supplementary fusarium testing report

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PROJECT
Cronulla Town Centre Upgrade - Stage 2
Cronulla Mall & Kingsway, Cronulla, NSW 2230

A Supplementary Report to Arterra's Pre-Development Tree Assessment Report 30/1/19: Regarding the Sampling and Testing of 23 *Phoenix canariensis* (Canary Island Date Palms) For Fusarium Wilt

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i EXECUTIVE SUMMARY

In September 2019, Arterra Design was engaged by the Sutherland Shire Council (SSC) to prepare a predevelopment tree assessment to inform the Cronulla Town Centre Upgrade – Stage 2. As part of this assessment Arterra was also to undertake a program of sampling and testing for *Fusarium oxysporum f.sp. canariensis* (FOC) in **23 *Phoenix canariensis* (Canary Island Date Palm)** located within the Cronulla Mall and adjacent the mall entry on the Kingsway.

The purpose of the sampling and testing was to ascertain, as far as reasonably possible if the pathogen, FOC, was present in the palm population and if so, to what extent. FOC is the pathogen that causes Fusarium Wilt of the Canary Island Date Palm, a disease that is lethal to *Phoenix canariensis* and certain Washingtonia Palms. Due to the infectious nature of the FOC pathogen and its inevitably lethal outcome for infected *Phoenix canariensis*, those palms found to be infected should not be considered for retention in developing the public domain design, nor considered for transplanting.

On 19 September 2019, sampling was carried out in accordance with Royal Botanic Gardens Sydney Plant Diseases Diagnostic Unit (PDDU) requirements. Samples were collected, bagged, labelled and delivered to the RBGS for laboratory testing. Fungal Identification (FID) tests were also undertaken to identify other potential fungal pathogens. The test results show only one *Phoenix canariensis* (T01) returned a positive result for FOC. It should be noted that this particular palm showed little obvious or visible symptoms to suggest the presence of FOC. The Fungal Identification (FID) test results confirmed the presence of numerous other pathogens within the population, some of which present with symptoms very similar to those that occur with FOC. Although affecting palm appearance and health, the other fungal pathogens are believed to be non-lethal.

The test results show a similar pattern to the results from previous testing, in that many palms may display macro symptoms consistent with Fusarium Wilt, however the visible symptoms bore little correlation to the laboratory test results.

On balance, it would be the author's recommendation to retain as many of the existing palms as possible within the future upgrade, as they are providing:

- A hardy and sizeable urban tree suitable to the coastal environment and urban condition.
- Historical links to the development of Cronulla and connection to the use of similar palms around the Cronulla Town centre.
- Provide a recognisable landscape feature and character signifying a sense of entry and arrival at Cronulla.

Other recommendations include:

1. Remove the palm (T01) at the southern end of Kingsway due to its positive test result for FOC.
2. For the palms infected with *Neodeightonia phoenicum* (Botryosphaeriaceae) undertake minor pruning to remove the most infected fronds, while maintaining strict hygiene protocols.
3. For all palms to be retained, improve their planting conditions via transplanting to a new improved planting pit or utilising other methods during the proposed upgrade to provide expanded and more appropriate soil volumes and water and nutrients as required to improve and enhance their overall condition and disease resilience. (eg. remove pavements around the palms, expand available soil volumes, fertilise and mulch around the palms and provide supplementary irrigation).
4. Remove any self-sown plants that may be growing with the canopy of the palms.
5. Maintain the strictest hygiene protocols when working on any palms within Cronulla.

1.0 INTRODUCTION

1.1 Background

On the 9 September 2019, Arterra Design was engaged by the Sutherland Shire Council (SSC) to prepare a predevelopment tree assessment to inform the Cronulla Town Centre Upgrade – Stage 2. As part of this predevelopment tree assessment, Arterra was also instructed to undertake a program of sampling and testing for *Fusarium oxysporum f.sp. canariensis* **(FOC)** within the **23** *Phoenix canariensis* **(Canary Island Date Palm)** located within the Cronulla Mall and adjacent the mall entry on the Kingsway. This report summarises the results of that testing.

