a typical links course on the Scottish coast
These courses were maintained by Nature - fertilized by seagulls, sown by windborne grass seeds and mown by rabbits.

During the 19th Century golf courses became somewhat more refined and included the siting of 18 teeing grounds and greens throughout the round.

It was not until the mid 1850's that the game became popular in England, to be located only on the heathland around London. No problem was encountered with this land which was superbly drained and easy to contour. 1888 saw the first club in the United States opened, that of St Andrews, New York. It was C.B. MacDonald, a Scotsman, who was instrumental in promoting and developing the game in the United States as well as creating the first course of real quality, the National Golf Links, New York.

The profession of golf course architecture developed around the turn of the Century to cope with the demand for golf courses. This attracted men like George Crump (Pine Valley), A.W. Tillinghurst, and Alister MacKenzie (Augusta National), who knew and understood links golf and had acquired the ability of adapting the principles of early architectural intentions to inland sites. They were concerned with the value of good drainage, the virtues of suitable...
grasses, the subtleties of green size in relation to the approach shot, as well as the building of holes* that made no secrets of hazards.

Significant changes in course architecture and equipment design took place in the game during the 1920's. The transition from hickory to steel shafts was quite dramatic in terms of results, as the club now became more rigid, and a greater distance was achieved hitting the ball. This was of great importance to the weak player who now needed less artistry and improvisation for fashioning his shots. Course architecture kept pace, if not ahead of the advances in equipment. The architects now incorporated new design features and gained a sound knowledge of the technical problems of construction and maintenance. The greens became sculptured, angled, tilted, baits were held out to the player, decisions forced and boldness encouraged. This then was the beginning of the development of modern golf course architecture, especially in the United States and Pacific areas.

As a result of the rapid increase in the number of courses required and the rise in land value during the 1950's, new construction skills and techniques evolved to cope with the demands of trans-
forming normally unsuitable land into land fit for golf. Although some of the results were disastrous, many splendid settings were created throughout the world. Water has become a dominant feature in the design, especially around the green, fairway bunkers have become staggered, and the length of the course has increased.\(^4\)

Throughout this modern era the contribution of the architects who have built courses of worth, has remained with the principles of those original architects, while adding their own individual imprint. Today, the design of a golf course has become a very specialised field and as a result the golf course architect performs a specific function. To create an outstanding golf course is a complicated process requiring a great deal of understanding and knowledge.

2. IN NEW ZEALAND

New Zealand, despite producing many exceptional golfers, has no course which by world standards could be ranked as first class. From the game's introduction into this country in 1871, the normal length of a course was
around the 5680 m (6000 yds) vicinity, accommodated within an area of 40 ha (100 acres). With the introduction of the steel shafted clubs the course length was stretched to 6000 m (6500 yds) for men and 5680 m (6000 yds) for women. Not only did the short nature of the courses contribute to their inadequacy in terms of world standards but the location of most courses was established on rich pastoral land rather than utilizing the abundant belts of seaside linksland.

Owing to strong Scottish and English ancestral traits in Dunedin and Christchurch, the first golf courses were developed in these two centres. This was in the early 1870's, but shortly afterwards the game had languished somewhat. Towards the end of the century, Christchurch and Hutt clubs had been established and this was the real beginning of the popularity of golf in this country.

There are some 370 golf courses throughout New Zealand and it would suffice to mention but two. Wairakei is one of the few courses in the country designed by a professional golf course architect. Set on 80 ha (200 acres) of rolling country excellent use was made of the natural features
and a sympathetic handling of the terrain was achieved in creating this an attractive and challenging course. It is a course which provides real length for championships, 6310 m (6900 yds) par 72.

A true linksland course is that of Paraparaumu, one which Gary Player said was "authentically great". Built in 1930, the minimum land that could be afforded at the time - 52 ha (130 acres) - it is a fine course but at 5945 m (6500 yds) it is now too small, the victim of a shoe-string type complex which has typified golf course development in New Zealand.

Although its length is short, it is the element of wind, both force and direction, that provides a testing time for any talented golfer. Natural, undulating fairways and carefully constructed tees and sand traps makes this course similar to those on the Scottish coasts. 6

REFERENCES
THE CHAMPIONSHIP COURSE
The planning aim of any course is to provide for a test of a golfer's playing skill as well as making it an enjoyable experience for him. It is no use creating a flat, featureless 5000 m course if there are no challenging and demanding situations to play. Nor for that matter is it worth creating a steep, rugged, vast course plagued with hazards that create nothing but frustrations for the very best of golfers. The golfer will quickly become bored or dissatisfied and go elsewhere. The course must therefore be stimulating enough for players to improve their game and yet remain interesting to play.

A course that can host major championship tournaments requires certain elements that a good average rural or municipal course does not have. Although such a course provides for the professional and scratch handicapped*, it is not devoid of the necessities for the average golfer. Therefore, different standards are catered for on a course capable of holding championship tournaments. For example, teeing grounds at distances suitable for mens, ladies and championship play, which creates hole lengths for players of varying ability - keeping the professional in check, rewarding the clever meritorious player, as well as suiting the average player.
It is important to realise that the average player is the mainstay of the game. He is the one who supports the club in daily activities, pays membership dues and organises and helps develop the club, and must be afforded pleasure in playing his course.

There is a combination of factors that increases the standards of a course, making it capable of supporting tournaments that have top-ranked players competing. The competitors must be faced with a variety of problems, inherent in the course design, that will test every type of shot - long accurate tee shots, accurate iron play, precise handling of the short game, and consistent putting. These abilities should be called for in a proportion that will not permit him to achieve a standard of excellence in any one of these departments, yet not offset deficiencies in another. Penalties should not be unduly severe, nor of the nature that will prohibit a full recovery by the execution of a well placed shot.

Sufficient length throughout the entire course is an essential requirement in today's game. Usually, nothing under 6130 m (6700 yds) is a test of adequate distance. Both physical and mental exercise are to be called
for - stamina, patience, daring
and resolve. For visual and
therapeutic reasons an element
of beauty is to be present,
whether it be natural or man-made.

It is so important that the course
provides the golfer with a lasting
memory in terms of challenge and
interest.
PHYSICAL REQUIREMENTS FOR GOLF COURSE DESIGN
1. THE SITE

It is desirable for the development of a golf course that the site contains natural features such as undulations, low rolling hills, wide valleys and level areas, and that these can be maintained and utilized as part of the design. It is certainly an advantage to work with a piece of ground that has these natural features, but it is not always possible. Flat and featureless sites can still provide the qualities necessary for strategy, interest and variety, it only means that the character is created by judicious variation within length of holes.¹

The course should be so planned and constructed that the fullest use is made of the land available. The plan must aim to secure the utmost practical advantage in use while employing all those features of the site most likely to produce pleasure and interest to the player.

Size

The area one selects is fundamental to the design of the course as well as its playing success. Below 40 ha (100 acres) for an 18-hole course is a severe handicap as length, interest and safety margins tend to drop below desirable standards.
An increase in size leads to better planning, separation of holes, avoidance of wet and barren land and provision for practice areas can be made. Fortyeight hectares (120 acres) is considered the minimum size of an average length course. The advisable size for an 18-hole championship course is about 65 ha (160 acres) which allows for spacious development for the course and its accompanying facilities.²

Topography

"The best golf courses are those, the holes of which have been designed and constructed to conform to the character of the ground at one's disposal."³

This was the advice given by the celebrated golf architect Dr Alister MacKenzie, whose underlying principle was to maintain and use the existing topography whenever possible. The natural ground contours dictate the play as well as making for natural hazards. It is therefore of vital importance for flat sites to use any undulations, hillocks and depressions that can be incorporated as a design element.

Shape

There is no one correct shape for the site of a golf course and normally it is a matter of incorporating a course
within a set boundary. The ideal form advocated is that of a clover leaf, i.e., three groups of six holes radiating around the clubhouse which is on an elevated piece of ground. This creates a triangular system and means no two consecutive holes are played with or against the same wind (Fig. 1).

However, this is rarely practicable, especially if the site is elongated, and the more usual system is to have two loops of nine holes. This allows for two starting points which is an essential criteria for tournament play.
Accessibility

The golf course should be located close enough to a main access route and distant enough for the club to maintain a certain amount of privacy. The club's adjoining road should be one of good condition to tolerate heavy and wet weather traffic and cars should be channelled by adequate road marking.

The road should terminate in the club's car park, large enough to hold all cars on a normal club day and provision must be made for the overflow of cars during tournaments.

A notice at the entrance to the club's access road should exist, so as to reveal the club's location.

Soil

Good turf is a basic requirement for the successful golf course, influencing playing conditions, visual quality and maintenance expenditure. Light sandy loam or medium soil is best for turf culture, although it is possible to grow acceptable turf on virtually any soil provided improvements can be effected to its texture and chemical properties. Soil requirements for good turf culture are:

- 200-300 mm of top soil of a light sandy loam quality
- well drained, especially as
the sport is primarily played in winter
- subsoil capable of moisture retention
- well aerated
- capable of supporting wear and tear
- composition comprising a small percentage of silt or clay
- reasonably fertile (a highly fertile soil is undesirable)
- pH between 4.8 - 5.3.

2. LAYOUT

**Total length**

A good course length for the average golfer is 5760 m (6300 yds). The length of a championship course usually ranges from 6130 m (6700 yds) to 6400 m (7000 yds). There are exceptions; Merion, reputed to be one of the toughest championship courses in the United States is only 5984 m (6544 yds), and the renowned Cypress Point course is 5910 m (6464 yds). Carnoustie (Scotland) on the other hand, is 6493 m (7101 yds), while Champions (USA) is a vast 6550 m (7164 yds).

The length of the course for ladies is in the vicinity of 5490 m (6000 yds) to 5800 m (6400 yds).

The majority of courses built today try to achieve a total length of about 6400 m (7000 yds), yet the difficulty of a course is not always correlated with its length, because it should take skill and guile to achieve
success on the golf course and it is not just a matter of strength.

**Composition**

A championship course usually has a par* of either 70, 71 or 72 (occasionally 69 or 73, but rarely). Today, par 72 has become the accepted standard in the minds of golfers, developers and architects because it provides for a balance of different par holes in each half of the round.

Although this has become the accepted norm, it must be stressed that the size and natural characteristics of a site determine what the total par should be. It may be that a shorter par 70 course is better than a forced par 72 because it is more demanding and natural.

The 18 holes of the course comprise a combination of par 3's, 4's and 5's, the sum of which equals the total par length.

Possible mixes for the total par of courses:

- Par 70:
  - 6 par 3's or 4 par 3's
  - 8 par 4's
  - 12 par 4's
  - 4 par 5's
  - 2 par 5's

- Par 71:
  - 5 par 3's or 5 par 3's
  - 9 par 4's
  - 10 par 4's
  - 4 par 5's
  - 3 par 5's

- Par 72:
  - 4 par 3's or 3 par 3's
  - 10 par 4's
  - 12 par 4's
  - 4 par 5's
  - 3 par 5's
Different length of golf holes in relation to par

Fig 2

par 73: 4 par 3's
9 par 4's
5 par 5's

Length of holes

The length of the hole will be determined by:
- slope of the terrain
- direction of play
- natural features from tee to green
- the desire to obtain a variety of lengths throughout the course.

The United States Golf Association has computed the distance for par 3, 4 and 5 holes as follows:

(Fig. 2)
Men:

- up to 229 m (250 yds) 3
- 230 m (251 yds) to
  - 429 m (470 yds) 4
- 430 m (471 yds) and over 5

Women:

- up to 192 m (210 yds) 3
- 193 m (211 yds) to
  - 366 m (400 yds) 4
- 367 m (401 yds) and over 5

Such distances are generally accepted, although there are exceptions occurring as at Champions course in the United States where the distance for a par 4 hole is 497 m (544 yds).

Length of holes between 210 m (230 yds) and 302 m (330 yds) are to be avoided as this is "no man's land", where the distance is an extremely difficult par 3 yet an easy par 4. Sometimes a hole in this category is often inevitable on restricted sites and if designed in a provocative manner it may achieve distinction.

Generally, the short holes range from 119 m (130 yds) to 192 m (210 yds), par 4 holes from 311 m (340 yds) to 421 m (460 yds), and with par 5 holes the distance is anything over 421 m (460 yds) and no longer than 558 m (610 yds).

The length should vary within the par 3, par 4 and par 5 holes. If the first nine holes have two par 3 holes then the shorter one could measure 119 m (130 yds) to 146 m (160 yds), thus requir-
ing an exacting four or five iron from the tee. The other short hole could be 164 m (180 yds) or more and capable of being reached with a long iron or wood.

The two par 5's should also vary; one being around the 439 m (480 yds) mark and the other 475-503 m (520-550 yds). Both distances require two full wood shots and well hit iron approaches.

The par 4 holes should begin with a distance of around 311 m (340 yds) and grade up in stages to an upper limit of 430 m (470 yds). This creates variety for the golfer and he is called upon to hit approach shots with different clubs.

The same type of structuring of hole length can take place on the second nine holes.

Distribution and layout of the holes

Although there is no stereotype distribution of hole length throughout a course, the aim is to contrive a range of holes that would test every club in the player's bag, and to provide the golfer with a variance in length, character and direction.

It is common to have a first hole that is a relatively easy par 4 of no more than 347 m (380 yds) to 366 m (400 yds) in length and one that is comparatively free of hazards and delaying features.
Heavy rough where the ball might get lost is not desirable. It is important that the hole be conducive for getting the golfers started off on their games as expeditiously as possible.

As the round proceeds, the holes should grow increasingly difficult. It is unreasonable for a golfer to execute difficult shots in the early stages of a round because he is not properly warmed up in his stroke making. In the latter part of the first nine holes there should be a predominance of par 5's which should create a testing finish.

The first and second nine holes should balance each other approximately in distance.

If the shape of the course is two loops of nine holes it is desirable to have the first nine holes ending at the club house. This means that the 1st and 10th tees, and 9th and 18th greens are located immediately adjacent to the club house. It allows for two starting points in competitions as well as the final hole close to spectators.

A problem encountered with two starting points is that congestion can often occur on the course. If a foursome started early in the day on the No. 1 tee and just before completing the first nine holes another began at the No. 10 tee, this would delay the progress of the early group.
of players.

The actual distribution of par 3, par 4 and par 5 holes must be considered. For a par 72 course the following proposal might be adhered to:
There are four par 3's, ten par 4's and four par 5's.

Par 3 hole distribution:
- the first two holes in the round should not be par 3 nor the last two
- they should be played in four different directions
- the longest could be played into the prevailing wind
- the four holes should be spread throughout the course, two in each half of nine holes
- there should never be consecutive par 3 holes
- the distance should be kept around or under the 183 m (200 yds) mark which gives every golfer the opportunity to reach the green with a good shot and thereby obtain his par or birdie
- a short hole could be 132 m (145 yds); medium to short 150 m (165 yds); medium to long 170 m (185 yds); long 200 m (220 yds). 8

The long and the short ones would be in one half and the medium par 3's in the other.

Par 4 hole distribution:
- the strength of the golf course
rests with the par 4 holes, and it is these holes which offer opportunity to develop good strategy.
- three holes could be long and hard, around 402 m (440 yds)
- four could be medium length 356-393 m (390-430 yds)
- three could be short holes 320-393 m (350-390 yds)
- balance is the important criteria for par 4's, and not to have ten holes around the same length.

Par 5 hole distribution:
- never have two consecutive long par 5 holes
- long par 5's must be interesting
- three of these holes could be holes which entice the golfer to play for the green on his second shot, and therefore the length would not be much greater than a par 4.

There would be one hole of at least 550 m (600 yds). This may prove a satisfactory programme to follow if the ground level is flat and there are few design constraints. However, it must be stressed that the distribution of hole length throughout the course should be governed by the existing topography. This may cause an imbalance of par 3, 4 and 5's in each of the nine holes, but if well designed holes are achieved then it is to the advantage of the club and the player himself.
Direction of holes

An east-west direction of holes is to be avoided where practicable because a large percentage of play is in the afternoon and a player finds it difficult and disagreeable to follow the ball's flight into the setting sun. If possible the angle of the sun should be over the player's right hand shoulder if the holes are coming from west to east (Fig. 3). Should this be impracticable, the location of such holes must be in the early part of the round.

There should be as few closely parallel holes as possible; crossing lines of play is certainly not advocated from a safety viewpoint, and as few consecutive holes as possible in the same direction.

At Muirfield, Scotland, only once do three successive holes pursue the same direction, forcing the golfer to play the wind from all quarters. The golfer thus is never bored by having the wind against or behind him for long spells, but he must take heed of its changing angle of approaches (Fig. 4).
Fig 4

Dog-leg holes provide a change in direction and avoid the monotony of a sequence of straightaway holes. This is especially important for par 5 holes.

Generally, it is important that variation in the direction of holes occurs throughout the course so as to avoid repetition and to test the golfer's skill against the elements.

3. GOLF HOLE ARCHITECTURE

There are three golf hole styles which are used in the layout of a course: penal, strategic and heroic. 10

(a) The "penal" hole. The hole is marked by numerous hazards which are unfairly placed in relation to the playing ability of the average inconsistent golfers. If the golfer makes an ill-executed shot he will be punished by being trapped in a hazard. The only way to avoid such punishment is to hit all shots straight, true, and in many cases, long. The majority of holes on the earliest courses were penal in nature, but today one or two holes of this type
are usually sufficient in composition and should be "short" or "drive and pitch" holes (Fig. 5).

(b) The "strategic" hole. This is designed so that a golfer can hit with his full power but must place his shots to obtain the most favourable results. Poorly played or slightly errant shots are not severely punished but it leads invariably to a false position which places the player at a disadvantage. Hazards are located in fairways and around greens in such a manner that if a golfer takes the risk with his tee shot and succeeds he will be rewarded with an easier shot to the green. Holes today follow the "strategic" hole principle which adapts itself best to holes of 365 m (400 yds) and over (Fig. 6).
Solid line: traps adjacent to the fairway force the conservative golfer to play safe to the left and away from trouble, but then is forced to play over traps adjacent to the green.

Dotted line: The most daring golfer plays his drive to the right, flirting with trouble. If his shot stays close to, although out of, the trap, he is rewarded by an easier approach shot to the green which is not guarded by a trap in front.

There is a big reward for the long shot (dotted) but promises almost certain disaster if the shot is not perfectly executed. A safer alternative (solid) is available, although at the expense of an extra stroke.
(c) The "heroic" hole. This hole is a blend of strategic and penal design and possesses alternate routes of attack with one generally much more difficult than the other. If the player successfully executes his shot over the more difficult route he is rewarded with an advantageous position for the next shot. This type of architecture is adapted to all length holes (Fig. 7).

4. ELEMENTS OF THE GOLF COURSE

(a) Teeing Ground

Teeing grounds should be located as close as possible to the preceding green. However, the requirements of the plan and the need for good individual holes could possibly override this consideration. The distance from the last green to the next tee is never any more than 75 m (80 yds) and a recommended distance is 20 to 30 m. A distance of less than 20 m is not desirable owing to the danger of being hit by an approaching golf ball, and the creation of a bottleneck.
Teeing grounds are of an elevated nature so as to give height to the drive and rectangular in shape. The size of the teeing ground varies considerably depending mainly on the length of the hole, terrain, available space and maintenance costs. Essentially they should be of an adequate area to distribute wear. On the average, tees are at least 250-350 m² in area for long holes and 350-450 m² for short holes. This will enable the green keeper to maintain the tees in good condition even under heavy playing conditions. The surface of the tees must be level.
Long tees permit adjustment to the lengths of the holes and ample width will provide for several changes at the same distance. The external slopes of the tee should be gradual, not only for maintenance purposes but for the visual appearance. Sloping sides reduce the formality of teeing grounds. Often there is considerable variation in the run of the ball between winter and summer play. It is possible to equate the playing value of holes throughout the year by having two or three teeing grounds, placed so that tee markers may be moved forward for winter play and backward for summer. This is especially the case for par 4 holes. Alternative teeing grounds result in the reduction of wear and tear on the turf, and enables variation in the angle of the tee shot.

For championship purposes, back teeing grounds are a necessity in order that the distances of some holes may be lengthened.

No room for error with the shot from this championship tee
If there are several tees providing for different standards of players, those can be linked together in a random manner to offer a natural form on the landscape.

Essential to the teeing ground is good drainage, and for this reason the ground should be pitched slightly toward the back. A 1-2% fall for surface drainage is recommended.

Except for dog-leg holes, it is desirable to see the flag from the tee.

Tee markers, seats, ball cleaners and shelter huts are items which complete the teeing ground area.

(b) Putting greens

The green is the ultimate target in the game and the most influential part of the course on the golfer's score. Its actual siting is an important factor of hole design and where possible, should be visible from the approach shot, especially for par 3 holes.

The shape of the green should not be formal, round or square. Generally, they are pear shaped. The size and shape depends to a large extent on the internal design derived from the situation, the strategy of the hole, the length and type of approach shot and the degree of expected use. Usually the green is larger for
shorter holes, although the normal size is between 418 m$^2$ (4500 sq ft) - 790 m$^2$ (8500 sq ft).\textsuperscript{12} This allows for three or four pin placements, reducing turf damage from concentrated traffic. There must be sufficient flat ground lying within the putting space and the ground should be dead level at the point near where the hole is cut for at least one metre on every side. Generally, about 75\% of the whole green should be flat.\textsuperscript{13} The surface must be well drained, receptive to well struck shots and firm, fast and true. It is desirable to have a tilt on the green, preferably from front to back as a design element and for drainage purposes. This slope should not exceed 5\%, although 3\% is more acceptable.\textsuperscript{14}

An elevated putting green

Putting green contained by trees, bunker and a slight rise to the back of the green.
If a green is entirely flat and devoid of character it is important to introduce undulations and contouring. This should relate well to the scheme of play, never be too extensive or so acute that maintenance problems occur, and should not produce great difficulty in reading the green.

All undulations of the green and contours of the shoulders must be mild enough so that no danger of scalping the grass with mowers occurs. The back and side slopes are to be carried out sufficiently far to permit machine mowing.

Entrance to the green should have a width of about 20 m.

Balancing of the green by contouring and bunkers is to be avoided. Placement of the bunkers around the green helps to define the size of the target area, thus intensifying the accuracy of the approach shot. However, they should not assist the player and framing the green with five or more bunkers is not advocated. It is better to have three bunkers, leaving one side of the green unprotected, so as to confront the golfer with the unexpected.

The function of bunkers is not only to act as a means of deception but to set off the shape and character of the green.

Well contoured ground to the entrance and side of the green can replace the usual bunkers.
by acting to deflect any mis-hit approach shot away from the putting surface.

Green guarding bunkers

There should not be two similar greens on the same course as each must have its individual characteristics.

Items associated with the green consist of well painted flagsticks set true in the hole,
brightly coloured flags (yellow is most easily visible), and aluminium putting caps.

Tight placement of bunkers across the front of the green. The aisles between each require hand maintenance but reduce walking in traps. Elevation of green and elimination of underbrush facilitate water and air drainage.
There is a wide opening to this green if the shot is properly placed to the right. The trap to the back catches a shot too strongly played.

(c) Fairways

"The fairways are the regulation routes to the greens".\(^{15}\)

For long holes there may be a choice of alternative routes according to the distance that a player is able to command by power of his shot (Fig. 8).

It is desirable to provide interest with undulating land because entirely flat fairways create monotony in the game. One of the main charms of the best seaside links is the undulating fairways where the
ground is a continual roll. Undulations that are introduced must conform in a natural manner to the already existing contours. Fairways that slope directly up or down a hillside are not good because this type of terrain is unduly fatiguing to golfers and the turf is difficult to maintain.

Fairway width is between 30-60 m with an irregular outline related to the scheme of play and merging not too obviously with the rough.

Distances of tee shots are important to determine the location of well mown fairway areas. The average player drives the ball some 150-200 m (180-220 yds) while the scratch handicapped player reaches around the 240 m mark. The whole fairway need not be mown as landing and holeout areas can exist amongst the rough.* This is especially the case on linksland.

Distance between fairways is essential and this area can be set aside for rough and tree

Undulations can define extent of fairway
planting which gives each fair-way an individual identity.

Avenues of trees down each fairway should be avoided.

Rough in front of the tee reduces mowing operation and adds additional character to a hole.

The functions that plant material perform are:
- directing shots
- helping to create strategically designed holes
- providing background colour, accent and definition
- to create interest
- for environmental protection.

Trees and shrubs chosen to perform such functions will be chosen for their
- ecological adaptation
- form
- visual beauty
- interesting structure
- seasonal foliage
- uniqueness.
Maintenance of species must be considered - pruning, spraying and watering - and their suitability and compatibility with turf growth, soil and climatic conditions.

Trees are not suitable to fulfil the function as a hazard because they can unduly punish a reasonable shot or reward a wayward shot with a rebound back onto the fairway. However, they are valuable if placed as features affecting hole strategy (Fig. 9). If this is the case they should be planted in groups, not in rows or as single specimens.

"heroic" shot
normal shot

Fig 9

The second shot on the fairway is screened by a group of trees which pose a severe problem of combining elevation with length if a "heroic" shot is attempted.

The lowest branches of the trees should be removed to allow the player, if in the rough, to play his shot out to the fairway.

Trees shading or interfering with air circulation about a green can have an adverse effect on the turf. Those that shed their bark,
leaves, twigs and needles can have the same effect. Desiduous trees become a nuisance when leaves fall on greens. Where the size of the course is large enough, planting can take place outside the playing area and could provide a good shelter effect.

(d) Hazards

The function of hazards in hole design are:
- to make the hole interesting
- to govern the play of the hole
- to catch the golfer's shot which is not quite good enough (Fig. 10). 16

The green guarding bunker has a considerable influence on the line of play to the hole. If it were not for this bunker the tee and approach shot would be uninteresting as there would be no object in endeavouring to hit a long shot over the stream.
No hazard should be included which does not have some influence on the line of play for that hole, and its placement must create a special effort in order to get over or avoid it.

**Bunkers (sand traps).** Bunkers are an essential element to any hole, both around the green and on the fairways, provided they are not used excessively and indiscriminately. The present trend is to reduce the number of sand bunkers and substitute mounds and grass hollows. This saves labour and maintenance costs, especially when the provision of sand is difficult as well as expensive.

Pot bunkers* riddling each side of the fairway or in a straight line across it are not acceptable and should be of a larger size and placed on echelon (Fig.11).

The placement of bunkers on the fairways should be at a distance to which the player drives to, about 190-210 m from the men's tee and 230-260 m from the championship tee. They should be placed so that the player must carefully negotiate or avoid them on his drive.

Bunkers should not noticeably help judgement of line or distance, and size, shape and relative location should vary.
If the line of play from tee to green is to the right, then it is best to bunker that side (Fig. 12).

Wing bunkers guarding the green entrance are fundamental in the strategy of a hole. These reduce the advantage of the safest line to play from the tee or second shot, and reward, by an easier approach shot to the green, those who have earlier risked carrying or skirting one of the hazards. They provide for accurate and skilful shots to the green, and any player wide of these bunkers is penalised by having a difficult pitch shot (Fig. 13).
The bunker in the centre of this view, guarding the approach to green, is functional if it presents a challenge to the big hitters. If this bunker and the one to the right only penalise poor shots, they become needless.

Bunkers must be shaped to blend harmoniously with the existing contours. A natural 'eroded' face with a random asymmetrical outline should be aimed at.

Green guarding bunkers

Hummocks and hollows. These features can effectively act as hazards, especially close to the green where they determine the roll of the ball towards or away from the hole. They can assist the player who has opened up the hole correctly, while acting as a hazard to those who have failed to do so. Where artificial mounding is required, it must be
given a natural appearance and relate to the scheme of the hole.

Effective drainage must exist in hollows if they are to be functional as hazards.

A grassed depression in front of the green shows up the topped shots so they will not run onto the putting surface. The bunkers make an exacting shot to a flat, easily maintained green.

A combination of a grassy hollow to the left and a sand trap to the right helps to make the player decide upon shot placement.

Water. A stream used or diverted strategically can act as the perfect hazard.

At Carnoustie, Scotland, the Barry Burn winds its way sinuously throughout the course
threatening the stroke that is slightly less than perfect, rather than the one that is slightly better than awful. The 10th green is within a loop on the Barry Burn which catches the mishit shot as well as the one that is sliced (Fig. 14).

On the 17th hole a solid drive in the correct direction from the tee will carry the Barry Burn twice, but against strong winds the tee shot must be placed on an island amidst the curves of the Burn \(^{17}\) (Fig. 15).

- Fig 14
- Fig 15

The 10th green at Carnoustie

A creek used for drainage purposes and as a hazard
Creeks, streams and rivers should generally be left in their natural state to be used as effective hazards as well as drainage courses.

Lakes can act as hazards and add to the uniqueness of a hole although have high installation costs. A classic example of a lake forming an extremely effective hazard as well as governing the play of the hole is the 16th at Augusta (Fig. 16).

Water in front of the green acting as a hazard. When the shot requires power to clear it, especially on a par 3 hole, a bunker has been located to the left.
Structures. To incorporate the hazards of railways, roads and sheds into the design may be thought unsatisfactory and unwelcome but these can form an excellent boundary and can have a potent influence at the holes which cross its path. The 17th at St Andrews, Scotland, is a good example (Fig. 17). The drive from the tee is over the corner of the hotel grounds, where railway sheds once stood. The player tries to chew off as much of the fairway as he can dare to land in a favourable position for his next approach shot. Too far to the left and the entry to the green is closed or the ball goes into the bunker and too far to the right it is out of bounds. The next shot leaves a very small margin for error. A fractional pull might finish in the bunker by the green or a slice or overhit might end on the road.
5. FACILITIES

(a) The Clubhouse

The clubhouse is an essential element of any golf course complex and is often an influencing factor in the standard and popularity of a club. Members and visitors require and expect comfort and good service. An atmosphere conducive to socialising is important and can be achieved through the means of architectural qualities, decorations and furnishings, good service and the site and surroundings.

Planning of the clubhouse is determined by an assessment of the role the club will play in the sport, for functions and a place for its members. For a privately owned club it can be expected that members would participate in a considerable amount of socialising, that facilities within would be extensive and of a high standard, and that provision would be made for the anticipated increase in guests and spectators for tournaments.

The siting of the clubhouse is an important and integral part of the complex, and is the first step in the planning procedure. The ideal situation for a club-
house is one where the building
is elevated, gaining maximum
advantage of topographical
features, sunshine and views.
It must be located convenient to
the access road, parking areas
and to the 1st tee and 18th
green. General requirements
for an all-year round private
club may include:

Vestibule
- entrance and waiting area
- coat room
- public toilets
- trophy case display
- phones.

Access can be gained from this
area to the office, dining-room,
bars and locker rooms as well as
the car park.

Administration
- manager/secretary office. It
is ideal to have a position
overlooking the entrance and
1st tee
- tournament controller's office
- public address system
- storage area

Bar and lounge
- bar and adjacent storage room
- a large central lounge with
good window area overlooking
the course. A room which is
capable of being used for
banquets, dances, entertainment
and other functions
- an adjacent dining-room that
can be utilized as a lounge
as well
- a covered terrace for summer
use, reached from the lounge room
- access from the lounge, bar and dining area to the foyer and kitchen

Kitchen
- receiving area
- rubbish area
- refrigerators
- hot food preparation area
- dishwashing
- dish, silver and glass storage
- toilet facilities
- access to the dining-room, delivery and rubbish pickup. Rubbish to be collected by municipal rubbish removal.

Locker rooms and changing accommodation
- men's and women's locker areas,

showers, washing, toilets and drying room
- bag storage
- janitor's storage room
- access to the foyer, pro. shop, 1st tee, parking and 18th green.

Provision can also be made for shoes and trolleys.

The men's and women's locker rooms should have privacy from all other groups, yet freedom of movement should exist. Once they leave the locker room-rest room area their pattern of circulation must blend with that of the other golfers to the pro. shop, course and parking area.

For social interaction there should be one common area where
all groups can meet. This area is normally separated and should not conflict with the flow of people engaged in formal activities and service deliveries.

**Committee room**

**Children and games room**
- television
- billiard and table tennis

**Pro. shop**
- merchandise display area
- office
- toilet and shower
- storage and repair shop
- access from this area to locker rooms, 1st and 10th tee, 9th and 18th greens, and the main drive.

A two-storeyed clubhouse has several inherent advantages:
- it allows for a more attractive and interesting exterior treatment
- placement of social and dining areas on the upper level so that members can take full advantage of the play and the landscape
- service facilities and locker rooms can be located on the lower level, easily accessible to golfers and delivery trucks
- although stairs, porches and balconies are involved, these can conveniently assist in defining and restricting complex circulation patterns.

An efficient plan creates satisfied and relaxed club members
and guests. Instead of duplicating facilities like toilets and phones, the incorporation of a service core in the building is advantageous. The kitchen can be centrally located to serve in several directions with a minimum staff in attendance, and one set of food service equipment. Locker-rest room facilities should be accessible from several directions and should not be remotely located. The concentration of facilities for full utilization aids plumbing, heating and electrical economies.  

(b) Facilities associated with the clubhouse

Car park
- located near the clubhouse entrance
- 0.5 ha of land can accommodate 100 cars. As the club will be used by large numbers only for short periods, during tournaments and functions, the area of available car park space can exist in two areas. One for everyday use which would be sealed and permanent, and a second area used during tournaments which could be grassed and of a less permanent nature.
- the park should be adequately lit
- planting would break up the large area and make it a more pleasant space.
- a path from the car park to the clubhouse, easily accessible and of a gradual slope.

**Service area**
An area should be allocated adjacent to the clubhouse for delivery vehicles. Large trucks delivering goods will require a sizeable turning area.

**Caterer's residence**
Depending on the membership of a club an on-site residence for the caterer should be provided. He can also act indirectly as a night-time caretaker. He should have an access route to the clubhouse from his residence.

**Practice putting green**
This should be of a considerable area near the clubhouse. The green is surfaced in the same manner as for greens on the course. It is best arranged with 9 or 18 putting holes spotted about the green and numbered so that a player can putt from hole to hole in a regular order. There should be plenty of area to move the holes owing to wear and tear on the turf. A good sized green should be 2000-2500 m² for 18 holes.

**Practice area**
Conveniently placed adjacent to the clubhouse, and of an area
For summer recreation a swimming pool would complement the tennis court facilities. Changing and toilet facilities could be used for both the courts and pool. A children's play area could be included, to keep them amused while parents are playing a round of golf.

**Utilities**

Water and power are absolute necessities for the course complex, being required for the greens, tees, clubhouse operations and maintenance facilities. The source of water should be close to the site, reliable and pure enough to drink and irrigate with.
Lighting
The clubhouse, car park, swimming pool, tennis courts, and maintenance building require adequate lighting.

(c) The maintenance building
A maintenance complex will serve the following functions:
- storage of machinery and supplies
- provide facilities for construction, painting, repairs, etc.
- service as an administrative office for the golf course greenkeeper and a base for his staff.

The location of the building should be on a flat area so that machinery can be manoeuvred and the mixing and storing of top-dressing can be done. It must be accessible to large trucks, easily connected to utilities, centrally located on the course and well drained.

Orientation of the building is an important factor, and any wide doors that exist should be positioned away from the direction of the prevailing rain. The building itself should be easily maintainable and complement surrounding buildings.

The size must be large enough for all machinery and materials storage, repairs, and personnel.

The building could include:
- equipment and fertilizer storage
- mechanical repair shop
- employee locker room, showers and toilets
- green keeper's office
- paint room and steam cleaning
- oil and grease storage room
and may total between 600-800 m² of floor area.²¹

(d) Maintenance equipment

To meet the demands of present-day golf course maintenance, the most modern and up-to-date equipment is needed. Maintenance equipment alone will not be the sole determinant of a successful golf course - administration, adequate budgets and skilled manpower are other important factors involved.

The following is a list that will be adequate for a championship course.²²

Trucks and tractors
- 1 utility tractor with front end loader for general construction and bunker maintenance
- 2 golf course tractors for general purpose
- 1 pick up truck for transportation
- 1 trailer for hydraulic tipping and hauling materials
- 1 dump truck (1-3 ton).

Mowing equipment
- 3 power driven green mowers and combs and brushes, e.g.
- Triplex green mowers
- 2 power tee and apron mowers
- 2 600 mm or 720 mm rotary mowers
- 1 set of 3 or 5 gang rough mower
- 1 set of 5 or 7 gang fairway mower
- 2 power lawn mowers
- 2 hand mowers
- 1 power grass edger for edging traps and planting beds.

Maintenance equipment
- 1 grassland harrow
- 1 750 kg flat roller
- 1 power sprayer with 900-1300 l (200-300 gal) tank, 10-25 CPM pump, 45 m high pressure tree gun, multinozzle and spray boom attachment. For large area spraying such as fairways.
- 1 mechanical aerator for greens
- 2 small sprayers of knapsack type for greens
- 1 power sprayer with 220-440 l tank, 5-10 CPM pump, multinozzle and boom. Used for green and tee spraying.
- 1 powered scarifier
- 1 power soil shredder for soil preparation
- 1 deep turf spiking machine for greens and fairways
- 1 2 or 3 m fertilizer spreader or 1 tractor drawn rotary fertilizer spreader
- 1 rotary tiller for the mixing of soil on green sites and other areas in preparation for planting
- 1 topdressing dragmat for levelling large areas before planting and following up of renovation work
- 1 250 kg hand lawn mower
- 1 leaf sweeper for greens and fairways
- 1 soil screen for preparation and mixing of soil amendments for topdressing
- 1 powered chainsaw
- 1 sod cutter for removal of sod
- 1 tractor drawn aerification machine
- 1 power portable centrifugal pump with suction hose for general purpose pumping
- 1 power spiker for reconditioning surface soil, reducing crusting and for seed bed preparation.

**Equipment and tools**

2 hole cutters
36 hole cups
2 cup extractors
3 hole trimming scissors
36 flagsticks and flags
9 to 18 practice green cups
9 to 18 practice green markers
3 sets of tee marks
6 golf ball washers
1 patching iron or divot repairer
18 rubbish containers
18 tee benches
2 large wheelbarrows
(8') stepladder
(20-30') extension ladder
3 mole traps
turfing iron
turf edger

**Small hand tools**
Shovels, forks, spades, iron rakes, wire rakes, brooms, sickles
Pick, hoe, shears, scythe, stone, crowbar, posthole digger, axe, hatchet, saw
Engineer's tools for running repairs to equipment
Carpenter's tools for general repair.

**Supplies for the course**
Seed or vegetable material for greens, tees, fairways
Seed for rough
Fertilizer for greens, tees, fairways
Lime
Insecticides
Fungicides
Herbicides
Soil sterilizer
Humus
Coarse sand

Topsoil
Bunker sand
All chemicals should be kept in a dry storage area not subject to freezing conditions.

6. **CLUB MANAGEMENT**

The permanent staff associated with the administrative and maintenance aspect of a golf club are:

**The secretary**
Controls various club activities and it is his handling of affairs that determines the success or failure of the club. His duties include:
- the keeping of accounts
- supervision of the clubhouse and indoor staff
Head green keeper
He will have between two to six groundsmen on his staff depending on the club's financial resources. It will be his responsibility to maintain the course to a standard that meets with the committee's approval.
- transmitting orders or instructions by the committee or directors
- a general supervision of the course in relation to its condition
- the running of competitions and social events.

Club staff
Consists of steward, stewardess, cooks, waitress, bar attendants, all of whom may be employed on a full or part-time basis depending on the need.

The club professional
He is an independent member of the staff and paid a retaining fee. The club provides him with a shop; he has sole rights to the sale of golf equipment and gives lessons on the course to players.

Caddie master
In large clubs there will be a caddie master who is an official charged with the control and booking of the caddies for tournaments. If the club does not have a full time caddie master it can be sufficient on occasion for the professional or a ground-staff member to act in this capacity.
REFERENCES

Chapters 1-6


5. Tyler, M. Mulvoy, M. and Spander, A.


8. Mulvoy, M. and Spander, A.


10. Tyler, M. pp 51.


17. Tyler, M. pp 47.

18. Ibid, pp 121.


22. National Golf Foundation booklet no. 3.

7. CONSTRUCTION

The conditions of the golf course have changed greatly over the last fifty years and the construction and maintenance of the course has become a specialized and labour intensive job. The putting greens are specially constructed, suitable grass is sown and the resulting turf receives continuous treatment and care. Teeing grounds are constructed so as to give maximum scope for well delivered drives. Natural features are fully utilized and supplemented by artificial constructions and hazards to enforce accuracy and add difficulty to the game.