The main purpose of the current sampling and testing was to ascertain, as far as reasonably practicable if the pathogen was present in the population of Palms, and if so, to what extent. FOC is a fungal pathogen that causes a lethal vascular wilt of the Canary Island Date Palm. This current testing was initiated by Council as a follow up to two previous testing programs undertaken on Canary Island Date Palm populations in 2014 and 2015. This previous testing was undertaken by Utility Asset Management (UAM) in areas surrounding Cronulla Town Centre, which found several Palms infected with the disease.

The results of the testing program is to inform the preliminary design phases of the Cronulla Town Centre Upgrade – Stage 2, by identifying those palms that are currently unlikely to be infected with FOC and those that are. Those without Fusarium may be worthy of retention and inclusion in the proposed designs. They may also be possibly considered as candidates for transplanting to alternative locations within the Mall and the immediate surrounds.

Due to the infectious nature of the FOC pathogen, and its inevitably lethal outcome for infected *Phoenix canariensis*, those palms found to be infected should be immediately removed and not be considered for retention, nor considered for transplantation.

Figure 1.1 – Context Plan showing the general location and context of the study area. (Photo Nearmap 27.01.19)

Figure 1.2 – Photo illustrating the method employed for frond sampling in Cronulla Mall. (Photo: Arterra 19.09.19)

1.2 Background on Fusarium Wilt of Canary Island Date Palms

History and Cause

Fusarium Wilt is a devastating disease of certain species of palms that was first observed in Australia in the early 1980s, when palms began to die in Centennial Park in Sydney. Fusarium Wilt has been observed at other locations in Sydney. As the name implies, Fusarium Wilt of Canary Island Date Palm is primarily observed in *Phoenix canariensis* (Canary Island Date Palm). The disease is caused by the fungus *Fusarium oxysporum* f. sp. *canariensis* (FOC). *Fusarium oxysporum* fungus has many different strains that cause wilt diseases in a range of plants, although each strain is restricted to a very limited host range - the strain that affects palms is restricted to palms. Although the symptoms of the disease are relatively distinctive, in many cases the disease can only be accurately diagnosed by laboratory tests. Identification of different *Fusarium* species is difficult and requires specialised training. It is not possible to test soils for the presence of *Fusarium oxysporum* because of the presence of other non-pathogenic strains that are indistinguishable from the pathogen.

Typical Symptoms & Biology

The fungus causes a vascular wilt. Specifically, it obstructs the xylem (water-conducting) tissue, which results in desiccation and death of the fronds. The fungus produces short-lived spores and it also produces chlamydospores, spores that can live in the soil and plant tissue for long periods (usually years). Because most of the root system is left behind after a palm dies from this disease, this mass of roots may act as a reservoir for the fungus for a long time.

Palms affected by this disease are characterised by an unusual type of frond death. The leaf symptoms include a one-sided death, wherein the leaflets on only one side of the rachis are desiccated or dead. This is often accompanied by a reddish-brown or dark-brown streak on the petiole and rachis on the same side as the desiccated or dead leaflets. Eventually, the entire leaf dies. The disease symptoms normally appear first on the oldest (lowest) living leaves, and then progressively move upward in the canopy until the palm is killed.

Fronds may die more rapidly on one side, or from the base or from the centre of the palm. Transmission of the fungus from palm to palm is primarily through contaminated pruning tools. There is no cure for this lethal disease. Fungicides have been ineffective against Fusarium Wilt. Eventually the whole palm will die. Affected fronds when removed from the plant will often show discolouration of the vascular bundles. This is best seen if the cut surface is wet and cleaned. Small blackened areas should be visible on the cut surface.

Experimental and observational evidence suggests that other *Phoenix* species may be susceptible to *Fusarium oxysporum f. sp. canariensis*, including *Phoenix dactylifera* (Date Palm), *Phoenix reclinata* (Senegal Date Palm), and *Phoenix sylvestris* (Wild Date Palm), but actual cases in the landscape are extremely rare when compared to cases associated with *Phoenix canariensis*. Similar symptoms were observed in *Washingtonia filifera* planted at Centennial Park and *Fusarium oxysporum* was also isolated from them.