There are many widely varying conditions met within the construction of a golf course that no one set of rules is applicable to each site and each design. The general sequence of events for constructing a golf course is as follows:

CLEARING THE SITE

Removal of unwanted trees and stumps, boulders, stones from the topsoil, drainage of swampy areas and the burning off of ground cover.

Cultivation of topsoil in a stony area must be viewed with caution as stones are likely to surface, creating construction and maintenance problems.

STAKING

After the design of the course
has been determined and mapped out, staking takes place. Greens and tees are staked out first, according to their location, followed by the extent of the fairway zone.

EARTHWORK
All existing topsoil in areas to be disturbed on the site should be removed by stripping with bulldozers and stockpiled as near the area from which it was taken as possible. After completion of the earthworks, the topsoil is either respread over the same disturbed areas or it can be used to raise greens, create hummocks and undulations and in areas where planting of trees takes place. Topsoil should be carefully managed because:
- there is often a shortage of topsoil
- the quality of the golf course turf will be better and achieved at a lower maintenance cost when the course is completely covered with an adequate layer of topsoil.

SITE DRAINAGE
Good turf cannot be grown in a waterlogged soil condition. Proper drainage ensures:
- better distribution of plant foods
- improvement in soil texture
- circulation of sufficient moisture
- plant roots can grow deeper
- faster growth rate
lessens the possibility of disease.
Each site has different drainage problems which can be handled by a combination of surface and subsurface drainage.

**Surface drainage**

Depends on:
- gradient of an area
- structure and texture of the topsoil
- the natural water table.

Swales. It is cheaper and easier to handle small drainage areas on the surface by means of grading swales or using existing ones. A swale should have at least a 2% slope and graded to fit into the existing contour so that the turf can be cut by mowers if necessary. A 12% slope is the maximum allowable for gang mowing.

Ditches, creeks and streams can handle excessive amounts of water runoff as well as water discharge from swales and pipes, forming an effective means to pass water off the site. They all form a circulation problem on the course and so adequate bridging must be provided, or, in the case of unsightly ditches, covered over.

Ditches create an unfair hazard, as they cannot usually be seen by the player.

**Subsurface drainage**

A system of shallow drains is advocated near the earth surface and located in areas of porous material with sufficient fall.
Concrete pipes should be installed across a course if it is necessary to drain adjacent watershed areas. The initial cost outlay may be expensive but will pay dividends by controlling runoff.

Tile drains: A 100-150 mm diameter perforated tile drain is installed in a trench which has been backfilled with crushed stone or gravel. Such drains can relieve areas that cannot be drained by swales, by intercepting seepages. They are most useful for the drainage of greens.

The materials used include plastic (P.V.C.) cement and clay.

IRRIGATION

The total quantity and seasonal distribution of precipitation is usually inadequate to maintain a green turf of acceptable quality. Artificial irrigation practices are therefore required in order to:
- provide a protective cover for the stability and retention of the soil which is subjected to heavy use
- ensure continued survival of turf grass
- provide a relatively standard consistency of texture for predictable reactions between ground and ball.

**Water rights** must be obtained from the local catchment authority before any drilling and utilization of water from the site takes place.

(a) **Water source**
An adequate water supply must exist so that the irrigation system can be operated at full capacity in accordance with the design.

(i) **Ground water**
This is normally the main source for a constant water supply to a golf course.

An investigation must be made to ensure that a sufficient amount of water can be obtained. Consultation with local well drillers who are familiar with the locality, or well recording in the area may be necessary. If there is some doubt as to the availability of the correct volume of water it is best to drill a test hole consisting of a 100 mm or 150 mm casing.²

Sources of ground water include artesian and subartesian aquifers. **Artesian aquifers**. Ground water that is under sufficient pressure to rise above the level at which it is tapped by a well, and to flow from the well at or above ground level. The height to
which water will rise above the ground level (the artesian head) in the well tapping these aquifers depends on:
- the depth of the aquifer (deep aquifers have higher heads)
- the height above sea level of the well site (wells near the coast have higher artesian heads than the same aquifer inland)³.

The amount of water that will flow or can be pumped from an artesian well is determined by the permeability of the aquifer and the construction of the well.⁴

Subartesian aquifers. Ground water that is under pressure but does not reach ground level in a well. Perched water tables. Ground water derived from local infiltration of rain or river water as is prevented from seepage down to the underlying aquifer by an impervious stratum and forming a lens. It will yield water to wells tapping it.

Wells
Allowance must be made for the natural rise and fall of the water level in wet and dry seasons. Factors to be considered when deciding on the depth to which a well should be sunk include:
- the amount of water required
- permeability of the aquifer
- depth to water level in wet and dry seasons
- annual and seasonal fluctuations of water table
- the approximate specific capacity of the well (i.e. relation between yields and draw downs)
- interference between wells
- the artesian head when artesian aquifers are present
- proximity of sources of water pollution
- to a depth where the water is pure and uncontaminated.

The most satisfactory well type depends on the amount of water required and the type of strata and aquifers to be penetrated and tapped.

Wells suitable for golf course irrigation purposes include:

Driven wells. A pipe 30 to 80 mm in diameter and fitted with a conical driving point that is forced into the water bearing stratum.

Drilled wells. A pipe 80 to 600 mm in diameter and drilled by cable tool in gravels and rotary drills in clay. The diameter of these wells depends on
- well depth
- physical properties of the strata to be penetrated
- aquifers that are to be tapped
- amount of water required.

(ii) Streams

Utilization of streams and rivers is determined by:
- size of the resource quantity
- the annual flow must exceed the maximum amount of water required for irrigation
- the perennial nature of the flow
- problems of silt, industrial wastes, fertilizer runoff.
Filters to remove foreign material from the source prior to pumping may be necessary.

(iii) Ponds, lakes, waterholes and reservoirs
These sources may involve excavation for water storage purposes. Sealing of storage ponds with plastic liners or a clay seal to minimise seepage losses is important for the continued success of that source for irrigation purposes. The pond must be kept free of weeds and algae.

(iv) Non-potable water
Can only be used if there is an inadequate supply of water from other sources. Not recommended unless:
- 95% of all solids are removed from the water
- odour is minimised
- chlorine added to control bacteria.

(b) Soil-Water factors
Moisture holding capacity and infiltration rate of the soils are important factors in determining the frequency rate of water application and quantity. Texture, structure and organic matter content contribute to the degree of the soil's moisture holding capacity. Fine textured soils such as clays hold water
for longer periods than do coarse gravels, therefore the intake rate of water decreases with time.

The amount of moisture in the soils can be checked by the removal of a soil sample or by inserting a tensiometer into the ground. This is a sensor which evaluates the soil-moisture conditions, thereby regulating the quantity and frequency of water application to the turf. The infiltration velocity of the soil is a critical determinant for the rate of water application. Infiltration of water can be impeded by an accumulated layer of mat and thatch, and it is only when the mat layer becomes wet again that the irrigation water can penetrate the soil surface.

Compaction by walking on the surface can also cause poor water infiltration.¹

Soil aeration. Turf grass must remain healthy and able to absorb water from the soil. At the same time the grass roots needs oxygen and if an excessive amount of water is added to the grass, the roots will suffer from a lack of oxygen which can result in wilting on a hot day.

Drainage. Free drainage is a necessity for good turf conditions. Turf grass is often over-irrigated as well as receiving heavy rainfall and provision must be made to dispose of excess surface ground water. This can be achieved by mechanical aeration, vertical
mowing, control of runoff and maintenance of infiltration rates.

Evapo-transpiration losses during December can reach 10 mm/day and during mid-summer losses can be as high as 13 mm/day on watered golf courses. High evapo-transpiration losses can change the soil from saturated to wilt conditions in four or five days.8

(c) Frequency of irrigation practice

Much depends on the skill and experience of the green keeper for a particular location and conditions so that he knows when to irrigate and how much to apply.

The frequency of water application to a golf course can be determined by:
- soil texture
- porosity
- subsurface drainage
- turf rooting
- degree of compaction
- micro climate factors.

One guideline in knowing how often to irrigate is when and where the turf grass shows early signs of stress due to a shortage of water. Visible signs of imminent grass wilting can be seen in footprint markings and brown spots on the green. The tensiometer can be used to check the moisture content in order to determine the frequency rate of irrigation.
Often it is quite common for water to be applied on a daily basis to ensure against stress and drought symptoms, especially in hot dry periods. Irrigation also helps to maintain a softer playing surface on greens, but can have a detrimental effect on turf grass. If applied in an improper manner, water may:
- increase the opportunity for soil compaction
- decrease turf grass vigour and quality
- increase the possibility of weed invasion, clover, diseases and traffic damage
- increase leaching of nutrients from soils, especially nitrogen and iron
- cause excessive wetness in low lying parts on fine textured soils.

Examples of irrigation frequency:
- excessively irrigated clay loam soils in a cool climate should be irrigated three times weekly
- sandy soils in a hot dry arid climate to be irrigated at least five times weekly
- three or four times/week irrigation of droughty, coarse textured soils where water retention is low
- newly seeded areas require a light, mid-day irrigation on a daily basis to ensure effective establishment and rooting without dessication.

The frequency rate of water per
irrigation from a sprinkler system is much higher than most soils can take (an average soil absorbs about 5 mm/hr). Therefore, recycling is a definite feature used to give the soil time to absorb the water at its normal rate. This allows the system to apply water for short periods of time and as much as necessary to fulfill those daily water requirements. Uniformity of water distribution must be achieved so that a spotted turf appearance does not occur. Correct choice of sprinkler heads, nozzles, spacing and water pressure ensures uniformity of water distribution. Spacing of sprinklers depends to a great extent on the wind conditions of the course.

A late evening time (11.00 pm - 5.00 am) to irrigate is recommended for the following reasons:
- reduced wind velocities at night result in increased sprinkler coverage and uniformity
- greater efficiency due to low evapo-transpiration losses because of cooler evening temperatures
- no interference to play
- reduced compaction problems caused by player traffic on wet greens
- off peak rate electricity charges.

One disadvantage for irrigating at this time is that pathogen activity is enhanced.
(d) **Amount of water**

The amount of water applied to turf grass depends on:
- the amount of water already present in the soil
- the soil-moisture retention characteristics
- water application relative to soil infiltration rates.

The **quantity** of irrigation water applied is a function of the **rate** and **duration** of application.

The duration should be long enough to permit wetting of the turf grass root zone which is normally at a depth of 150-200 mm. This encourages deep rooting and results in more vigorous high quality turf.

The quantity of water applied affects the species composition of the turf grass community. An irrigation programme maintaining a high soil moisture level encourages species such as bentgrass, whereas judicious irrigating permitting the soil moisture to be depleted encourages fescue grasses which do not tolerate high soil moisture levels for long periods. In New Zealand the average peak use per week under high summer temperatures is 45 mm (1.8 in.). In some areas few weeks out of the season will require this much water but it could be required to meet the need at crucial times and the system should have the capacity to supply this amount of water.
in one week.

On average in Christchurch throughout the dry spells\textsuperscript{12}: 50-60 mm water/week are required for greens 40 mm water/week are required for tees 25-30 mm water/week are required for fairways.

The factor of 45 mm is sufficient to account for the loss of efficiency by way of water distribution, application, runoff, percolation and evapo-transpiration.

(e) Types of sprinkler systems

Quick coupler valve sprinkler system

Buried water mains are used to distribute the water and at intervals along the mains quick coupling valves are installed. The top of the valve is flush with the turf and is covered with a hinge cap. Upon irrigation, a rotary impact sprinkler and a valve opening key is inserted in the quick coupler and left on for the allotted watering time. Balancing the sprinklers throughout the system is important and the ratio of sprinklers to valves does not usually exceed 1 : 10. The sprinklers are moved from one valve to another after the required water application has been completed or when the green keeper can return to shift them. Water application rates for this system are high and ponding is common. The initial cost for
this system is lower than for an automatic system but the operational cost is high because of the dependence on labour. The efficiency for this system is low.

**Automatic sprinkler system**

This type accounts for the majority of today's golf course installations. It is a system based on rotary pop-up sprinklers. Non-corrosive P.V.C. or polythene plastic underground pipes are used, to which are connected permanently located sprinklers arranged in a geometric design pattern. For an efficient operation much depends on sound engineering and hydraulic design. The rotary pop-up sprinkler is controlled by a remote valve, either electrically or hydraulically activated. This valve is operated from an automatic controller which can be centrally or field located and is electrically operated. Control wires connect the automatic control system to the remote control valves and for the hydraulic system, plastic tubing is used.

A programme can be preset on the automatic control programmer up to two weeks in advance providing for water applications once or several times a day or night, alternate nights, once a week, or once a fortnight, etc. The system continues to function on a preset programme as long as the programmer is not affected.
The advantages of this system are:
- low operational cost
- enables the green keeper to maintain a healthy turf with a minimum quantity of water
- no wastage of water
- can be used for the application of fertilizers and herbicides
- provides control and flexibility.

However, there is a very high initial capital cost.\(^{13}\)

Semi-automatic system
Either: A time clock operated pump with pop-up valves turned on and off manually,\(^{14}\)
or: A combination of quick-coupling manual and automatic remote control valves. All sprinklers run on one night are installed after play is complete and the automatic controller cycles through the system as pre-determined for that particular night. After the irrigation cycle is complete the sprinklers will be picked up in the early morning hours, prior to play and mowing.\(^{15}\)

(f) Irrigation programming
The pressure available determines the programme to be operated and the nature of the site determines the circuits.

Manual programming. There are two methods for fairway watering:
- zone fairways into three areas of six fairways per area and plan on watering one of these areas per night. This results
in an every third night water cycle
- zone fairways into two areas of nine fairways per area and plan on watering each of these areas in one night. An every other night water cycle results, with the whole course being watered three times a week.

The sprinkler diameter should cover between 50-70 m.
The order of selecting the appropriate programme is:
- sprinkler head selection
- number of fairway quick-coupling valves to be known
- one of the two above methods to be selected
- amount of time allowed to water fairways
- pump capacity selected

Automatic programming. This is very similar to the manual system but the timing is adjustable and should some areas need more water the time could be increased while other areas may need less water, then the time is decreased.

(g) Water distribution lines
These lines are responsible for the delivery of the water from the source to the sprinkler heads. Selection of the pipe size and type depends on:
- water application requirement/unit time
- carrying capacity
- life expectancy
- cost of pipe, fittings, installation, pump operation
- pressure at which system is to be operated.

A small pipe costs less than a larger pipe, but friction loss is greater in the small pipe and this increases the cost of pumping water.

Types of distribution lines include:

**Permanent lines.** These are the primary type installed for golf courses whereby pipes are buried in the ground. Risers are located at designated intervals that connect to surface pop-up or quick coupling heads. Installation of permanent lines is done after subsurface drainage lines are installed at a lower depth. Lines should carry water to sprinkler heads with low friction loss.

**Portable lines.** A portable hose attached to a sprinkler head mounted on a stand. Not utilized as much today because of operational cost.

**Pipe material**
Cast iron (for mains), steel, plastic (P.V.C.) and cement asbestos. The material to be used must have strength under high pressure and be resistant to corrosion. Plastics are most common today and are easy to work with.

**Pipe laying**
The soil cover over cast iron and cement asbestos pipes should be at least 600 mm as protection.
from heavy machinery.

All pipe of 50 mm diameter and smaller should have a slope of 140 mm/30 m toward the drainage outlet. Larger pipes should have a slope of no less than 50 mm/30 m.17

After the piping with laterals, water outlets, valves etc. is completed, the system should be tested and all air removed.

Pumps
A pump of the proper capacity must be obtained in order to achieve uniform effective water distribution by sprinkler heads.

The delivery capabilities and water pressure that the pumps develop must:

- be sufficient to lift water from the source to the nozzles
- overcome the frictional losses occurring in the distribution lines
- maintain the required operating pressure at the nozzle to give proper distribution and range of spray pattern for sprinkler heads.

The pump's capacity depends also on the size of area to be irrigated allowing for 80% efficiency and the water source.18

Turbine and submersable pumps are generally used for deep wells. These are efficient, require little maintenance and are driven by electric motors.
GRASSES

"The ideal grass for use on a golf course should have short tillers producing an abundance of fine bottom herbage. It must be of good colour and be able to withstand the fairly dry conditions which usually prevail on a well drained course." 19

These characteristics are the primary determinants for grass selection. The turf must also have an immunity to diseases and pests and be hard wearing to thrive under heavy traffic and repeated close mowing. As well as these qualities, the grass must be maintained at a high standard.

Grass species

Two grasses are utilized throughout New Zealand for golf courses: browntop and Chewings fescue. The usual mix used for both fairways and greens is: 1 part browntop: 2 parts fescue applied at 18 g/m².

Festuca rubra (Chewings fescue)

The foliage is very fine, close growing, withstands hard wear, is of a good colour and capable of thriving on practically all good soils. It does not have a pronounced creeping habit, but of a tillering type and the grass is one which forms a compact sole of turf while it is able to withstand close mowing.

The grass prefers an acid soil
pH of 4.5-5.5 with low to medium fertility.

**Argostis tenuis** (browntop, bent)
A grass with a fine foliage and creeping habit by use of short runners. This spreading habit is to some extent a check to the establishment of weeds and is more capable than most grasses of standing regular and close mowing. In dry weather the grass must be copiously watered or it degenerates into a mass of hard brown stems, but is capable of withstanding extreme conditions making it a hardwearing turf. The grass prefers a pH of 4.8-5.6.

**Weeds**
The aim in weed control is to retain the more tolerant and desirable fine leafed grasses. It is therefore a matter of using grasses that are tolerant to acid conditions and to toxic sprays. Both browntop and Chewings fescue will grow better in sweet fertile soil than they will in sour impoverished soils, but these grasses will also persist and form a fine leafed turf under more acid and harder soil conditions than will many of their competitors. Browntop and Chewings fescue will tolerate and survive under high concentrations of toxic chemical sprays and applications of sulphate of ammonia and iron fertilizer, whereas most weeds and clovers would be destroyed.
Although these grasses can withstand close defoliation by the mower, wear and tear, and can tolerate climatic and environmental conditions they cannot tolerate competition of a dense mat of weed and clover growth below mower blade height which will stifle the grasses out of existence by utilizing soil nutrients and water and gradually take their place. Flat weeds, mat weeds and clover must therefore be eliminated for grasses to thrive.

**Weed control**

Weed infested turf areas on the golf course are objectionable because of their:
- unfavourable appearance
- unevenness of cover
- variable growth
- effect on a player's skills.

Even with the most painstaking care in preparing the seed bed it is impossible to eradicate all unwanted plants. Cultivation will eliminate many of the unwanted species and those that do appear will be sprayed before seeding is done.

Herbicides play an important part in maintaining a reasonable degree of uniformity in turf cover and care should be taken to use the most appropriate type.
<table>
<thead>
<tr>
<th>Common name</th>
<th>Botanical name</th>
<th>Herbicide for control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckshorn</td>
<td>Plantago cornopus</td>
<td>MCPP</td>
</tr>
<tr>
<td>Catsear</td>
<td>Hypochaerus radicata</td>
<td>MCPA, Turfmaster, Banvine</td>
</tr>
<tr>
<td>Clover</td>
<td>Trifolium spp.</td>
<td>245T, Banvine</td>
</tr>
<tr>
<td>Bindweed</td>
<td>Convolvulus spp.</td>
<td>Banvine</td>
</tr>
<tr>
<td>Cudweed</td>
<td>Gnaphalium spp.</td>
<td>dicamba, Turfmaster</td>
</tr>
<tr>
<td>Dandelion</td>
<td>Taraxacum officinole</td>
<td>MCPA, Banvine, Turfmaster</td>
</tr>
<tr>
<td>Daisy</td>
<td>Bellis perennis</td>
<td>MCPA, dicamba, Banvine</td>
</tr>
<tr>
<td>Hydrocotyle spp.</td>
<td>Hydrocotyle spp.</td>
<td>dicamba, Banvine, Turfmaster</td>
</tr>
<tr>
<td>Chickweed</td>
<td>Cerastium glomeratum</td>
<td>MCPPB, Banvine, Turfmaster</td>
</tr>
<tr>
<td>Plantain</td>
<td>Plantago spp.</td>
<td>MCPA, Banvine, Turfmaster</td>
</tr>
<tr>
<td>Onehunga weed</td>
<td>Soliva spp.</td>
<td>Turfmaster, Banvine</td>
</tr>
<tr>
<td>Pearlwort</td>
<td>Sangina procum bens</td>
<td>MCP, Banvine, Turfmaster</td>
</tr>
<tr>
<td>Docks</td>
<td>Rumex spp.</td>
<td>MCPA, Banvine, Turfmaster</td>
</tr>
<tr>
<td>Sorrel</td>
<td>Rumex Acetosa</td>
<td>Banvine, MCPA</td>
</tr>
<tr>
<td>Yorkshire fog</td>
<td>Holcus lanatus</td>
<td>Vanvine, Turfmaster</td>
</tr>
<tr>
<td>Poa annua</td>
<td>Poa annua</td>
<td>Endothal, Turfmaster</td>
</tr>
</tbody>
</table>
Herbicides for weed control:

**MCPA**
A formulation based on sodium and potassium salts. Applied at 0.05 l/100 m² as a fine leaf spray. Very effective on annual and rosette weeds. Can be damaging to seedling browntop but little adverse effect on mature plants.

**MCPP (mecoprop)**
This is used in combination with MCPA in the ratio of 0.1 l MCPP : 0.05 l/100 m², applied in spring or autumn. Good for mat weed control.

**2,4-D**
Used at the same rate as MCPA and will give similar weed control, but has an adverse effect on browntop and mature plants. It is therefore not recommended for weed control in fine turf.

**Dicamba**
Usually a mixture with either MCPA or 2,4-D using 0.25 g of dicamba and 135 g of either MCPA or 2,4-D/4.5 l. Applied at 0.05 l/100 m² and will control most weeds and clovers.

**2,4,5-T**
Spraying clovers with 2,4,5-T at the rate of 0.1 l/100 m² will prove effective. It has less damaging effect on young browntop than is the case of MCPA or 2,4-D, but often has limitations on common weeds.
Banvine
Contains 2,4-D and dicamba in the form of an aqueous concentrate. Applied at the rate of 0.10-0.15 l in 9.0-12 l of water/700 m² for the control of broadleaf weeds and clovers. Should only be applied to turf at least 12 months old.

Turfmaster
Contains MCPA and MCPP both as potassium salts in the form of a water miscible concentrate. Controls a wide range of annual and perennial broadleaf weeds and is the most strongly recommended control for weeds on greens. Applied at 4.5 l/0.4 ha for established turf. On young turf a 2.2 l/0.4 ha application is recommended. Since Turfmaster is specially formulated so as not to damage fine grasses such as browntop, Chewings fescue, crested dogstail an overall application should be made using any conventional low volume spray equipment or knapsack sprayer. Best results will be obtained from spraying in spring or autumn when the weeds and turf are in vigorous growth. It should not be applied if rain is expected within a few hours; application should be avoided during or following long periods of dry weather. Ammonium fertilizers are capable of checking the vigour of weeds but do not prevent or eradicate them. Fertilizers can be used in conjunction with selective herbicides especially...
when the fertilizer is applied 10-14 days before the weed killer.
For general use of checking weed growth:
3 parts by weight of sulphate of ammonia
1 part by weight of sulphate of iron
20 parts by weight of lime free sand or friable compost.
Applied at 120 g/m² or four to six times during the season.

For checking the vigour of established weeds:
3 parts by weight of sulphate of ammonia
1 part by weight of sulphate of iron.
Applied at 30 g/m². 26

There should be no heavy use of sulphate of ammonia and iron on acid matted turf as it will suffer severely and will be slow to respond.

Moss
The presence of moss in greens interferes with the growth of the grass and the aeration of the soil. Sometimes moss is only a temporary winter growth due to an excessive amount of moisture in the soil. Aerating by spiking can alleviate this. The more persistent growth of moss is due to impoverished soil conditions. Areas having an adequate phosphate and nitrogen content remain moss free provided they are not in an over-acid
condition. There is no specific treatment for the prevention and eradication of moss because much depends on the site conditions.

If the soil is infertile a general fertilizer followed by dressings of nitrogen applied in spring and autumn can check the vigour of moss growth:
75 parts by weight of sulphate of iron
15 parts by weight of sulphate of ammonia
10 parts by weight of sand.
Applied as a fine powder at 0.3 g/m². 27
The most effective method of control by selective weed killers is that of NaPCP (sodium pentachlorphenate) solution applied at 0.5 l/100 m² and well watered in to saturate the moss material. Spraying is most effective in late autumn and spring.

Turf pests
The most serious pests found in turf on the golf course are those that bite off, chew and swallow pieces of grass. These include the grass grub, porina and earthworms.

Grass grub (brown beetle):
Capable of eating the roots of grass and causes patchy yellowing and dying off of the turf.

Porina (Wiseana cervinata):
As a caterpillar the pest feeds at night on the grass surface to
weaken the grass, loosen the fibre to give a chewed look. It is most active in spring and autumn.

Control of pests:

<table>
<thead>
<tr>
<th>Pest</th>
<th>Insecticide</th>
<th>Instructions</th>
<th>Formulation</th>
<th>Rate/0.4 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworm</td>
<td>Rotenone</td>
<td>Applied in spring while soil acidity is developing. Has immediate killing effect on worms</td>
<td>Wettable powder</td>
<td>110 ml/4.5 l</td>
</tr>
<tr>
<td></td>
<td>Carboxyl</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
<td>85 ml/22.5 l</td>
</tr>
<tr>
<td></td>
<td>Endosulfan</td>
<td>&quot; &quot;</td>
<td>Concentrate</td>
<td>28 ml in 22.5</td>
</tr>
<tr>
<td>Grass grub</td>
<td>DDT</td>
<td>Mixed with a fertilizer and broadcasted. Applied in Feb-April every 2-3 years</td>
<td>Wettable powder</td>
<td>2 lb a.i</td>
</tr>
<tr>
<td></td>
<td>Diazinon</td>
<td>Applied in autumn and watered in with 10 mm of water</td>
<td>Pellets</td>
<td>2 lb a.i</td>
</tr>
<tr>
<td>Porina</td>
<td>Diazinon</td>
<td>Applied in autumn and spring. On greens cut and rake or brush to remove the protective covers from the tunnels before applying</td>
<td>Pellets</td>
<td>1 lb a.i</td>
</tr>
<tr>
<td>Porina</td>
<td>Fenitrothron</td>
<td>As above, from March to June</td>
<td>Pellets</td>
<td>1 lb a.i</td>
</tr>
</tbody>
</table>
Earthworms cause undesirable unevenness by casting. If the soil is kept in an acid condition, the turf seldom becomes infested. Control measures may have to take place after autumn rains because the worms continue activity through the winter and spring. If the earthworms are left untreated, the stability, resilience and wearing quality of the greens is reduced.

Turf diseases

Fungi, nematodes and viruses are capable of causing diseases damaging to turf.

Environmental effects on diseases:

- soil fertility: high levels of nitrogen increase the possibility of Fusarium and brown-patch. Low nitrogen levels favour Red Thread.
- soil type: fungus develops in wet and poorly aerated soils.
- pH: turf growth in calcium deficient soils is more susceptible to disease than in soil with adequate calcium amounts.
- watering: good drainage is essential and waterlogged soils are prone to disease.
- humidity: high humidity favours fungoid growth.

Diseases

Fusarium Patch (Fusarium nivale)

Small dead patches showing cottony threads in early morning.
The leaves of the grass then turn yellow and light brown. Prevalent in late autumn and winter, although high humidity or wet turf may cause outbreaks.

Alkaline soils and high levels of nitrogen encourage Fusarium Patch to develop.

Control:
- good drainage
- removal of dew
- light applications of sulphate of ammonia
- fungicides - Benlate, Mancozeb, Dyrene, Daconil.

Brown Patch (Rhizoctonia solani)
This appears as circular or irregular patches of purlish-green grass and later turns brown.

Prevalent from midspring to late autumn.

Control:
- removal of dew
- avoidance of high nitrogen levels
- fungicides - PCNB, Daconil, Benlate, Mancozeb.

Red Thread (Corticium fuciforme)
Identified as red threads of mycelium in patches up to 0.5 m in diameter. In favourable conditions, the disease can spread rapidly. Common on light, easily leached soils that have low levels of nitrogen.

Control:
- increase nitrogen levels with
fertilizer
- fungicides containing calcium
- moderate control from Mancozeb and PCNB.

CONSTRUCTION OF COURSE ELEMENTS

(a) Putting greens

The putting green is essentially flat with gentle undulations to add interest and character. Pronounced undulations add to the difficulties of green keeping as high spots become scarred with mowing and depressions become damp and prone to clover development.

There is no definite depth of top soil for a green as much depends on the geological character of the situation. If the subsoil is relatively porous during wet weather, but capable of storing moisture in dry periods a good turf can be maintained on 200-250 mm of top soil. On gravel or chalk the grass is likely to burn quickly in a dry summer, and therefore a depth of 250-300 mm of fertile top soil is needed.

Heavy clay is a poor foundation and the surface soil will need lightening and improving to a greater depth as the turf will
suffer severely from expansion and contraction. It is important that the green has soil to sufficient even depth and is porous, retaining excess moisture and not drying out too quickly on the crests.

**Preparation:**

**Building the green**

Removal of the topsoil at the beginning is recommended even if little alteration in the contour of the ground is made. Then adjustment to the subgrade is made before replacing an even layer of top soil.

If there is insufficient soil to provide the required depth additional soil must be imported or obtained from elsewhere on the course.

**Drainage**

The green must be freely drained, neither too damp nor too dry. Surface water should be shed to the sides or one side of the green.

After the shaping of the subgrade, drainage trenches are cut into it and about 25 m of perforated drain tiles for each 90 m² of surface is laid in these ditches.³³

The tile drain network is essentially a herring-bone pattern. It consists of a series of main drains into which discharge, from both sides, many roughly parallel branches at an angle of 60° to the main drain (Fig. 18).
The discharge from the main drains usually extends out to a low lying area, swales, a storm drain or ponds, at a similar angle.

A uniform fall is essential, usually a 1% fall is necessary for the main drain and a 2% fall for branch drains. A 4 m interval between branch drains should exist in clay land, 7-10 m in clay loams, 14-20 m in light loams. The tile drain trenches are then filled with gravel, about 20 mm in diameter, coarse sand follows and then the seed bed mixture (Fig. 19).

Irrigation
There must be a good water supply provided during the construction.
Topsoil
After the grading of the subsoil, drainage and water supply installation, the surface needs loosening to a depth of 150 mm preparation for the topsoil.

Stones are to be removed from the surface so as to provide a fine layer in which to sow the grass seeds.

The seed bed is made by spreading the topsoil in 100 mm layers until the desired depth is attained (200-300 mm) and then consolidated. There must be a uniform depth of topsoil as variations in the growth of grass occurs if this does not occur. More soil should be placed on the crests and slopes than in the hollows.

If there is insufficient site topsoil, a light loamy soil should be imported from one place to ensure uniformity in quality. The problem with imported soils is the weed potential, some of which may be harmful. Soil should then be
procured from a site which is known to be clean, placed in position so that weed seeds can generate and the plants destroyed before the grass seeds are sown. The soil could also be sterilised but this is expensive.

Fertilizing

Two methods of fertilizing the seed bed:

Well-rotted manure (not fresh manure as this causes sinkages and contains weeds) provides organic elements and humus which improves the texture of the soil. The amount applied to the green is in the order of 1 m\(^3\) to every 100 m\(^2\). The compost should be mixed thoroughly with screened topsoil in the ratio of 1 : 3 and a 30 to 50 mm compost spread over the surface to make a good seed bed. This method has been superseded by the application of a mixture of artificial fertilizers. It is usual to have a ratio of nitrogen, phosphates and potash. The best dressing is one that is rich in more than one form of nitrogen and contains a good proportion of phosphate together with potash. If no weeds are present the sulphate of iron can be omitted. If daisies are present the sulphate of ammonia should be increased. The presence of clover means a reduction in the quantity of lime and potash. If the turf is sour, sulphate of ammonia should be
lessened, and lime used as a separate dressing. A typical dressing for an average soil is:
2 parts sulphate of ammonia
1 part superphosphate
at the rate of 30 g/m².
Half the fertilizer should be broadcast one way and the other half across the other way.

It is not always necessary to apply lime to the seed bed as most grasses thrive in the absence of lime but growth is often encouraged. Sandy and peat soils can be very acidic and require a light dressing of lime which is raked in during the preparation process. A good combination consists of ground chalk, limestone and carbonate of lime applied at 100 g/m². This does not burn the grass. 36

Lime should only be added to neutralize the soil and not to promote alkaline conditions as this increases the incidence of clover and flat weeds.

Preparation for seeding

Generally, a three or four week interval between the time of construction of the green and the sowing of grass seeds is desirable. This allows for soil consolidation and for weed seeds to germinate and to be cleared.

Prior to sowing, a firm and friable surface must be created by the use of roller and rake. All
large stones are to be removed and the surface broken up finely. Worm casts must be dealt with as these can ruin the smooth surface of the green. Porina and grass grubs are problems, especially in the second and subsequent years after laying down the green. Such pests can be controlled by the application of a selective weedkiller or arsenate of lead. The latter is applied at a rate of 60 g/m² and this protects the greens for up to six years before a further application is required. The arsenate of lead should be mixed in the same proportion as fine soil to facilitate even distribution and spread. This dressing should precede the final preparation of the seed bed.  

Sowing
A minimum quantity of 25 g of seed mix/m² produces good turf one year after sowing. If there is a need for fast initial growth for early use of the course 40 to 55 g of seed mix/m² may be necessary. Much depends on the type of soil, climatic and environmental elements.

Half the seed should be sown one way and the other half across the other way. It should then be covered by a light raking and finished off to a uniform level surface by a 1 m straight edge.

The last operation is a light
rolling of the ground in two directions. 38
Climatic conditions determine the most suitable period for sowing. In the North Island and warm areas of the South Island mid autumn is a suitable time to sow as good growth can be expected before cold conditions set in. If autumn is short and heavy frosts are to be experienced, a mid-spring sowing of seed is desirable. In this case more attention to the area sown will be required especially under watering because seedling turf will be developing under warm and dry conditions.

Autumn time is chosen for sowing as there is usually enough moisture in the soil for germination, which takes about 10 to 15 days. 39

Protection against birds is a must as they can cause much damage by scratching, feeding and dust bathing on the green. Methods of prevention include tin strips, rags tied on twine connected to stakes, a network of black thread, red lead, poisoned wheat, or a light covering of soil.

Treatment of greens subsequent to sowing
The quality of the turf depends very much on the treatment given in the early stages to its development. Watering of a newly sown green should be carried out by the application
of a fine spray to a depth of 70 mm.

Fertilizing
If the soil pH has been corrected by the appropriate fertilizers prior to seeding, fertilizer applications after seeding will be limited to a nitrogenous fertilizer to stimulate leaf growth and phosphatic manure to promote good root formation.

A mixture of sulphate of ammonia and superphosphate in the proportion of 2 : 1 is sufficient. Dressings following this should consist of a 3 : 1 mixture. The initial quantity should not be excessive, a maximum of 30 g/m² is recommended.

As soon as the grass appears, a dressing of 15 g/m² should be applied. To minimise damage to the young turf grass sprinklers should be used to wash fertilizers off the foliage.

Rolling
A light rolling takes place only when the green surface is in a suitable state, so as to break down any small soil lumps. This practice should be done only when the ground is dry and preceding the first cutting.

Mowing
Good growth control of the turf is attained by close mowing procedures. A lenient mowing does not produce a fine turf and coarse grass, clovers and weeds are allowed to flourish.
The first cut takes place when the turf has reached a 30-40 mm height and in dry conditions. Only reel mowers with a catcher are used. Clippings must not be left on the green as serious damage can be incurred.

Weeding

It is impossible entirely to prevent and eradicate weeds before sowing of the greens; therefore the removal of weeds from the greens by hand becomes a necessity. Care must be taken so as not to gauge holes. Most of the weeds are annuals in newly sown turf and their presence is of short duration.

The application of selective weed killers can be an effective means of destroying the more persistent weeds.

Surface ready for play

The green, if sown in autumn, should be ready for play in October although it needs careful nurturing over the first season. Much will depend on the weather. If the turf growth is backward in mid-December causes for this failure may be due to:
- period of drought following spring growth
- excessive moisture
- hurriedly prepared seed bed
- indiginous rapid-growing weeds and coarse grasses.
Putting green approaches

The approach is that area where the fairway merges with the putting green. Its condition is a very important part of the coarse and much that is said regarding the construction and maintenance of greens applies to approaches. The approach surface should neither leave the ball dead nor be so fast that the ball runs on past the green.

(b) Fairways

Usually it is necessary to regrade and cultivate the areas intended as fairways. Cultivation of stony areas should be viewed with caution and utilization of existing turf, if of good quality, may be considered.

Attention must be given to the grading of fairways to permit mowing without scalping or missing growth in depressions.

Preparation

For large scale preparation a scraper can be used and on hillwork caterpillars are useful. Preparation procedure:

- removal of topsoil
- adjust subsoil
- replace topsoil
- cleaning the ground
- drainage installation
- seed bed prepared by repeated harrowing
- firm surface needed before sowing by light rollers
- all stones removed
- consolidation of soil, and germination of weeds
- weeds destroyed by selective weed killers and hand picking prior to sowing.

Drainage
Tile drains are the recommended form for drainage of the fairways. The diameter of the main drains is 100 or 150 mm depending on the extent of the land to be drained. A similar herringbone pattern as used for green drainage is adhered to and branch drains of 70 mm in diameter join the main drain at 5 m to 10 m intervals depending on the soil's porosity.

Drains are located at a depth of 400-500 mm. Drainage trenches are filled in with gravel or rough clinker followed by sand and soil.

Fertilizing
A 3 : 1 standard basal fertilizer mix of sulphate of ammonia and superphosphate is applied to fairways (at 125 kg/ha) although much depends on the soil's deficiencies. This should be done 10-14 days before sowing.

Sowing
The fairway seed mixture need not
be as heavy as for putting greens and tees and a mixture of 30 kg to 0.4 ha is a recommended application. Suggested mixture:

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<tr>
<td>Browntop</td>
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</tr>
</tbody>
</table>

Sowing of the seed should be carried out as follows:
- in dry soil
- in calm conditions
- even seed distribution by sowing in two operations, crossing each other
- during autumn.

Subsequent treatment of fairways

Judicious rolling of the fairways aids in producing turf with a fine, even surface and when the grass is 80-100 mm in height the first rolling takes place. Two or three days later the grass is cut with blades set high so as to encourage turf development.

If the sowing is made in autumn, a second application of fertilizer mixture is made in early July, followed by another dressing in October or November. Play on the fairway depends to a great extent on the climatic conditions and turf growth.

Care must be taken to control weed growth that is bound to come away strongly on the more fertile parts of the fairway.

Fairway rough

It may be necessary to sow the rough, depending on the original
condition of the site. If the rough is sown a cheaper mixture of seeds may be used or the same type as for fairways, only in smaller quantities per area.

The rough should be mown periodically to give some chance of finding balls should the shot go wide. The rough grass should remain longer than that of the fairway so as to define the extent of the fairway.

(c) Teeing grounds

Teeing grounds are the hardest worked parts of the course and their ability to withstand the hard wear to which they are subjected depends on the method of construction.

If the soil is fertile and turf is robust, good tees can be formed. In light soil the existing surface must be replaced with 100-150 mm of loam to produce good turf results, while heavy soil causes drainage problems. It is essential that the surface and subsoil be porous enough to allow for percolation from the surface. If this is not achieved a muddy and unstable surface results, being entirely unsatisfactory for a firm stance when teeing off. Therefore about 150 mm of rubble or clinker forms a sound foundation, with 150 mm of light soil on top of this which allows for good drainage. Large teeing ground surfaces with broad approaches
are recommended as traffic is less concentrated on them. This allows for several entry and exist points on and off the teeing area.

The shape of the teeing grounds must conform to the existing natural surroundings, avoiding square lines and sharp edges. Teeing grounds are often incongruous with their surroundings because of their design and construction.

(d) Bunkers

Bunkers should be of sufficient size to enable the playing of shots from within them without the feeling that space is too restricted.

They should be placed no closer than 3 m from the putting surface. If they are closer, large amounts of sand will be hit onto the green by explosion shots. A 2 m minimum spacing allows adequate room for the distribution of foot traffic around the green. Bunkers should not be placed more than 7 m from the green as part of hole strategy. Where a series of overlapping bunkers are to be constructed at any green, the
space between any two of these should not be less than 7 m.44

Bunkers should not be oblong or round in shape. The edges should be irregular, to break the hardness of line and to look as natural as possible (Fig. 20).