If in the field, symptoms appear typical for Fusarium wilt, but Fusarium is not isolated from the testing, then the symptoms may be an expression of other fungal pathogens or petiole/rachis blight. Many of the petiole/ rachis

blight pathogens are not culturable from plant tissue. The latter is not a true vascular wilt and usually does not kill the palm, but the resulting individual leaf symptoms are very similar on *Phoenix* species.

Factors Affecting the Spread of the Disease
There is very little information on the factors that predispose palms to this infection. The fungus may spread via soil water. It is more common on sandy soils however it is not known whether clay soils are unfavourable to the disease or whether it has not yet been introduced to palms on these types of soils.

The two most common methods of the disease being introduced into new areas are by transplantation of infected palms or by the use of cutting implements (pruning tools) that have not been sterilised between use on nearby palms.

Control
Once a palm is infected, all the evidence to date suggests that it will ultimately die. Obviously, the best option is to remove the tree and as much of the root ball as possible once the disease has been diagnosed. This is especially important if the palm is located close to other susceptible palms. The infected remains of the palm should be disposed of at a suitable landfill site or by incineration.

There are no effective fungicides and effective control is dependent on avoidance of the disease. Several steps must be taken to minimise and avoid the spread of the disease.

1. Assume that every susceptible palm is a source of the fungus and always sterilise chain saws and cutting implements between use.
2. Do not move palms from suspect areas (e.g. eastern Sydney) to areas where the disease does not occur. Obtain transplant palms only from areas thought to be clean of the disease and have them tested before transplanting.
3. Use high levels of hygiene in all horticultural practices relating to palms. Clean equipment after each job and do not transport soil.
4. Ensuring adequate soil moisture and a good supply of nutrients to palms. Potassium is often very important in their nutrition and disease resistance.
5. Do not plant new *Phoenix* or *Washingtonia* species of palms in areas where the disease is known to occur.

1.3 Previous Testing & Reports

A testing program was carried out on selected palm populations in the surrounding area in September 2014 and April 2015. Palm frond samples were collected by UAM and sent to the Royal Botanic Gardens, Sydney for FOC testing. Seven (7) palms were sampled in 2014, with three (3) returning positive results for FOC. In 2015, 81 palms were sampled, with 10 returning positive results for FOC.

A cursory inspection by Arterra in September 2019, revealed that seven of the palms located in Beach Park Avenue, tested in 2014 remained. Review of current aerial photography indicates that the three (3) palms that returned a positive result for FOC in 2014, still appear to be in relatively good condition, while two others that showed no symptoms and returned a negative test result in 2014 are now in very poor condition, showing clear signs of crown collapse. Interestingly, of the 10 positive results for FOC obtained in the 2015 testing, three of the samples showed no visible symptoms of FOC at the time of the sampling, yet still returned a positive result.

This indicates, visual symptoms alone are insufficient, and often unreliable, in determining the presence of FOC.

1.4 Conduct and Author Qualifications

As author of this report, Arterra Design confirms that Robert Smart is suitably qualified (AQF 5 Consulting Arborist) to provide comment and the required arboricultural advice pertaining to these matters.

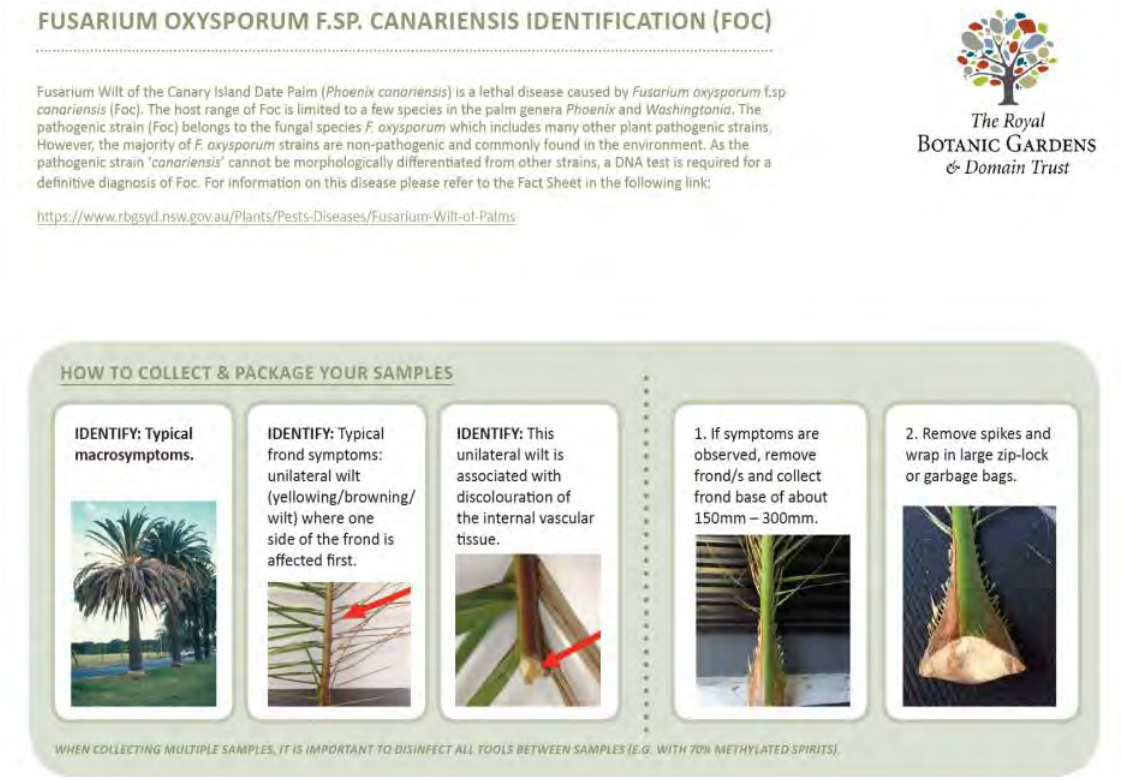
Arterra provides specialist consulting arborist services only and does not provide any physical tree services such as climbing, pruning, removal, root investigations or root pruning. Our advice is based on impartial professional assessment only, as we do not derive any financial benefit from specifying pruning or other physical services. We will not specify any such activities unless we determine them to be essential to ongoing tree health or stability.

1.5 Palm Sampling & Inspection Methodology

On the 19 September 2019, Robert Smart of Arterra carried out an assessment of all the trees in the Mall and directed frond sampling of 23 *Phoenix canariensis* (Canary Island Date Palms) located within the Cronulla Mall and immediately adjacent the Mall on the southern side of the Kingsway, Cronulla, between Geralle Street and Cronulla Street.

Prior to attending site, the palms' positions were confirmed and overlaid on commercially available aerial imagery dating from January 2019. A unique identification number was allocated to each palm and recorded on the aerial photograph for reference within the field. Plastic zip-lock sample bags were prepared and prenumbered for each palm, corresponding to the plan.

Palm sampling was carried out and the samples prepared in accordance with Royal Botanic Gardens Sydney Plant Diseases Diagnostic Unit (PDDU) requirements (as presented below).



FUSARIUM OXYSPORUM F.SP. CANARIENSIS IDENTIFICATION (FOC)

Fusarium Wilt of the Canary Island Date Palm (*Phoenix canariensis*) is a lethal disease caused by *Fusarium oxysporum* f.sp *canariensis* (Foc). The host range of Foc is limited to a few species in the palm genera *Phoenix* and *Washingtonia*. The pathogenic strain (Foc) belongs to the fungal species *F. oxysporum* which includes many other plant pathogenic strains. However, the majority of *F. oxysporum* strains are non-pathogenic and commonly found in the environment. As the pathogenic strain '*canariensis*' cannot be morphologically differentiated from other strains, a DNA test is required for a definitive diagnosis of Foc. For information on this disease please refer to the Fact Sheet in the following link:

https://www.rbgsyd.nsw.gov.au/Plants/Pests-Diseases/Fusarium-Wilt-of-Palms

The Royal Botanic Gardens & Domain Trust

Figure 1.3 – Royal Botanic Gardens Sydney, PDDU - FOC information sheet (Photo: RBGS PDDU 09.09.19)