Poor shapes:

Desirable shapes:

Fig 20

The edges of bunkers should be constructed to have a natural effect. This can be produced by revetting the top of the face of the bunker and tearing the turf about with a fork. Rough turf from the spare ground on the course does for this purpose. The same effect can be obtained by laying turf to an irregular line over the edges of the bunker. This method however, is costly and time consuming. The bunkers should be somewhat higher at the back (facing the player) than the front so that a player approaching them is conscious of their presence and that the ball will not bounce over it. They should be so formed that the ball will run back towards the middle of the bunker. The floor of the bunker should not be flat, but concave. A bunker is badly de-
signed when the low side is lipped (Fig. 21).

This prevents the golfer with a tight lie from playing his ball out as the lip will "hide" the ball. The sand should be at the same level as the turf at this point in the bunker. Fairway bunkers are constructed shallow enough to permit a player to play a recovery shot rather than deep as are green bunkers.

Bunkers are filled to a certain level, depending on their lie, with sand which is coarse enough to remain in the bunker under windy conditions. They are to be kept free of all vegetative growth.

Bunkers, like all other elements
of the golf course, require adequate provision for drainage; unless this is provided during construction, they are liable to become catchment areas during rains. In heavy soil it is best to build the bunkers above the existing grade for drainage purposes (Fig. 22). Depending on the ground condition a bunker may require either a sump at its base which collects and disperses water to a storm water sewer, or a soak pit.

(e) Mounds and hollows

Artificial mounds and hollows must be related to the existing topography. A general rule when grading mounds is to make the batter extend from its highest point to where it joins the existing level twelve times as long as the mound is high. The batter should never be smooth but have movement. Much will depend on the actual construction and no plans can adequately portray the desired result. A fold or hillock around a green must have a sharper than one in twelve slope, otherwise it is lost. Artificial hollows are equally important in design and the same principle in their construction follows that of mounds. A good hollow does not show exactly where it begins and ends. Batters that are too sharp with a flat bottom between them should be avoided (Fig. 23). On heavy soils with low percolation rates, a grass hollow should not be made on a green
or fairway unless it is allowed to drain naturally to the side and away from that area.

Fig 23

Desirable form

8. MAINTENANCE

(a) Putting greens

The success of a putting green surface lies in the skilful performance of specific operations at the correct times. In essence, the surface should be uniformly low and truly cut and at the same time the turf must be able to control the ball.

Mowing

As soon as the greens are well established the turf should not be permitted to exceed 20 mm in height at any time. Generally, the finer grass species will thrive under fairly close mowing which enables them to receive maximum light at ground level. Greens are mown during most months and in a dry condition. Mowing should not be done during frost. The usual criteria adhered to, although much depends on local and seasonal conditions, are:

1 cutting per week in winter
2 cuttings per week in spring
3 cuttings per week in summer.
Putting green mower. Capable of cutting 18 greens in less than four hours.

In dry weather it is important to avoid close cutting as this affects the surface and root growth.

Mowing should be done in a different direction each time, so that the turf does not develop a grain, and the mower is run off the green to turn in order to avoid scarring. Motor driven machines are appropriate in today's high cost of labour and give the best cut. The pace of the green can be regulated by the height of the cut according to the season. In late spring the height of the cut should be raised so that the greens will not be too fast during summer months. The same applies if greens are cut too low in late autumn. It is desirable to have slow greens during November and good growth of turf. During March the cut is gradually raised for there to be plenty of grass on the green before the cold weather sets in. It is definitely
beneficial however, to mow the greens during the winter months as it keeps the grass from becoming coarse.

**Rolling**
This should be limited to the consolidation of the turf. A light roller (1-2 cwt) is recommended. Much depends on the type of soil as the mowing machine will do most of the rolling necessary. Rolling is best undertaken when the surface is dry but the underlying soil contains sufficient moisture to permit compression.

**Aeration**
Constant traffic on the greens makes the surface hard and impermeable, and the underlying soil may become consolidated making it difficult for certain elements to penetrate resulting in a thick fibrous unhealthy mat of turf. This can be remedied by a turf spiking or slicing machine which opens the soil by slits or cuts, or by coring of the soil, a method whereby plugs of soil can be removed. All these processes have the following effects:
- create an even absorption of water and fertilizing elements
- soil water holding capacity increases
- more oxygen is able to get to the roots
- plant food and moisture are carried to a greater depth and improves vigorous root growth
- surface drainage improves in wet weather.

Aerating should be done at least once a year in autumn, especially coring. Slitting of the soil can be done during the year when conditions are suitable.47

A deep spiking aerator machine for putting greens, approaches and teeing grounds.

A hollow wring aerator for putting greens.

Watering
An ample water supply must be made available to each green. Rainfall is not usually adequate, and it is inconsistent when it does fall. For maintaining a good green an artificial watering system must be installed. Greens should never be permitted
to reach the stage where it is obvious that lack of water has caused damage to the turf.

Watering generally is commenced in late spring as soon as there is evidence that the quantity of grass being removed by the mower is declining.

Watering is important for:
- good turf coverage
- to hold a well pitched ball
- maintaining uniform greens.

Water accumulation can occur in the hollows of undulating greens which causes problems in maintaining uniformity to a green surface and weeds and clover tend to accumulate. Control of this situation can be achieved by careful attention to aerating and levelling off these hollows and humps which may be causing the problem.

Watering should be continued for a time to spak the ground to a depth of 80-100 mm. A light sprinkling in dry conditions only causes the grass roots to grow towards the surface. Trouble too can occur from overwatering. A mist spray is preferable to hose pipe.

Water should not lie on the greens in the day and be subjected to the sun's heat. Scalding of turf and fungoid diseases can occur if the greens are watered during the day.48
Soiling
Greens should receive some soiling twice a year and preferably during the main growing periods of autumn and spring, when turf recovery is most rapid. If the surface levels, running surfaces need to be improved or the turf needs vigorating, light dressings should be applied when necessary. Heavy applications are not recommended and the quantity should not exceed a depth of 5 mm, less would be better.

Fertilization
Defoliation causes depletion of soil nutrients, therefore the soil requires fertilizers to restrict this. New greens should be treated with a 3 : 1 mixture of sulphate of ammonia and superphosphate.

Soil tests should be carried out in the first year or two to determine the nutrient level and from this can be assessed the fertilizer requirements. Continued use of sulphate of ammonia will eventually lead to a condition of intense acidity that will become harmful. Lime would then be added to the soil. The pH of the soil for greens should be corrected if it is outside 4.8-5.3. At Coringa country club 5.2 is considered ideal.

The 3 : 1 mixture of sulphate ammonia and superphosphate should be applied at frequent
intervals in small quantities. Recommended is a monthly dressing of 15-30 g of mix per m². Even a light fortnightly dressing with the appropriate quantities can be desirable.

Fertilizer applications in dry periods should be watered with sprinklers.

Resting greens
Maintenance of greens involves great difficulty owing to the fact that they are subject to constant wear and tear. If the green is large enough, one half can be closed for rest and this should be done during the growing season. However, very large greens create an increase in labour and work.

Temporary greens located on approaches can overcome this problem if it exists, especially when renovation is taking place, and during periods of hard frost.

The procedure outlined for green maintenance can be applied with modification to fairways and tees.

(b) Fairways

Mowing
Frequent mowing promotes a good mat of turf as well as reducing growth of weeds and clover, and provides for a good bounce and roll of the ball for drives. Tractor drawn multiple gang mowers with 3, 5 or 7 units are the recognized standard implement
used to mow fairways. These cover the distance in the minimal amount of time to any other implement although grass cuttings are left to lie on the ground. Cuttings can supply plant nutrients to the soil but are capable of scattering weed seeds. During dry spells and hot weather it is advisable to mow closely, as the grass coverage forms some protection to the roots in the heat of the sun. Grazing of animals on fairways is not recommended, but is sometimes done on rural courses where maintenance is difficult or when a club lacks financial resources.

Watering
This is an essential requirement for the maintenance of good turf, although installation is expensive (see Chapter on Irrigation).

Rolling
One good rolling in spring to counteract frost heaving is sufficient. The ground surface must be dry when rolling takes place and the underlying soil moist enough for compression.

Aeration
On medium to heavy soils, spiking of the ground is advised. The advantages for spiking are the same as for greens. A gang spiking machine is the best method.
Fertilizing
The turf must be regularly top-dressed with fertilizers. Each fairway should have one good dressing of fertilizer every third or fourth season. Generally the nature of the soil determines the type of fertilizer to be used:
- clay soils are deficient in phosphate
- light soils have a need for nitrogen and potash
- pure sand requires large amounts of phosphate.

Spring is the best time to fertilize fairways. A 3:1 mix of sulphate of ammonia and super-phosphate is usual, and sulphate of potash can be added if required.

The need for lime on fairways can be indicated by a thin mossy turf with bare ground and Yorkshire fog being prominent. Lime should therefore be applied as a soil corrective rather than as a plant nutrient. Its general effect is to reduce acidity and should only be added if soil acidity has become excessively high. The addition of copious amounts of lime encourages coarse grasses, weeds and worm development.

Teeing grounds
Maintenance of tees is similar to that of greens, although the resulting turf does not have to be quite as fine and well cared for. The procedure of fertilizing and
repairing turf from divot marks and moving the teeing off marks so as to relieve worn patches of ground for recovery should be conducted on a regular basis.

(d) **Bunkers**

The depth of bunkers should be maintained at no less than 150 mm and if less, resanding should occur.

They should be raked and maintained in good order every day. This not only creates a neat appearance but prevents weeds from becoming established.

Sand river sources contain many weeds and it is desirable to use a sterilant to reduce the degree of weed infestation from this source.

An hydraulically driven ride-on rake for bunkers. This will complete 130 bunkers in one day.

Bunker edges should not be sprayed with herbicides that act as vegetation killers. This causes disfigurement, untidiness, crumbling of bunker edges as the turf dies off, and possible damage to neighbouring greens. Mowers can
give a cut that overlaps the edges of a bunker and the top turf surface can be kept trimmed and hand clippers used for grass overhangs.

REFERENCES

Chapters 7-8

1. Dawson, R. pp 37-42.
4. Ibid, pp 103.

17. Ibid, pp 27.
21. Turf Culture Institute, pp 152.
22. Ibid, pp 145.
23. Ibid.

25. Ibid.
27. Ibid, pp 165.
28. Turf Culture Institute, pp 164.
29. Ibid, pp 165-166.
32. Sutton, M. pp 44.
34. Dawson, R. pp 30-43.
36. Ibid, pp 58.
38. Turf Culture Institute, pp 224.
41. Sutton, M. pp 81.
44. Levy, E.B. et al., pp 78-84.
46. Turf Culture Institute, pp 229.
47. Ibid, pp 179-182.
49. Ibid, pp 229.
51. Ibid, pp 88-89.
52. Turf Culture Institute, pp 110.
A. LOCATION

The site is located on McLeans Island, 15 km from the centre of Christchurch and in an area of high recreational value. The site covers 110 ha on the southern banks of the Waimakariri River within easy motor access (Map 1).

B. EXISTING CHARACTER

The site is essentially flat, its character determined by the course of the Waimakariri River. It is not entirely featureless as depressions and sandy knolls are quite apparent. Although the site has certain inherent features, the primary attraction is its containment and definition created by the external features of the Southern Alps, Banks Peninsula and surrounding plantations.
C. PHYSICAL ENVIRONMENTAL FACTORS

1. PHYSIOGRAPHY

Geology

The site is situated on an outwash fan of the Canterbury Plains which has been built up by the Waimakariri River over a period of time. The material of the fan consists of transported gravels from the Southern Alps extending to a considerable depth below the surface. There are no recorded specific depths of gravels, but oil exploration bores in the vicinity of the Selwyn River have reached the gravel base at depths ranging between 500 m and 700 m. The overall pattern of the region is one of flatness although surface irregularities are quite characteristic.

Topography

Due to the proximity of the site to the Waimakariri River (a distance of 1500 m) irregularities of the surface occur in the form of old braided channels and swales, 1-2 m deep, traversing the site in west to east direction. These were formed through the process of channel and dune formation, currently in progress on the very fringe of the Waimakariri River.
Several dunes can be located on the site, formed by the deposition of silt and sand and shaped by the prevailing winds. They form the highest point on the site, at 3 m.

Erosion potential

Erosion susceptibility of the site is negligible, although if cultivated the erosion rate would increase. The dune areas may have erosion potential, when stabilised their moisture storage capacity is relatively high, exceeding the stony sand type, and carries a dense cover of marram grass. If this cover is destroyed, wind erosion can occur, exposing the underlying gravels.

2. CLIMATE

The site falls within the eastern South Island climatic region.

Rainfall

Consistent with the Canterbury Plains region this area records a mean annual rainfall of 635 mm. This precipitation is derived from cold fronts associated with a following southerly wind. Occasionally, several days of rainfall accompany the wind from an easterly direction. Considerable monthly variation in rainfall occurs, and in the period August
TABLE 1: Climatic data recorded at Christchurch Airport (6 km from the site)

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<td>6.3</td>
<td>4.5</td>
<td>3.9</td>
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<td>9.9</td>
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<td><strong>Rainfall mm</strong></td>
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<tr>
<td>Mean</td>
<td>50</td>
<td>46</td>
<td>53</td>
<td>57</td>
<td>72</td>
<td>60</td>
<td>55</td>
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<td>46</td>
<td>47</td>
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<td>110</td>
<td>144</td>
<td>147</td>
<td>194</td>
<td>198</td>
<td>168</td>
<td>181</td>
<td>149</td>
<td>120</td>
<td>137</td>
<td>140</td>
<td>148</td>
<td>987</td>
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<td>Low</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>11</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>8</td>
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<td>Average No. of days with rain mm (1945-77)</td>
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<tr>
<td>max. 1 day rainfall</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>81</td>
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<td>Evaporation total mm (1964-77)</td>
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<tr>
<td>Mean</td>
<td>194</td>
<td>162</td>
<td>121</td>
<td>79</td>
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<td>206</td>
<td>1318</td>
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<tr>
<td>High</td>
<td>214</td>
<td>192</td>
<td>159</td>
<td>98</td>
<td>62</td>
<td>41</td>
<td>45</td>
<td>61</td>
<td>120</td>
<td>178</td>
<td>225</td>
<td>250</td>
<td>1420</td>
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<tr>
<td>Low</td>
<td>166</td>
<td>126</td>
<td>84</td>
<td>48</td>
<td>28</td>
<td>16</td>
<td>14</td>
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<td>59</td>
<td>101</td>
<td>141</td>
<td>175</td>
<td>1099</td>
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<td>Days with frost (1953-77)</td>
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<td>Ground</td>
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<tr>
<td>frost av.</td>
<td>-</td>
<td>-</td>
<td>0.6</td>
<td>3.6</td>
<td>8.7</td>
<td>17.5</td>
<td>19.1</td>
<td>15.8</td>
<td>10.1</td>
<td>5.6</td>
<td>2.3</td>
<td>0.3</td>
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<td>frost av.</td>
<td>-</td>
<td>-</td>
<td>0.1</td>
<td>0.3</td>
<td>4.0</td>
<td>12.0</td>
<td>14.3</td>
<td>9.5</td>
<td>3.9</td>
<td>1.1</td>
<td>0.1</td>
<td>-</td>
<td>45.3</td>
</tr>
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</table>
to February an inadequate rainfall can occur, resulting in severe drought conditions. The greatest quantity of rain falls between the months of April to July (Table 1).

Temperature

The mean annual daily temperature is $11.5^\circ C$, with $16.5^\circ C$ recorded as the mean temperature for January and $5.8^\circ C$ for July. Extreme air temperatures are sometimes experienced with north-west conditions and $35^\circ C$ temperatures can occur.

The mean annual number of bright sunshine hours is 1990, and monthly figures range from 215 hours in January to 120 hours in July. The site receives plenty of sunshine as there are no shaded areas of note. However, within the next ten years there will be a significant shaded area created by the \textit{Pinus radiata} plantation to the south of the stopbank.

As is typical with the Christchurch region, the site receives $15\frac{1}{2}$ hours of sunshine daily in midsummer and 9 hours in mid winter.

Ground frosts

A high number of ground frosts are recorded for the area, 83.6 days of frost annually. Although this incidence depends to a large extent on cold air draining off the Southern Alps to the lowlands, local conditions of exposure and aspect play a significant role in determining the severity of
ground conditions. Ground frosts occur frequently from late autumn to early spring. As well there is the occasional severe late spring frost which can have a damaging effect on young, unprotected plant growth. Winter frosts of 5°C to 10°C are common and are usually followed by generally high day temperatures, enough to melt the severest of frosts. As the site is of an open nature with no significant shade persisting, the problem of frost would not greatly affect ground conditions (Table 1).

Winds
The prevailing winds are from the north and northeast directions and these influence the whole of the Christchurch area, and 50 km inland. Prevalent also, although not as frequent, are the rainbearing winds from the south and southwest. The northwest wind, with drying properties, occurs sometimes at high strength during the summer months. It is an important wind for its effect on soil erosion and formation, especially in the vicinity of the Waimakariri River, and this factor alone imposes restrictions on plant growth.

( Climatic data obtained from Meteorological Office recordings, Christchurch Airport, a distance of 6 km from the site.)
3. SOIL

The site consists of Selwyn very stony soils with associated patches of sand dunes exhibiting properties which can be correlated with the geological and geomorphic nature of the area. Deposits on which the Selwyn soils were formed were laid down some 300 years ago and were subject to flooding until recently. Evidence of this is seen in the braided and undulating channels. The soils are then of recent formation and where they are not cultivated there is an incipient topsoil layer of loamy sand and very stony sand on sandy gravels containing a low amount of organic matter. The depth of this topsoil layer very rarely exceeds 200 mm and is usually 80-100 mm.²

The soil is characterised by its excessive drainage property, low available moisture storage ability, and susceptibility to wind erosion. The land primarily is capable of supporting extensive grazing, for production purposes.

A moisture deficit exists in summer and early autumn which means that pasture production is confined to late autumn, winter and spring (Table 2). The available moisture storage capacity for this type of soil for the top 460 mm is less than 25 mm and the readily available moisture is about 18 mm.³ During the course of the dry season irrigation would be necessary.
TABLE 2: Estimated water balance (mm) (1946-77)

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
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<tr>
<td>Average runoff</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>30</td>
<td>23</td>
<td>13</td>
<td>8</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Average deficit</td>
<td>51</td>
<td>43</td>
<td>25</td>
<td>10</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>36</td>
</tr>
</tbody>
</table>

Water requirements for the growing season rise from 38 mm/month for September to 102 mm/month for April (i.e. 1.3 mm/day in September to 3.8 mm/day in December-January).4

The mineral ingredients of soils usually contain in their composition, all the elements essential to plant life, except nitrogen which is found in organic matter. Of the elements necessary for vegetative growth nitrogen, potassium and calcium are those on which the greatest demands are made. The minerals of the Selwyn soil like all soils, do not contain phosphorus in sufficient quantity to support healthy plant life for long periods without add-
itions. This is no great problem with adequate fertilization and the soil responds to phosphate application. The measure of acidity, pH, of the Selwyn very stony soil, is 5.9.

4. WILDLIFE

The only wildlife reserve close to the site is Orana Park, which contains a variety of different species of animal and bird type.

Pine plantations offer limited habitats for exotic birds and there are a few open country native birds. The Waimakariri River supports wildlife, especially in the lagoons which are a habitat for brown trout. The on-site wildlife consists of rabbits and hares, and although these are noxious animals they are kept under close control by the North Canterbury Catchment Board. The presence of sheep in the area decreases the possibility of natural habitats for other wildlife.

5. VEGETATION

Although there is a considerable amount of juvenile pine species, ground cover and low shrub vegetation on the site - gorse, broom, marram grass, matagouri, flax, tussock, moss, needle moss and a kowhai tree - it is the external site vegetation which helps to form and define the existing spatial characteristics and landscape pattern.
Gorse bushes are the site's main type of vegetation.

Afforestation programmes began in the 1930's on the southern bank of the Waimakariri River to provide for both river control and timber production. A large proportion of these plantations of *Pinus radiata* were destroyed in the northwest gale of August 1975, so that over the last few years the clearance of wind thrown trees and a replacement programme have taken place. The loss of these trees in the storm was not only a production loss but a visual one as well, and definition to the southern boundary of the site no longer exists as it did previously. Vegetation does not provide any adequate shelter from the prevailing winds especially to the east and south where the boundaries are almost wide open at present. At the west end a good stand of poplar species and pines protect against the northwest wind. *Pinus radiata* trees have been planted on the north, east and south boundaries and will become functional in about ten years time.