The palm's unique identification number was corelated with its position on the plan and location in the field. Each palm's general health and condition was then broadly assessed via a visual inspection from the ground. Fronds displaying potential symptoms of Fusarium Wilt were identified for sampling. An AQF5 qualified utility arborist then harvested typically one or possibly two sample fronds, using a clean, sterilised handsaw, accessing the crown of the palm via a truck-mounted elevated work platform (cherry picker). The sample fronds were then handed off to Rob Smart on the ground. The hand saw was taken by ground crew, scrubbed and soaked in a bucket of methylated spirits while a clean, sterilised saw, was handed to the utility arborist in preparation for collecting the next sample.

The tree number of the sample was again confirmed and cross checked against both the plan and the prenumbered sample bag. The sample frond was then trimmed (to be approximately 300mm of live tissue from the base of the frond) using a sterilised saw and secateurs, then bagged and set aside in a sample box. All trimming equipment was then scrubbed and soaked in a bucket of methylated spirits ready to prepare the next sample. This process was strictly repeated for each palm in the sample population. (Refer also to Appendix 4.2 for individual photos of each tree and the fronds sampled).

Figure 1.4 – Sterilizing pruning equipment in methylated spirits, frond samples trimmed ready for bagging. (Photo: Arterra 19.09.19)

During the preliminary visual assessment, field notes were taken using an Apple iPad and FileMaker Pro database to record the general health and condition of the palms. A photographic record of all palms and general site context was taken using the inbuilt Apple iPad camera and a Panasonic Lumix TZ220 digital camera.

General conditions were inspected around the base of all palms to inspect for any obvious signs of trunk or root dysfunction or decay. Observations were made to check for any recent likely trenching or disturbances that may have impacted the palms. The position of the palms provided unimpeded access to all sides and the ground surface immediately surrounding the palms. The weather conditions were overcast with intermittent light showers, with wind moderate.

2.0 OBSERVATIONS & DISCUSSION

2.1 Site Location & Context

Cronulla Mall and Kingsway are located on a local rise to the west of the southern end of Cronulla Beach. The study area is a very typical urban environment. The palms are located within fully paved footpaths on Kingsway and the pedestrianised Mall. The Cronulla Mall is oriented north-south and the Kingsway runs perpendicular east-west. The area is relatively exposed to almost constant sea breezes and occasional salt spray, however the palms within the Mall are slightly more sheltered than those on the Kingsway, due to the protection afforded by the surrounding buildings.

Given the limited space, harsh growing conditions and the exposed coastal location, *Phoenix canariensis* would normally be considered as a suitable, sizable and hardy solution to the street tree planting. The palms are growing in a variety of surrounds. Although palms are typically considered able to tolerate smaller soil volumes than other trees, all are still considered to be within relatively small growing areas for the species and the size of the tree.

The palms within the southern part of the Mall are growing in raised timber planters, approximately 2.4m square. Roots are readily seen around the edges of the planter and are often lifting the timberwork above the pavement. This is symptomatic of the trees having limited soil volumes and indicating that the root mass has most likely now fully exhausted the available soil resources. None of the palms appear to have functioning irrigation installed.

Figure 2.1 – Site proximity to Cronulla Beach, highly exposed to salt spray and sea breeze. (Photo: Arterra 19.09.19)

Figure 2.2 – View of palms in the southern end of the Mall that appear to be located in relatively constrained soil volumes. (Photo: Arterra 19.09.19)

2.2 Testing Observations & Discussion

Species and History

The 23 *Phoenix canariensis* (Canary Island Date Palms) assessed and sampled for this report were installed as mature palms that were transplanted during a public domain upgrade around 1988. It should be noted that there are many other *Phoenix canariensis* (Canary Island Date Palms) in the immediate vicinity of the sample population, some of which have previously tested positive for FOC. Most palms seemed to display fronds with leaf edge burn and shrunken trunk girth just below the fronds. This may indicate that growth and vigour have been deteriorating in the last few decades leading to slower growth rates.

The palms displayed a range of vigour from good to relatively poor. A number did display clear visible symptoms that could indicate the presence of FOC, while others displayed very few or no symptoms at all. Although a number of palms displayed some clear, visual symptoms that may indicate the presence of FOC, similar symptoms may also be attributable to a variety of other similar non-lethal fungal pathogens. A number of palms also displayed symptoms of what was initially believed to be a plumed scale. A sample of this was collected and sent for more formal identification by the Royal Botanic Gardens, Sydney. They subsequently advised that this pest was the fruiting body of *Graphiola* – False Smut or Leaf Spot fungus.

As discussed earlier in this report, various strains of Fusarium oxysporum are widely distributed in the environment and cause wilt diseases in a range of plants, however each strain adversely impacts only a very limited host range of plants. Although the symptoms of FOC are distinctive, in many cases the disease can only be accurately diagnosed by laboratory DNA testing. It should be noted that the sampling process is critical in achieving the most reliable test results possible. It is possible for a palm to be infected with the FOC pathogen, however the pathogen may not be present in every frond, and the palm may not currently display symptoms of the infection at all.

On this basis, it is possible for a sample to return a 'false negative' for a palm that may still be infected. For this reason, a preliminary visual assessment is carried out to try and identify fronds that may most likely be infected with FOC pathogen. Where no fronds displayed clear FOC symptoms, a relatively random sample of a live frond displaying the worst condition within the crown was collected for testing. In summary, a positive FOC DNA test confirms that a palm is infected and will ultimately die as a result of Fusarium Wilt. However, a negative result does not guarantee that the palm is not infected with FOC, it only means that the particular frond sampled did not have the FOC pathogen present.

This report also reflects the condition of the palms at a specific point in time. The test results cannot unequivocally confirm that palms tested for FOC, and returning a negative result are not infected with the pathogen nor will not be infected in the future. No guarantees are given or implied by Arterra in relation to the accuracy of the test results for FOC, produced by Royal Botanic Gardens Plant Disease Diagnostic Unit, nor as to the likely ongoing health and condition of any palm tested.

Summary of Test Results

The following table (Table 1) provides a summary of results for the RBGS – Fusarium (FOC) and Fungal Identification (FID) testing. Refer also to Appendix 4.1 for the explanation of the scientific methodologies employed by the RBGS.

The table summarises the results of the testing for each palm. The FOC column identifies whether a particular palm tested positive or negative for *Fusarium oxysporum f.sp. canariensis* (FOC). Only one palm tested positive. (T01) The second column presents other general fungal species that were potentially identified from the testing process that was undertaken by the RBGS.

Eight (8) of the palms had *Neodeightonia phoenicum* identified as being present, including the palm that also tested positive for FOC.