The Catchment Board's management policy of the plantation areas
is to mill mature and leaning species and to replant with *P. radiata*. This has already occurred on parts of the south boundary and the same is proposed for the southeast corner and northern side, beyond the stopbank.

The mature stand of pines in the southeast corner of the site. These are ready for felling.

Exotic species of *P. radiata* (the most common species in the area), *Populus nigra 'Italica'* , and *Populus alba* are specific to the vicinity of the site and the choice of these species reflects their suitability to the environmental factors of climate, soils and water resources. Growth of these trees can be restricted by the low rainfall and shallow soils.

Deciduous trees are generally less affected than coniferous trees, by the high water tables which occur in winter, although they are more demanding of higher fertility and suitable conditions while they are in leaf.

All vegetation would do better with irrigation in the dry period, improvement in soil conditions, careful protection and a maintenance programme (Map 2).
6. HYDROLOGY

Surface water

The main natural source of water in the vicinity of the site is the Waimakariri River which derives its supply from catchments in the Southern Alps.

The surface water classification of the Waimakariri River is both class 'C' (minimum standard for primary contact recreational uses) and class 'D' (the lowest class of fresh water and is the minimum standard for use in general recreation, agricultural use and industrial water supplies). As a result of the main bed of the Waimakariri River becoming clogged with colluvium and because of its braided nature, there is always the possibility of flooding. As the colluvium level increases, the level of the river bed becomes raised with respect to the adjacent land. Wilson concluded that the Waimakariri River is currently aggrading its bed for a distance of about 25 km from the coast; the elevation at that point is 55 m. This buildup of material makes the levels on both sides of the river low in comparison to the water level and would be inadequate during flooding when the braided courses reach capacity.

To control the flood potential, several stopbanks have been installed, and the one of particular significance to the site, the McLeans Island stopbank, was
constructed in 1968 to protect against the most severe of floods in 100 years, with 1 m of free board. Trees buffer the stopbank on both sides to aid in controlling the potential flood waters of the river.

There has been no flooding of the land from the south bank of the river to the McLeans Island stopbank.

Rainfall is the other source of surface water. Due to the porous nature of the soils most rainfall percolates through the ground at a very fast rate.

Ground water

"Ground water resources in the Canterbury Plains area are particularly reliant on the under- 

ground lie of gravel substrates." ⁸

The ground water of the site is derived from two sources: rainwater that has been moved downward to the zone of saturation, and more predominantly, seepage from the Waimakariri River. There has been no apparent pollution of the Waimakariri River from the leaching of excess nitrogen from the soil, nor the accumulation of nitrates in ground water. ⁹

The level of ground water resources for the site can be located at about 6 m, with a seasonal fluctuation of up to 2.5 m. ¹⁰ Although the piping of a race system from the Waimakariri River is possible, it is recommended, and more feasible, to drill wells to the under-
ground aquifers because, for the needs of the golf course, ground water reserves offer the greatest potential.

For the purpose of irrigation, the water table alone provides an insufficient supply. For a constant and adequate supply, wells must be drilled deep into the zone of saturation. At Coringa Country Club there are two wells, one at a depth of 10 m which often runs dry in the summer period, and the other at 20 m which supplies a constant all year round supply.

Draw-down on wells in this vicinity is between 3 m to 5 m.

With scant data available on well drilling in the area, determination of the underground strata is difficult and there can be no strict correlation between discharge and depth. Something in the region of $68 \text{ m}^3 \text{ hr}$ discharge from a 150 mm diameter well at a depth of 7.5 m was recorded for a well drilled at Harewood.11

As the limiting depth of aquifers is difficult to locate there has been evidence at Harewood to show that aquifer permeability diminishes below 31 m.12 It implies that this depth might be regarded as an effective aquifer base.

D. CULTURAL AND MANMADE SITE INFLUENCES

Activities on the site are relatively few, except for the infrequent grazing of sheep, so
attention is focused on the external site influences.

Administration

McLeans Island is under the jurisdiction of two county councils, Paparua and Eyre. The main access road is a rough boundary between the Counties - Eyre occupying the territory to the north and Paparua to the south. However, this does not mean that County policies are divided for the area, as the controlling authority is the North Canterbury Catchment Board (N.C.C.B.).

In the 1960's the N.C.C.B. became aware of an increasing demand for land for both formal and informal recreational purposes and was able to provide McLeans Island as an area for such activity, as well as improving the access route.

Paparua County has designated the area "Quarry" in their District Scheme, although this is at present under review. Eyre County has no such scheme.

Due to the nature of the land and the N.C.C.B.'s management of this area for recreation, both Counties are prepared to reinforce this "recreation" zoning.

The N.C.C.B. leases much of McLeans Island to private and commercial organisations for recreational purposes, and reserves the right to establish criteria for selection of appropriate organisations. At
present there are eleven recreational lesses.

Industry

The most significant industry within the site's vicinity is Christchurch airport (6 km distant). Not only do the number of buildings and associated dwellings have a visual impact on the motorist, its influence is far-reaching, with the noise of jet engines and flight corridors. The noise of the engines is quite apparent, and the site is situated within the 85 dB noise contour level. Other forms of industry nearby are the Isaac Shingle Company (4 km) and, adjacent to the site, Orana Park quarry. The
Isaac Shingle Company is too distant to have any serious influence, except that Harewood and Willows Road carry the heavy trucks. The quarry of Orana Park is only for temporary use as material is being transported away so as to create a lake as part of the Park's future development. Heavy trucks constantly use the same access road which serves the site while crushing and grading machines provide a constant noise disturbance. The N.C.C.B.'s policy is to restrict the digging of pits and to take shingle from the main river bed instead.

Productive Grazing.

Much of the open and undeveloped land under lease is for sheep grazing. Only extensive grazing can be carried out due to the land's low agricultural value and its non-productive value over the summer months. The site's existing use is for the infrequent grazing of sheep. In the event of the Waimakariri River flooding to the McLeans Island stop-bank, the site can be used to accommodate stock threatened by floodwaters.

Forestry.

Along the southern banks of the Waimakariri River Pinus radiata plantations are a dominant part of the landscape. As part of the N.C.C.B.'s policy for river control and timber production,
this species was planted in the 1930's. Most of the milling currently undertaken is of wind-thrown trees from the 1975 storm.

Recreation

Users for recreational purposes include:

Facilities include a pumphouse, ablution block, clubhouse and show rings. Provision has been made for future development. Dog shows are held on most weekends by the Club.


c. Caravan Club. 13.4 ha of land for the purpose of caravanning. Spaces have been created amongst the trees.

d. Christchurch Smallbore Rifle Club. The Burnett Range. Three ranges were developed for the Commonwealth Games competition in 1974 and are now used for local competition.

e. The Combined Workingmen's Club. 140 ha of development serving the ten workingmen's clubs of the Christchurch region. Included is an 18-hole golf course, clubhouse, picnic area. Proposed are: three football grounds, caravan site, swimming and tennis facilities and motels.

f. Coringa Country Club. 137 ha. An 18-hole championship golf course and clubhouse with land for future development of other
Sporting activities and facilities.

G. Kustom Car Club. Occupying 5.2 ha with a clubroom, ablution block and picnic facilities.

H. Labour Party picnic playground for Riccarton and Wigram branches. 12 ha of adventure playground and passive picnic area.

I. Naturist Club. 14 ha. The site is used for most of the year; wind shelter and free drainage being the main site values.

J. Orana Park Wildlife Trust. The park occupies 80 ha and is open to the public on all days. A natural environment exists with much future development planned.

K. Vintage Car Club. A branch of the New Zealand wide organisation occupying some 13.5 ha. Facilities include: two halls, storage shed, ablution block, workshop, sports area and caravan site.

Other non-organised activities in the area include jogging, boating, trail bikes, gameshooting, fishing, swimming, picnicing, walking, camping and pine cone and wood collecting. (Map 4)

Trail bike riders are not encouraged to use the area. They are difficult to restrict to any one area or from the area completely. They create an erosion problem as well as increasing the noise level.

Discharging of shotguns and rifles occurs. This is illegal and incompatible with other act-
ivities in this area. Small game is hunted and targets often chosen indiscriminately.

Rubbish dumping, especially of car bodies and household waste, occurs in lesser developed areas.

Services
Electricity: An 11 000 volt line exists and is adequate for existing facilities.
Telephone cables: Adequate for present and proposed development.
Both power and telephone lines are located along main access through McLeans Island.
Water Reticulation: Each organisation has its own well. There is a constant annual water table at approximately 5 m below ground surface. Wells for drinking purposes are located at a lower depth of 15-20 m.
Septic Tanks: All existing organisations have their own septic tanks which do not interfere with the quality of well water.
Power transmission lines: Located 3 km to the east of the site running in a north-south direction from Islington to Nelson. A double row of pylons exists, both positioned close to each other to reduce visual impact.

Access
Only one main sealed road provides access from Christchurch to the recreational area on McLeans Island. A metal road exists from
the entrance of Orana Park to the site and beyond. At present, public access ends at Orana Park with a locked gate preventing further progress. It is proposed to join Willows Road to Chattertons Road to form a linkage with the Old West Coast Road. Construction has just begun on this project.

Emergency access to the site is gained along the top of the stop-banks, although the N.C.C.B. has control of this circulation.

Health

Atmospheric pollution existing in Christchurch during the winter is dissipated around the base of the Port Hills and to the south over the Plains by the prevailing northeast wind. The site is not affected by this phenomena and skies remain clean and clear.

Site

Afforestation: *Pinus radiata* trees were planted in 1974 on the south side of the stopbank, and in 1977 along the boundary with the Combined Workingmen's Club. In the southeast corner of the site *P. radiata* seedlings from fellings have grown to 4-5 m in height and provide a dense appearance. Juvenile forms of *P. radiata* (up to 300 m in height) exist in the shingle bed at the northwest end of the site inside the stopbank. They are developing slowly in difficult conditions.
Stopbank: Acting as the northern boundary of the site is the McLeans Island stopbank, maintaining a constant height of 3 m.

Shingle pit: Recently the quarrying of gravel for stopbank maintenance purposes was carried out on the site in the northwest corner. A pit of 5 m deep was created, and still remains.

Access: Shingle and grass roads skirt the interior of the site, as well as along the stopbank, and across the site from the stopbank to the southern boundary road. The on-site roads are of poor quality and only for Catchment Board purposes.

Fences: Farm fences exist on all boundaries, except along the west end of the stopbank and the eastern end of the southern boundary. Where young trees have been planted, a double row of fencing has been installed for protection purposes. Old fence lines divide the eastern end into two large paddocks for the grazing of sheep. Infrequent uses of the site include trail bikes and game shooting.
E. VISUAL ASSESSMENT

To assess the visual and spatial characteristics, the site has been zoned according to areas that have identity and those that lack this characteristic and become part of the Canterbury Plains landscape. Each of these zones will be described and evaluated with regard to their significance to the design of a golf course. Owing to the generally flat nature of the site, many of the zones overlap into other zones in terms of visual experience.

Assessment has taken place from seven focal points (A-G) using the "isovist" technique. This is a means of describing zones by plotting the limits of vision from the focal point of that zone. It is these limits of vision which help to define a particular zone.
Focal point A
Observation from a 2.0 m height.
There is a strong spatial definition to the north and northwest, but the limits to vision are weakly defined to the south making this a zone that relates to the Plains landscape. From this height the scale of the zone is far reaching, but the closeness of a solid backdrop of pine trees makes it more comfortable for human occupation.

From this point a panoramic view for 180° exists with the Southern Alps dominant as a distant visual limit to the zone.

LEGEND
- tree horizon
- distant tree horizon
- Southern Alps
- Banks Peninsula
Focal point B

The lack of any visual definition to the east means the zone becomes part of the Plains landscape. The scale is enormous with respect to the human, as the southern and northern perimeters diverge and open up the whole zone in the easterly direction. This effect will be reduced with the growth of the pine plantation on the site's easterly boundary. To the west the zone closes, pertaining to a much smaller scale. Strong spatial definition by pine trees exists in the southeast corner. This vegetation gives the zone vertical scale, making it suitable for human use near the trees.

LEGEND

- tree horizon
○○○ distant tree horizon
△△△ Southern Alps
□□□ Banks Peninsula
Focal point C
An almost limitless spatial zone, too large to have a strong sense of identity. The zone is of a scale unsuitable for human use unless broken up by trees. Some definition to the north is provided by the stopbank and shelter belt beyond, but elsewhere the zone flows off to join the Canterbury Plains. Zonal definition will be provided to the east with the growth of the existing pine plantation.

LEGEND
--- tree horizon
○○○ distant tree horizon
▲▲▲ Southern Alps
■■■ Banks Peninsula
Focal point D
A well defined zone, small in scale with spatial escape through the sand dunes to the Southern Alps and Port Hills. The southern extent of this zone is weakly defined but overall the zone is of a human scale and a definite part of the site.

LEGEND
- tree horizon
- distant tree horizon
- Southern Alps
- Banks Peninsula
Focal point E
The zone flows across the Plains to the city and becomes contained by the Port Hills. It is the Port Hills that form an important backdrop as the height of the trees does not diminish their significance as they do with the Southern Alps.

The southern limit is weakly defined and vision only becomes contained by a distant horizon of a pine plantation. A strong sense of enclosure exists to the west and north although permeable shelter belts allow for views to the Southern Alps.

The overall enormity of scale and lack of containment makes this an uncomfortable space for human occupation.

LEGEND
- tree horizon
- distant tree horizon
- Southern Alps
- Banks Peninsula
Focal point F
A well contained and enclosed zone of human scale. Filtered views of the Southern Alps give depth to the zone, but their significance is diminished by the closeness of tree belts. Only to the south does the extent of the zone flow outward, contained by a distant pine plantation. The zone is very much part of the site.

LEGEND

- tree horizon
○○○ distant tree horizon
△△△ Southern Alps
▲▲▲ Banks Peninsula
Focal point G

The zone flows outward to the east and its limit in this direction is very weakly defined. The Port Hills are the dominant feature to the southeast while a stand of poplars contains the zone to the west. It is their height and proximity that makes the zone more comfortable for people and with better definition to the east the zone will relate more strongly to human scale. The limit of the zone is reinforced by the stopbank and shelter belt to the north.

LEGEND

- tree horizon
- distant tree horizon
- Southern Alps
- Banks Peninsula
REFERENCES


2. Cox, J.E. pp 34.

3. Ibid, pp 100 Extracted from Table 18.


5. Ibid, pp 101 Extracted from Table 19.


7. Wilson, D.D.

8. Mandel, S.


10. Cox, J.E. pp 103-104 Figs 36 and 37.

11. Mandel, S.

12. M.O.W. and Development, pp 44.


14. Giller, M.T.
EVALUATION OF SITE FACTORS
From the physical requirements for the game of golf and the site's physical and visual characteristics can be evaluated the design constraints and possibilities in terms of their significance to the design of a golf course.

1. LOCATION

The site selected is suitable for a golf course for the following reasons:
- the existence of eleven groups and organisations in the area relates strongly to recreational interests and activities and the potential for further development. Adequate services in the form of electricity and telephone communication to McLeans Island exist.
- the future zoning of McLeans Island as "Recreational" by the Paparua County Council in the District Scheme and the strong possibility of Eyre County following suit
- the close proximity to Christchurch Airport and the Waimakariri River prevents residential and industrial development taking place on McLeans Island
- the porosity of the soil makes the site suitable for golf course development where good turf coverage is required and drainage a necessity for year round play
- the site is in easy reach of Christchurch and well served with
a sealed road. Future development of this road to link with the Old West Coast Road will provide access in two different directions from that existing at present, making the site more accessible - except for the noise of overhead aircraft the environment is unpolluted and any smog existing over Christchurch is dissipated to the south by the prevailing northeast wind - the abundance of a fresh water supply from underground aquifers for irrigation and clubhouse purposes - the land is not of high production value.

2. SITE CHARACTER

Although the southern and eastern boundaries of the site are open to the Canterbury Plains and to prevailing winds, the young plantations offer a potentially permanent backdrop to the site. The site would then become contained, the space well defined, and the site would no longer belong to the vastness of the Plains' landscape which is the feeling at present.

The stopbank, defining the extent of the site to the north, is reinforced by the radiata pines (Pinus radiata) and poplars (Populus nigra 'Italica') acting as shelterbelts. On the site the general gradient is 0.5% from west to east, enough to maintain flow of a water course. Old
stream swales and depressions, 1.0-1.8 m in depth, traverse certain parts of the site, indicating the drainage pattern of the land form.

Sandy knolls form the only dramatic change in height on the site and three of these outcrops are quite apparent near the centre of the site. It is these features of depressions and knolls that should be developed upon and elaborated by artificial construction to create interest, variety and to determine hole strategy. Existing topography must be used whenever possible, especially any features on an essentially flat site.

3. SITE SIZE AND SHAPE

The site is of a size large enough to permit the layout of an 18-hole championship length golf course, clubhouse, accessory buildings, amenities and the planting of vegetation with provision for an access route from the main road.

The shape of the site is not capable of including a layout consisting of three groups of six holes radiating around an elevated clubhouse. The shape is however, conducive for either two loops of nine holes or nine holes out and nine back to the clubhouse, allowing for variation in hole length. The clubhouse
should be positioned to make the
maximum use of views, aspect,
sunshine and shelter from pre-
vailing winds. In this respect,
its siting should be the first
consideration in the design.

4. SOIL

Good turf is the basic ingredient
of a successful golf course. The
extent to which a golf course can
be used and the expenditure re-
quired for the maintenance of the
turf depends very much on the
character of the soil. Any soil
that is reasonably fertile, light
and porous is capable of producing
good turf, as will a loamy soil if
its foundation is porous. In this
respect the Selwyn very stony soil
will produce good turf coverage
provided sufficient water is
applied, the pH altered to acidic
conditions, and artificial drain-
age installed to supplement
natural systems.

The pH of the soil is 5.9, a
condition which is not acidic
enough for the proliferation of
the fine grasses of browntop and
Chewings fescue and the prevention
of coarse grasses and weeds. An
application of fertilizers sulphate
of ammonia and superphosphate
in the proportion of 3 : 1
applied at 125 kg/ha will rectify
the situation to reduce the pH
to 5.2-5.3.

Gravels are to be found very near
the surface throughout the site
making topsoil a relatively
scarce resource. An average depth of topsoil is 80-100 mm which is insufficient for green and tee construction where 300 mm of topsoil is required, and even fairways will require a greater depth from that existing. For fine quality turf, topsoil will need to be imported. The porosity of the soil is reflected in its infiltration rate of 10 mm/hr.\(^1\) This minimises the accumulation of surface water, reduces the possibility of turf disease and clover growth and allows for play throughout the year. With this high infiltration rate and a marked seasonal rainfall variation (a significant soil-moisture deficit occurs between November-April) an artificial irrigation system is a necessity, especially for putting greens. The source of water for the irrigation system is from underground aquifers. A well should be drilled to a depth of 20 m for a continual all-year-round supply and operated by a submersible pump. This allows for a 3-5 m drawdown when the pump is operating. In hot dry weather of December to February when evapo-transpiration rates can reach 13 mm/day, the recommended irrigation interval for turf is every second day. The amount of water added per irrigation is 10-20 mm/300 mm depth of turf depending on the type of surface being irrigated.
The weekly amount of water required for greens is 50-60 mm, 40 mm for tees, and 30 mm for fairways.

Water should be applied preferably from midnight to dawn, hence the turf has a chance to dry out during the day and this allows play to continue uninterrupted. For night-time watering it is practicable to install an automatic pop-up system operated by a programmed time clock and valve controls. Although expensive initially this system is most efficient in handling large amounts of water and reduces labour operating costs.

5. HYDROLOGY

Water is of prime importance for the maintenance of a golf course. The site is very fortunate in having an abundant ground water resource and there is no need for storage basins to act as a water supply. Pumping of water from a depth of 20 m gives an adequate supply for an artificial irrigation system. Pumping to a depth of 7-10 m only, gives a seasonal supply as a shift in the aquifer level occurs during the summer period.

6. CLIMATE

It is expected there will be no significant variation in climatic factors due to the size of the site. Variation may occur however with the inclusion of any elements into the design, like vegetation. Future growth of
perimeter vegetation will have an influence on wind intensity, shade and sunshine hours, frost conditions and shelter from rain. Winter rainfall (May-August) will provide sufficient moisture to plant materials and turf maintenance but there is a marked seasonal variation and dry periods with little rain can occur in summer and autumn periods. Rainfall comes from the direction of the southwest.

The prevailing wind is from the northeast and protection for the clubhouse must be considered. Trees will perform an important function in this respect. It is only the northwest wind which can reach high velocity; little protection can halt this wind.

7. **VEGETATION**

The soils of the site are of an impoverished nature for the vegetative growth of trees and shrubs. Species of trees able to be grown on the site are limited, and any that are planted on the site should follow closely along the lines of what exists in the vicinity of the site. Species capable of being grown on the site under existing conditions include:

- *Acacia* spp.
- *Cedrus atlantica*
- *C. deodara*
- *Cordyline australis*
- *Cupressus arizonica*
- *C. macrocarpa*
- *Eucalyptus* spp.
- *Pinus radiata*
Populus alba
P. nigra 'Italica'
Sophora microphylla
Changes to the soil conditions and the application of water will increase the selection of plant material.

Planting of trees and shrubs as part of the design are important:
- to create hole strategy
- to provide environmental shelter
- for visual purposes
- breaking up a vast amount of land and making the site more comfortable for human use.

Vegetation should be located so as not to inhibit views of the Southern Alps which form an important backdrop to the site. Fairways should not be flanked by long stretches of vegetation that create monotony. However, fairways and greens must be given definition and trees can fulfil this purpose.

The N.C.C.B's policy of maintaining and developing pine plantations will continue to help contain and define the extent of the site.

Irrigation will be necessary to establish newly planted trees.

It is important that the first few holes are not directed straight into the early morning sun (avoid a northeast direction) and that
the last three holes are not directed into the late afternoon sun (avoid a northwest-west direction). To test the player's skill, holes should be orientated so as to utilise all possibilities of wind conditions. Where possible, consecutive holes should not be orientated in the same direction and players should not be always struggling into the northeast wind.

8. VISUAL PHENOMENA

A lack of spatial definition exists within the site. Definition that does exist is only formed when one is in close proximity to sand dunes and gorse bushes. At a greater distance from these features they become insignificant in defining spaces because of a lack of height on an essentially vast and flat landscape. The present nature of the site is not conducive for human use because of the enormity of scale and the lack of protection from climatic elements. So as to make this a more comfortable environment the space must be broken up with the planting of trees.

The extent of the site is very well defined to the west and north, and filtered views of the Alps through the trees will be an asset when considering the direction and location of holes. The site is very poorly defined on the southern boundary and flows out across the Plains.
View to the north from the knolls of juvenile pine plantation, stopbank and shelter belts.

The extent of the southern boundary is poorly defined.

would be recommended that planting take place within the boundary so as to enclose and define the extent of the site.

In the southeast corner of the site, the scale is suitable for human use, due to the height of a pine plantation which acts to protect this space from winds. As a strong impermeable backdrop, it directs the observer's view to the Southern Alps, a feature which is most impressive from this point. With this in mind, it could be a possible location for buildings and associated facilities.

REFERENCES

DESIGN PROGRAMME
THE "IDEAL" GOLF COURSE

"The ideal course", says Dr Alister MacKenzie, "is one that affords the greatest pleasure to the greatest number, gives the fullest advantage for accurate play, stimulates players to improve their game and never becomes monotonous."¹

An ideal course in reality never exists, because a course that is ideal to one player may not be held in the same high regard by someone else. However, there are certain principles that an architect must adhere to in order to produce a design that will be functional and testing to all types of players.

Essentially, a golf course should be a test of a player's skill. It should be difficult as well as being capable of providing interest. Difficulty does not arise from the presence of long grass verges, narrow fairways, small greens and blind approaches, bunkers and greens, all of which cause annoyance and irritation and reducing continuity to the game. Difficulty arises from the player having to make a choice between alternative routes to the green. This calls for great judgement and skill especially when he takes a risk in accomplishing an heroic shot in order to place a shot to gain an advantage for the next one. He must also avoid those features strategically incorporated into
the design so as not to be penalised. Not only must the player compete against his opponent and the rigours of the course, but he must cope with environmental influences as well. In this respect, holes will be distributed throughout the course in different directions so as to test the player against the elements from all quarters.

All natural beauty and features should be preserved whenever possible in order that the course be blended as naturally as possible into the existing contours and the landscape as a whole and any artificiality introduced must complement and merge imperceptibly with that already existing. The result should be one of total harmony and congruity.

DESIGN PROGRAMME

The design programme is based upon the recognition of the physical components of the site and those for the game of golf. It is the synthesis of these two components studied in a composite form that ultimately provides the physical determinants of the design proposal.

Basic philosophy adhered to in determining the type of golf course imposed onto the site:
- to provide a course that is
a challenge to all classes of players, of considerable length (approx. 6400 m) and of interesting character
- to be harmoniously incorporated into the existing landscape
- that it be an environment enjoyable to spend time in for a round of golf
- that the clubhouse complex be conducive for aftermatch functions and activities
- that the golf course, in total, be a contained unit allowing for a degree of privacy, definition and shelter.

CIRCULATION

The entry point to Newlands Golf Club from Willows Road is located in a safe position with respect to traffic movement. A clear view of oncoming and passing traffic can be gained. The Club's access road follows a similar path to the existing N.C.C.B. road and will serve all vehicles except those associated with maintenance of the grounds. The road terminates in a car park adjacent to the clubhouse.

N.C.C.B. access route on the site, south east corner.
Access to the maintenance building is located off the N.C.C.B. access road, west of the clubhouse, terminating adjacent to the building. Separation of vehicles to the clubhouse and maintenance facilities reduces conflict, especially as the maintenance vehicles are of a heavy type and the area adjacent to the clubhouse should be conducive for pedestrian use.

A small access road between the maintenance building and clubhouse is provided for the need of swift liaison between the ground staff and administration. The access road dividing the west end of the site at present will be realigned beyond the stand of poplars with N.C.C.B. approval. The poplars form a natural boundary definition for the golf course and there is no need for heavy vehicles passing across the site. Other N.C.C.B. roads on the site can be relocated without difficulty, with greater use being made of the stopbank road.

THE GOLF COURSE
Owing to the general flatness of the site any notable landforms have been maintained and utilized as part of the design programme. Excavation
on a large scale has not been planned for because it is important that the general pattern of topography be maintained as well as remaining in character with the surrounding landform. Subtle undulations to fairways and green frontages, elevation of tees and greens, widening of existing depressions to act as hazards, and the extension of sandy knolls will be the extent of excavation work. The depression extending the length of the course will be used as a water course, an important feature for governing the play of holes, creating difficulty, and providing interest. Water will be pumped from underground aquifer sources at the western end of the golf course and with a sufficient natural gradient will flow to the east end. Sealing of the depression will be necessary.

The layout of the golf course is based on a configuration of two loops of nine holes. This allows for two starting points, the 1st and 10th tees. In order to accommodate this layout within the site boundaries, the clubhouse has been located in a central position with starting and finishing points within close distance. A location for the clubhouse
in the southeast corner would have provided shelter from the northeast winds but a well spaced 18 hole layout with the 1st and 10th tees, and 9th and 18th greens adjacent to the clubhouse was not practicable. This location provided the best protection on the southern side of the site from the prevailing northeast wind. However, it is difficult obtaining complete protection from this wind, and architectural design and planting can reduce the forces of the wind.

A practice fairway is located in a convenient position to the clubhouse, within short walking and calling distance.

The course is a par 72, each nine holes comprising two par 3's, five par 4's and two par 5's, resulting in a balanced composition, although lengths vary within the par 3's, par 4's and par 5's. The total length of the course is approximately 6 400 m (7000 yds), providing for a test of length as well as skill in hitting the ball for both the professional and average player. Provision is made for championship men's and ladies teeing grounds, for each hole.

The direction of the holes
tests the player against all the climatic elements and does not favour play in any one direction. The orientation of the first three holes is away from the direction of the morning sun, while the afternoon sun will be at the player's back for the last few holes. Depending on starting times for a round of golf, this will adequately cater for the majority of cases as players will not be faced with having to play balls into the low angle of the sun late in the day.

Vegetation
Plantations surrounding the course are generally of a juvenile and healthy nature. (Milling of the mature stand of _P. radiata_ in the southeast corner is to be undertaken by the N.C.C.B. although replanting will be made.) Design of the course has been made within the framework of these plantations which, in a mature state, will provide environmental shelter and site containment.

Provision has been made to selectively thin the pine plantation adjacent to the stopbank, and with N.C.C.B. approval the plantation to the north of the stopbank will be thinned. This will
allow for the continuance of views from the clubhouse to the Southern Alps and foothills. It is essential to plant trees on the course for environmental protection, to govern the play of the hole, to create fairway and green definition, for a visual quality, and to provide spaces that are suitable for the players' comfort. Planting of trees will occur throughout the course but will not inhibit views of the Port Hills and Southern Alps from teeing grounds and fairways. The southern boundary will be reinforced with massed planting so as to define the site more emphatically.

Plant species will be essentially the same in character as those existing in the vicinity, but applied irrigation will increase the variety of species. Under these improved conditions, plant material selection may include:

**Evergreen**

- *Acacia* spp.
- *Caragana arborescens*
- *Cedrus atlantica*
- *C. deodara*
- *Cupressus arizonica*
- *C. macrocarpa*
- *C. torulosa*
- *Cytissus scoparius*
- *Dodonea viscosa*
Ground cover

Ajuga reptans
Bergenia cordifolia
Choisya ternata
Chionocloa spp.
Coprosma kirkii
Cortaderia spp.
Cotoneaster spp.
Euphorbia wulfenii
Festuca spp.
Hedera helix
Pachysandra terminalis
Phormium Cookianum
P. tenax
Santolina chamae cyparissus
Senecio greyii
Stachys lanata
Vinca spp.
Eucalyptus spp.
Juniper spp.
Pinus radiata
Pseudopanax crassifolium
Pittosporum tenuifolium

Deciduous

Alnus glutinosa
Betula spp.
Cercis silicuasrum
Cladrastis lutea
Gleditsia triacanthus
Larix decidua
Populus alba
P. chinensis
P. deltoides
P. nigra 'Italica'
Robinia pseudoacacia
Sophora microphylla

Soil

An additional layer of topsoil will be required at the west end of the site, especially adjacent to the stopbank where an absence of topsoil exists. Where any excavation takes place topsoil will be stockpiled and replaced.

Stones must be removed before
the sowing of grass seed takes place.

THE CLUBHOUSE

The clubhouse has been located on the southern boundary of the course for the following reasons:
- the P. radiata plantation will provide protection from cool southwest winds and rain
- a north orientation provides maximum amount of daily sunshine, especially important for the activities of swimming, tennis, children's play and for socialising
- this orientation makes full use of views to the Southern Alps and foothills
- the distance from Willows Road gives privacy to the clubhouse complex
- within easy reach for utilization of public utilities of electricity and telephone lines
- the close proximity to the 1st tee and 18th green.

The clubhouse will be of a two-storeyed elevation, giving an overall view of the course.

The flat terrain is suitable for locating the clubhouse and the accessory facilities of car parks, tennis courts, swimming pool, barbecue and play area.

Two car parks have been located to the south and
adjacent to the clubhouse, one permanent and the other for temporary use. This location is convenient for use by golfers and their trolleys. For an overflow of cars during tournaments a third car park is located off the access road, 250 m from the clubhouse. This will be used by spectators who will have no real need to use the clubhouse facilities.

A route to the clubhouse will be provided for vehicles leaving passengers at the club.

MAINTENANCE FACILITIES

The maintenance building has been located close to the clubhouse for liaison with administrators and is in a relatively central position on the course. The P. radiata plantation will provide good shelter from the southwest winds, and the building is orientated to the north.

LEISURE RESOURCE

As part of the site investigation it was found that a lack of continuity existed between recreational users of McLeans Island as each club or association has its domain fenced off from all other users. It is therefore
proposed to provide for a
recreational use/s that will
encompass a large part of
McLeans Island and used by
the different clubs and
visitors.

The Caravan Club attracts
visitors for weekends and
holidays, golfers from the
three clubs spend a considera-
able time in the vicinity,
visitors to Orana Park and to
shows and displays held by the
different clubs provide a
nucleus of people capable of
utilizing further recreational
resources, as do clubs from
town wishing to use the land
for recreational activities.
Possible activities include
cycling, jogging, walking,
orienteering, camping, trail
bike riding, shooting and horse
riding. Tracks and roads will
be developed and existing ones
utilized for routing of
different activities and areas
of interest will be planned for
along these routes.
Routing will not interfere with
existing club activities,
although locating tracks around
the perimeters is quite feas-
able depending on the club
activity. Prior to any
possible development of this
scheme, acceptance and approval
must be gained from the
N.C.C.B. whose land this is,
and from the leasees whose land
may be included in the proposal.
Visual appearance of the area
is subject to the milling of plantations by the N.C.C.B.

Requirements for activities:

**Camping**
- an available water source
- flat ground for camps and extra activities
- open area and vegetation
- access road to the camp area.

**Cycling**
- utilize existing roads
- tracks and roads must be safe for cycles
- no pedestrian conflict
- sources of interest throughout the routing
- utilize river as a point of interest.

**Jogging, walking and orienteering**
- variety in terms of natural features
- the need for vistas and views, containment and expanse to heighten the senses
- points of interest on the routes and shaded areas for relaxation
- several routes serving different areas and of different distances
- a need for wooded areas for orienteering.

**Shooting**
- open spaces devoid of people
- an adequate amount of
game to shoot.

**Trail bike riding**
- land that is of poor quality
- land which has natural features to negotiate
- located at a considerable distance from people due to a high noise level.

**Horse riding**
- in areas where there is no conflict with motor traffic
- a routing that has points of interest with views, spaces of different sizes, shaded and open areas
- well constructed tracks not too stony, preferably grass.

**REFERENCES**


The design proposal has evolved from an understanding of the site factors, the physical determinants of a championship course, and the needs of a private club. The result is a golf course that tests the players both mentally and physically, a challenging course that offers alternative routes for many holes, and an area of land that has a character conducive for spending several enjoyable hours in.

CIRCULATION

It was originally intended to have a separate access for vehicles to the clubhouse, and to the maintenance building. It is now proposed that one access road to the whole complex will create a more contained and unified Club. Confusion as to the correct entrance for maintenance vehicles will not exist with only one access, and a point near the clubhouse will act to determine the direction of respective vehicles.

The entry point to the club has also been relocated from that proposed in the design programme. This is for two reasons:
- that the area on both sides of the Club's access road can be controlled by the Club itself, whereas with the original location, the road shared the boundary with the Combined Working Mens' Club
- on approaching the golf course

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itself, the arc of the car allows the driver and passengers to gain a view of a portion of the course and clubhouse before turning towards the car park.

The length and direction of this road creates privacy for the Club as well as a pleasant introduction with a drive through the woodlot.

A notice, "NEWLANDS GOLF CLUB", will mark the entrance to the Club. The width of the road will be 7 m and sealed, with a grass verge of 10 m. The direction of vehicle progress near the clubhouse is determined at the roundabout. Alternatives are:

- to drive through the car park and leave passengers at the clubhouse entrance
- to park the car in the permanent car park
- if this park is full, then entry from the roundabout is made to the temporary car park
- to drive to the maintenance building.

CAR PARKS

The permanent car park for 100 cars is a one-way system with sixty-degree parking. Adequate control of this system will be provided with signs and arrows as well as the angle of parking. As most users of the park will be members,
they will become easily accustomed to this system which permits a flow of traffic with minimum conflict. Trees in the car park will help to break up and soften the large space. The surface will be sealed in asphalt.

Two other car parks are located for an overflow from the main park during tournaments and large functions. Both are grassed and surrounded by vegetation to reduce the visual impact of such large areas with cars.

Under normal conditions the main car park will be sufficient to accommodate cars.

THE CLUBHOUSE

The siting and design of the clubhouse is, in the minds of many golfers, just as important as the golf course itself. The clubhouse has been an influencing factor for determining the layout of the course because it is considered essential that it enjoys a northerly aspect, utilizes views of the Southern Alps and that a sufficient area adjacent to the building can include two starting and two finishing points.

The size of the clubhouse and accessory facilities has been based on a projected 700 financial members. The clubhouse is of a two-storeyed elevation of brick material,
coffee in colour, with dark brown iron roofing. A setting conducive for after match socialising has been allocated on the upper floor and dining and bar facilities are available. Viewing of play and panoramic vistas of the Alps and foothills can be gained. A balcony allows better scope for enjoying the play and scenery in fine weather. The ground floor plan provides the facilities of a secretary's office, tournament controller's office, Pro. shop, mens and ladies locker rooms, public cloakroom, steam room, lobby area and storage rooms.

The area in front of the clubhouse has been designed in a functional manner to cater for the heavy use outside the locker rooms. Trolleys and spiked shoes are particularly heavy on such an area, therefore hard surfacing is a necessity. An area has been allocated for socialising, with shelter provided from the north-east wind.

A swimming pool, tennis courts, changing rooms, outdoor bar and children's play area are located to the west of the clubhouse, a location that gains maximum amount of sunshine. Shelter is provided from the north-east by a brick wall and tree planting. The changing facilities are shared by those playing tennis and swimming. This area is an entity of its own, yet views of the course can be seen and a path links this area to the
clubhouse and car park.

MAINTENANCE BUILDING

Access to this building is from the Club's main road. A large single-storey building constructed in the same material as the clubhouse serves as a storage shed, workshop, a base for the grounds staff and the head green keeper's office. A sealed area to the side and front of the building will be used as a car park for staff vehicles and ground machinery. A maintenance access route is located within the perimeter of the course to provide access of vehicles and machines to the greens, tees, fairways and any other features that require attending to.

THE GOLF COURSE

Few restraints interfered with the layout of the course except that existing trees on the perimeter were maintained, depressions were utilized as were the knolls. Each hole is an entity in itself - its extent defined by planting, rough grass, natural features or hazards. The composition of the course provides variety for the player. The par 3 holes vary in distance and strategy and require different shots from a lofted iron to a long iron. It was considered important that the par 3 holes
of each 9 holes should be of varying lengths and that they be distributed throughout the round, i.e. hole no. 4, 7, 11, 16. The par 5 holes vary in length and character to provide two full shots and a well hit iron approach shot from various distances. Although the 9th and 10th holes are two successive par 5's, the former is considerably shorter, providing an opportunity for the big hitter to aim for the green with his second shot, although with risk. The par 4 holes require a full wood shot from the tee. The remaining distance varies in character and length so the player must hit his approach shots with different clubs. There are three long par 4's (420, 410 and 400 m), three medium (360, 370 and 380 m) and three short (340, 335 and 350 m).

There are 18 different and challenging golf holes, each posing problems to the player and testing his skill with little feeling of duplication. The basic style of architecture employed is one of "strategic" and "heroic", whereby the player must place his shots accurately in order to gain a favourable result. The penal system has not been adopted as this penalises the good meritorious shot. Bunkers, stream, lake, depressions and trees act to fashion the strategy of most holes.
Course elements

(a) Fairways

Although there are inherent subtleties in the existing topography, excavation of fairway areas will be necessary to create advantageous and difficult lie positions. Large scale excavation is not proposed owing to the gravelly nature of the soil and the fact that hole strategy can be determined without great earthwork manoeuvres.

Unwanted gorse, tree stumps and unused fence lines will be cleared from the site.

No artificial drainage of fairways is required owing to the porosity of the soils.

The majority of fairway hazards are designed to reward the good shot and provide an alternative route with loss of a stroke for the poorly executed shot. The landing area and fairway bunkers are approximately 200-240 m from the tee with a view of the green from the approach shot. The width of the fairway is between 30-60 m.

On some holes the area in front of the green and teeing ground has been left in grass longer in length than that of the fairway. This heightens the accuracy of the player's shot as well as reducing the amount of mowable grass.
A considerable distance between fairways provides for an area of rough and tree planting, protection for the player’s safety from any mishit shots, and to strengthen the identity of each hole.

(b) **Putting greens.**
The greens are 500-600 m² in area and provide sufficient space for several flag locations. Each green is different, depending on the angle of slope, undulations and entrance. The entrance to many greens is guarded by bunkers which demand a variety of approach shots and degree of skill to carry them. The selection of areas for greens was determined where possible by natural features, i.e. near the stream, depression or on a knoll.

All greens are slightly elevated, 0.5-1.0 m, requiring an amount of grading to blend them in harmoniously with the surrounding landscape. Additional layers of topsoil will be added to putting greens.

Although the soil is extremely porous, each green and bunker near the green will have a tile drain complex to take away water from the putting green area. Compaction of soil and a turf mat build-up reduces porosity of the putting green soil. Aerating will alleviate this
problem as well, and this can be carried out in autumn and spring with a mechanical spiking machine.

The putting greens will be laid with Chewings fescue and browntop, in the quantity of 2:1 applied at 17 g/m². For these grasses to grow satisfactorily the soil pH must be altered from the present 5.9 to 5.2-5.3. Therefore a quantity of 1 part superphosphate and 2 parts sulphate of ammonia will be applied at the rate of 30 g/m². Fertilizing of the greens will take place once a week with a quantity of 3 parts sulphate of ammonia to 1 part superphosphate.

Mowing of the greens will take place once a week in winter, twice a week in spring and three times a week in summer.

(c) Teeing grounds

These are elevated, giving additional height to the shot and a chance to survey the length, strategy and scenic quality of the hole. Basically rectangular in shape, the teeing grounds vary in size between 280-350 m², which allows for wear and tear and moving the tee markers.

Three tee areas for each hole are provided - mens, ladies and championship. Where possible, all three have been located on the same area of
elevated ground, but in the instance of hole No.10, a distance of 80 m separates the championship and ladies tees, two separate teeing grounds are necessary.

(d) **Bunkers and hollows**
Their placement has purpose and they have not been indiscriminately incorporated into hole design. Excessive mounding has not been planned for as it becomes incongruous with the essentially flat landscape. Subtle undulations have been incorporated into the area surrounding the green so as to assist the player who has opened up the hole correctly yet acts as a hazard to those who have failed to do this.

**Lake and stream**
An underground aquifer has been tapped at the west end of the golf course to provide water for the depression. The depression has been modified to hold a body of water that is 2.5 m - 4.0 m wide and 1.0 - 2.0 m deep.

For a constant flow of water at 30 mm/sec, and allowing for a seepage rate of 8-10 mm/hr, a 73 l/sec quantity of water will be pumped from the well. A 12 kw electrically operated submersable pump will lift this body of water from a depth
The water will fill the pond (2.0–3.0 m in depth) before proceeding down the channel. The depression will be lined with stones of approximately 8–10 mm diameter. In order to slow down the flow rate, a series of weirs (one every 100 m and 1 m in height) will be constructed. The water then drains into another pond before flowing off to the Waimakariri River in a constructed channel.

It is intended to pass the water under the stopbank by gravity, although final approval by the Catchment Board will be necessary. If this is denied, then pumping the water over the stopbank will result.

**IRRIGATION**

To irrigate the course a fully automatic clock-control system operating hydraulically activated remote control valves is designed for. This applies water through permanently installed rotary heads. A submersable pump will supply water from a depth of 20 m. This will provide a constant rate of supply. The pump and clock-control system will be located in a shed in the centre of the course. PVC piping will be installed to route water to fairways, teeing grounds and putting greens. There will be a single row of sprinklers for the fairways each having a 27 m
radius and a 60% overlap.

Each green has four sprinklers located on the edges, and the teeing grounds, depending on the size, will average two sprinklers.

The site receives 635 mm of rain annually with a moisture deficit occurring in the summer. Therefore no irrigation will be necessary in the winter, except in exceptionally dry conditions. From mid-October to February, the automated system will be operated on the basis of supplying 7 mm/night. Each green will receive two twenty-minute waterings/night and each teeing ground, ten minutes/night.

Watering will take place between the hours of 11.00 pm and 7.00 am, although the duration and quantity will depend very much on the climatic and soil conditions, at that time.

PLANTING

The planting of species on the golf course will not only enhance its physical appearance but will help to create spaces that are more suitable for human occupation.

Trees have been used to:
- provide backdrops to greens
- identify fairways
- shade teeing grounds
- strengthen the strategy of
- create an environment in which playing golf is an enjoyable experience
- provide shelter from prevailing winds.

As the site will be devoid of vegetation initially, gorse will be maintained in appropriate places to create definition to fairways and greens until trees become functional.

It has been preferred to establish evergreen species on the course as they provide an all-year-round function with deciduous species, mixed with evergreens, located near the clubhouse for their attractive forms, foliage and flowers.

LEISURE RESOURCE
The following activities have been decided upon as part of McLeans Island recreational resource:
- camping
- cycling
- walking
- orienteering
- horse riding
- jogging
- trail-bike riding.

Shooting was not considered compatible with existing and proposed users owing to the element of danger involved.
HOLE DESCRIPTION

This description is based on the championship length of the course.

Hole No. 1 340 m (372 yds) par 4 "Westward". The paramount requirement for the opening hole is that it should enable play to flow from the outset and this is exactly what the first hole does. It is straightforward, posing few problems and allowing the golfer a good start, and a chance to loosen up. The hole should be played straight away from tee to green although the drive must be accurately played as a bunker can catch the half hit and sliced tee shot. Trees and gorse to the left define the extent of the fairway. The only difficulty with the hole is in the choice of the correct club for the approach shot to the green - whether to pitch the ball or run it onto the green. The green is slightly elevated and slopes away to the stream.
Hole No. 2 410 m (445 yds) par 4
"The Alps". After the straightforward first hole, the player is brought against the stern test of reality. This hole is the severest par on the course and places considerable demand on the tee shot. The best line for this shot is to the right side of the fairway which provides for a good position for the approach shot to the green. Two bunkers guard the edge of the fairway at 200 m for anything mishit, while a large bunker will take care of any ball from the big hitter that is long but not straight enough. The tee shot is also governed by the cluster of trees which eat into the left side of the fairway.

The fairway is slightly undulating and can have an influence on the roll of the ball. The second shot requires a long iron which again must be hit with considerable accuracy to a narrow and well protected green. Not only does the green slope away on all sides but an overhit or sliced ball will meet with disaster in the stream to the right, and one that is not cleanly struck or bold enough may land in the depression in front of the green. From the depression a delicate chip shot is required, one that does not run too hard to the back of the green.

This hole is subject to cross winds from the southwest and
northeast, increasing the hazardous nature of this hole. Views of the Alps add to the visual quality of this hole.

### Hole No. 3
490 m (536 yds) par 5 "The Burn". It is important that a par 5 provides a continuing test of control and thought. A strongly hit drive is required from the tee to provide for a clear approach shot to the flag. The player must decide whether to:

(a) go for a bold shot and carry* the stream at 240 m so as to give himself a chance of getting onto the green in two shots and a chance for a birdie (one stroke under par for the hole)

(b) drive over the trees on the left of the fairway, landing near the stream, and then another long drive with a 3-wood or 2-iron onto the green

(c) play safe and drive about 230 m leaving himself a safe position for his second shot, followed by a chip shot onto the green.

This green is capable of being reached by two excellent shots requiring deadly accuracy and considerable strength. The bold shot courts with disaster - if the ball rolls into the stream, the player drops a stroke, yet if he overhits, it may land in the bunker and the possibility of losing par. The green opens to the right
side of the fairway, and any approach shot from the left must carry the bunker.

The difficulty of this hole is increased substantially during strong northwest wind conditions.

Hole No. 4 140 m (153 yds) par 3 "Poplars". This hole is a psychological problem to the golfer. The hazard confronting him is a means of threatening his peace of mind and he has no option but to direct his shot over the lake. Only a mis-hit caused by a faulty swing would bring disaster to his shot, otherwise the ball should land on the green.

The scratch handicapper on the other hand, is concerned only with the flag placement - choosing the correct club and deciding which part of the green to aim for to give a favourable putting position. A ball landing at the back of the green, a definite possibility in a southwest wind, will leave a very difficult and long downhill putt. Anything overhit will be caught by bunkers to the rear, leaving a difficult chip shot.

The hole brings a sense of total satisfaction to the player whose ball lands on the green beside the flag. With a backdrop of dark green pines, a vivid contrast is gained with the light green colours of the turf and the lake adds to the serenity and beauty of this hole.
Hole No. 5 390 m (427 yds)
par 4 "The Corner". A dogleg to the right, enticing the player to chew off as much as possible of the corner in order to give a good approach shot to the green. If he plays down the right side, skirting the trees, and with a northwest wind blowing, there is a strong possibility of carrying the bunker at 250 m, but the prevailing northeast wind could restrict such long distance hitting. The second shot calls for a 6 or 7-iron giving plenty of loft so that the ball holds on the green. Even if one plays safe, the tee shot should be placed on the elevated part of the fairway. If it fails to hold the fairway, which narrows sharply, and rolls into the hollow, it makes for an awkward angle to the green for the approach shot.

The green opens up more and more as the drive is played to the left because bunkers closely guard the green on both sides, increasing the accuracy required to land near the flag.
Hole No. 6 360 m (394 yds) par 4 "Pines". A punishing drive into the prevailing northeast wind will result in a 4 to 6-iron approach shot onto the green. A series of bunkers to the right governs the direction of the tee shot, although a strongly hit drive of 260 m could carry the bunkers, if the wind is conducive for such play. If this shot succeeds the player is rewarded with a straight forward approach to the green of no more than 100 m.

The green is built into the existing knoll and is well elevated, sloping gently towards the front and dipping away sharply behind, as well as into the approach area. The knoll defines the green to the right. Any approach shot not landing on the green will mean a delicate recovery shot from the deep bunker or hollows.
Hole No. 7 170 m (186 yds)  
par 3 "The Crater". As the name implies a large bunker is the main feature of this hole. Play is from the tee on the knoll to an elevated green defined by trees. Anything from a 5 to 8 or 9-iron can be used depending on the wind direction. The prevailing northeast wind will drift the ball to the right and allowance for this movement should not be so great that the ball is pushed to the left and well below the green. The tee shot should be pitched near the front of the green so it can be allowed to roll to the flag. Too much backspin on the ball will cause the ball to roll back onto the fairway. The deep bunker will take care of anything sliced or mishit.
Hole No. 8  410 m (448 yds) par 4 "Panorama". From the teeing ground the routing for this hole is clearly defined. The sloping sides of the three knolls define the extent of the fairway and trees control the direction of the dogleg. A strong southwest wind will make this hole a difficult test of length. The pro. will be aiming to clear the first hazard, a 1.5 m deep depression at 230 m. If this shot is too big there is a strong chance the ball will land in the rough or trees at the dogleg corner. Precise judgement with the tee shot is required. It is important to gain a lie in the centre or slightly left of the fairway because bunkers are tantalisingly close to the right side.

With the wind at the player's back the length of the approach shot will not seem as prodigious as first thought and with a 4-iron he will reach the green in two shots. Any shot just short of the green will be in trouble as the stream makes for a difficult entry and the fairway slopes into it. Bunkers protect the green and catch anything overhit.

The green is essentially level with a slight forward slope.
Hole No. 9  475 m (520 yds)  
par 5 "Tricky". This is certainly not a lengthy par 5 hole, but wind conditions, natural features and hazards makes this more difficult than the length implies.

The tee shot is governed mainly by the stream meandering its way along the right side of the fairway and clusters of trees to the left. It is essential then that the ball is hit straight and true, otherwise the player's position for the next shot will be severely handicapped.

If the player finds himself to the right on the fairway and with the flag unsighted, he can either be prepared to play down the fairway to the corner and leave an extremely long third shot to the green, or play over the trees to the approach area of the green. This in itself would be a spectacular shot but the problems to be negotiated are immense.

On gaining a good position for the second shot the player can either play a 4 or 5-iron to below the green approach for a chip onto the green and an easy par 5, or go for a daring 2-iron or 3 wood shot onto or beside the green and a chance for a birdie.

Anything hit to the left of the target area will be caught in the bunkers, while an overhit shot rolls off the back of the elevated green. For this hole the player is faced with the decision of...
whether to try for the green on his second shot. In northwest conditions, this is a definite possibility but a cross wind from the east or south makes it more hazardous. The reward for successful, bold play is most enticing and on such holes is where tournaments can be won or lost.

The hole has an imposing backdrop of clubhouse and the Port Hills.

Hole No. 10 525 m (575 yds) par 5 "The Donga". This is a hole riddled with hazards, yet played correctly it is no more difficult than any other hole.

The strategy of the hole is quite simple.

The intrusion of the lake into the left side of the fairway directs the shot to the middle and right side of the fairway. A cluster of trees to the right directs the shot even further and anything sliced will be taken care of. From the fairway a 3-wood or low iron will be sufficient to land between the stream and depression. From there a chip shot onto the green and two putts will secure a comfortable par 5 for the player.

However, the player is faced with other options from the tee. If the wind conditions are anything but from the northeast, the player can attempt to drive over the corner of the lake, leaving himself in a favourable position for his
next shot. In this shot he is faced with the decision of either placing the ball between the stream and depression, or for the area between depression and green. If this shot is not bold enough it may be caught in the depression which is deep enough that he can only see the top of the flag and with the green sloping to the left it makes for a difficult shot.

The green is nestled into the pines and the green is further defined by bunkers at the entrance.

Hole No. 11  160 m (175 yds)  par 3 "Windy". Following the two par 5 holes, this hole will provide a complete change in strategy for the player. He must not be inhibited by the body of water, because if he is and hits the ball to the right, bunkers await. The difficulty of this shot is further increased in northwest wind conditions with the ball being directed towards the lake.

The green is essentially level, with slight indentations at the entrance, so the ball should be directed at the flag.
Hole No. 12 370 m (405 yds) par 4 "Waimakariri". A straight and controlled drive should place the ball on the elevated part of the fairway at 230 - 260 m. A tee shot that is too bold will encounter a bunker to the left of the fairway while a sliced shot may not avoid one of two bunkers or the rough beneath the trees. The narrow fairway allows little room for error with the tee shot. For the second shot a medium to lofted iron is enough to land the ball on the upper tier of the green. Anything overhit will roll into the pine trees, leaving a difficult chip back onto the forward sloping green. The hollow in front of the green and bunkers, governs the play of the shot onto the green.
Hole No. 13  335 m (368 yds)
par 4 "Everyone's Folly".
A clear view of the flag can
be gained from the teeing
ground and a straight and accur­
ate drive will see the ball
land on the elevated part of the
fairway. For his next shot the
player is faced with two options:
to pitch or run the ball onto
the green, both requiring
delicate judgement and placement
onto the small green. The
fairway is narrow and bunkers
eat into it, especially the
one in the approach area to
the green, making the entrance
extremely narrow and tight.
Although not a long hole,
Hole No. 14  400 m (437 yds)
par 4 "The Spoiler". The
direction of the tee shot is
slightly to the right of the
centre so as to gain a good
lie for the approach to the
green. First, a wide depression
must be negotiated, at a depth
of 1.5 m. If the ball lands
in this the player has little
chance of completing his par
for the hole.

The hole provides the opportunity
for the player to chew as much
off the right side of the fairway as possible, although it is
risky with trees and a bunker
strategically placed. If the
shot is successful the green
has opened for the approach shot.

The approach shot must carry
two depressions of between
1.0-1.5 m in depth and must be
strongly hit to carry the
second one so as to reach the
green.

With the flag located on the
right side of the green the
tendency will be to slice
the ball, so a bunker is
located to catch this shot,
which was on target but not
accurate enough. Any shot to
the back of the green will
leave a very long putt of
about 15 m to the flag.
Hole No. 15  500 m (547 yds)  
par 5 "Mountain View". This hole is visually appealing with views to the Southern Alps, especially in northwest conditions, as the blues of the foothills form a strong contrast with the light green turf. In these conditions a powerful tee shot is required, followed by a long second shot to the green.

The difficulty confronting the player with the second shot is the indecision of whether to hit over the bunker at 60 m from the flag so as to get closer to the green, or to play safe in front of the bunker but increasing the demand placed on the approach shot.

The green is elevated and sloping gently to the right, away from the knoll into which it is nestled. The surface is essentially level and the green is backed, so as to control any shot which runs too hard past the flag.
Hole No. 16  200 m (210 yds)  
par 3 "Sandy Knoll". A well contained hole, separated from the others by knolls. The tee shot is from atop a knoll onto a green which slopes forward into the fairways. With the prevailing wind at the player's back, a medium to low iron could be used, and a 3-wood for southerly conditions.

Although there are no additional hazards, ground modelling determines the strategy of this hole, making it imperative to land close to the flag.

A ball not landing on the green will mean a delicate chip shot, and the possibility of it running off the other side of the green. If the flag is to the rear of the green, the wrong choice of club could result in over-hitting into the vegetation behind. Anything that is hooked will find trees.

This hole requires a precise choice of club selection, a truly hit tee shot and a well stroked putt.
Hole No. 17  350 m (383 yds)  
par 4 "Reprieve". From the teeing ground much of the left side of the fairway is blind, although the flag can be comfortably seen. The tee shot must carry the outer limit of the knoll and anything sliced to the right will be in danger of landing in the bunker at 230 m or the shallow depression which runs along the right hand side of the fairway. A tee shot to the left will open up the green for the approach shot.

If the approach shot, a 7-iron would be sufficient to land on the green, drifts to the left into a bunker the player has an awkward 25 m chip shot onto the green.

The green is large, 600 m², and if the ball lands on the forward part the player may have a problem in getting to the flag at the back of the green in two putts. It is essential for the approach shot to land as close to the flag as possible.
Hole No. 18  380 m (415 yds)  par 4 "Tally Ho". For this hole the emphasis rests firmly on the tee shot. First, there is the diagonal row of bunkers to clear and then there is a bunker on the left which eats into the fairway. The need for an accurate tee shot is heightened with such a small landing area available. There is also an alternative for the player to hit over the stream at 230 m, in order to have an easier approach to the green. For the ball that lands before the stream a medium iron will land the ball on the green, while a lofted iron is used from a distance of 130 m.

The entrance to this green is the most closely guarded on the course, and the most demanding shot is required in terms of accuracy. The approach shot must therefore be aimed for the centre of the green to clear the hazards.

In terms of length this hole is not demanding but it is a hole which can change a player's fortunes and provide a climactic finish because of the placement of bunkers, the location of the stream and the alternatives enticing the player.
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REFERENCES

Bunker. An area of bare ground, often a depression which is covered with sand.

Carry. The distance between the point of hitting the ball and its first bounce on landing.

Course. It is the whole area within which play is permitted and it is the duty of the authorities in charge of the course to define its boundaries.

Divot. A small strip of turf taken out of the ground in playing iron shots.

Draw down. When a well is pumped its water level is lowered, the amount of lowering being directly proportional to the quantity of water pumped.

Fairway. The area of turf specially prepared between the tee and green.

Flag. A movable indicator centred in the hole (cup) to show its position.

Green. (putting green). The part of a golf hole specially prepared for putting the ball into the cup.

Handicaps. A system of awarding bonus strokes which enable golfers of differing levels of ability to meet on equal terms.

Hole. The playing area from the tee (teeing ground) to green (putting green).

Holing out. A ball is "holed" when it lies within the circumference of the hole set within the green.
Irons. Clubs, the head or striking part of which are made of metal.

Par. The number of strokes required by a first class player at each hole. The sum of each hole par is the total par for the 18 holes, e.g. a par 4 hole is one a player can reach from the tee in two shots and two putts.

Pot bunkers. Small circular sand traps that used to dot fairways under the "penal" style of architecture.

Rough. The area within the course not specially prepared for play.

Round. Consists of playing the 18 holes of the course in their correct sequence unless otherwise authorised by the club committee.

Scratch handicap. A handicap of nought. The player neither gives nor receives strokes in a match.

Teeing ground (tee). The area from where the ball is put into play.

Wood. Clubs, usually of four different kinds whose heads are made of wood. Used for longer shots.
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BIBLIOGRAPHY
New Jersey, Prentice Hall, Incl.

Soil Bulletin 34, Wellington.

Dawson, R.B. 1968. Practical Lawncraft and Management of Sports 
Turf. London. Crosby Lockwood and Sons Ltd.

Garnier, B.J. 1958. The Climate of New Zealand: A Geological 

Parks and Recreation, Lincoln College, University of 
Canterbury, N.Z.

Golf Development Council. 1972. Elements of Golf Course 
Layout and Design.


Jones, R.L. and Rando, B.L. 1974. The Urban Land Institute 
Technical Bulletin 70: Golf Course Developments.

Levy, E.B. et al. 1954. Construction Renovation and Care of the 


Mackenzie, Dr A. 1920. Golf Architecture (Economy in Course 
Construction and Greenkeeping). London. Simpkin Marshall, 
Hamilton Kent & Co.

Mackenzie, Dr A. 1920. Golf Architecture (Economy in Course 
Construction and Greenkeeping). London. Simpkin Marshall, 
Hamilton Kent & Co.

Plains.