Table 1 – FOC and FID Test Results

Palm ID #	Visible Symptoms at time of sampling	FOC – RBGS DNA Test Results	RBGS General Fungal ID – Test Results
01	Generally good health and vigour. Only minor symptoms, but on several fronds. Very exposed to ocean winds.	**Positive**	*Neodeightonia phoenicum*
02	No significant fusarium symptoms, except for one frond which was sampled. Very exposed to ocean winds.	**Negative**	*Neodeightonia phoenicum*
03	Minimal symptoms of fusarium noted. No particularly one-sided dieback noted on fronds. Worst looking, lowest living frond taken as sample.	**Negative**	Negative
04	No significant one-sided frond dieback noted on the tree, but many fronds suffering tip burn. Very exposed to ocean winds.	**Negative**	Negative
05	Only minimal signs of fusarium related symptoms. Similar to nearby palms with general tip burning to leaf edges. Very exposed to ocean winds.	**Negative**	Negative
06	No notable one-sided dieback of fronds but canopy appears sparse and general frond decline is occurring well into mid-to-upper canopy. Generally worst looking, living lower frond sampled.	**Negative**	*Neodeightonia phoenicum*
07	Minimal symptoms if any. Mostly healthy-looking fronds even in lower canopy. Worst looking, lower living frond sampled.	**Negative**	Negative
08	No definitive symptoms of fusarium. One of the tallest palms on ridge top. Very exposed to ocean winds. Some signs of bark dysfunction just below fronds for 1.5m.	**Negative**	Negative
09	No significant symptoms of fusarium noted. Outer bark casing up the top of the trunk gone for approx. 2-3m below fronds.	**Negative**	*Malassezia synpodialis*
10	Worst frond mid canopy taken. Some other dead fronds noted in mid canopy. No definitive symptoms of fusarium noted.	**Negative**	Negative
11	No significant symptoms. Some minor unidentified plumed scale activity noted in sampled frond. Worst looking, live frond sampled.	**Negative**	Negative
12	Some symptoms of one-sided frond dieback. Minor unidentified plumed scale activity on sampled frond. Trunk noted with several holes and leaf scars missing in outer bark. Palm appears relatively healthy.	**Negative**	*Neodeightonia phoenicum*
13	Definite symptoms of one-sided dieback on a few fronds. Appears relatively good vigour otherwise.	**Negative**	*Neodeightonia phoenicum*
14	No clear symptoms of fusarium noted. Many lower fronds dead but no obvious signs of disease. Typically decline appears bilateral on fronds and simply senescence of lower fronds.	**Negative**	*Xenoacremonium sp.*
15	Some minor symptoms of fusarium-like dieback but on only a few fronds. Minor unidentified plume scale activity noted.	**Negative**	*Neodeightonia phoenicum*
16	No fusarium symptoms noted. Worst looking, living lower frond sampled.	**Negative**	*Sterigmatomyces hyphaenes*
17	Definite symptoms of fusarium wilt. Numerous lower fronds dead and collapsing. Definite single sided staining to rachis.	**Negative**	Negative
18	Significant dieback of lower fronds to about mid canopy, but very few showing signs of one-sided dieback. One noted and sampled.	**Negative**	*Neodeightonia phoenicum*
19	No significant symptoms of fusarium, generally most fronds looking relatively healthy and green. Quite sheltered position. Significant unidentified plumed scale activity noted on frond.	**Negative**	*Duportella trigonosperma*
20	No significant symptoms of fusarium. Most fronds looking relatively healthy. Worst looking living lower frond sampled. Relatively sheltered position.	**Negative**	Negative
21	No obvious symptoms of fusarium noted. Worst looking lower living frond sampled. Self-sown fig noted in canopy. Some mid canopy frond dieback and general tip burn to majority of fronds.	**Negative**	Negative
22	Some symptoms minor symptoms but no notable one-sided dieback noted. Some mid canopy frond death noted. Worst looking living lower frond sampled. Bitou bush seedling self-sown in canopy.	**Negative**	Negative
23	Some minor symptoms but no notable one-sided dieback noted. Some mid canopy frond death noted. Numerous lower dead fronds. Worst looking living lower frond sampled. Bitou bush seedling self-sown in canopy.	**Negative**	*Neodeightonia phoenicum*

Palm Rot of Phoenix spp. caused by Neodeightonia phoenicum

Information is not readily available regarding this fungal pathogen. Reports from Palm populations in Greece were found upon an internet search. Initial symptoms are reported as pale, elongated spots that gradually turned to dark brown streaks extending along the leaf base and rachis. In early stages, the upper parts of the leaves usually remained unaffected. Eventually decay and premature death of leaves occur, followed by terminal bud necrosis. Shoot blights and stalk rots were also observed. *N. phoenicum* is synonymous with *Diplodia phoenicum* and formerly also known as *Macrophoma phoenicum*. From studies, petiole rot, blight, and leaf necrosis were evident on all inoculated plants within 6 weeks after inoculation with the pathogen. *N. phoenicum* has repeatedly and globally been reported on *Phoenix dactylifera* (Date Palm).

(National Centre for Biotechnology Information, U.S. National Library of Medicine, Bethesda MD, USA - https://www.ncbi.nlm.nih.gov/pubmed/30722323 accessed 6 November 2019)

False Smut of Phoenix spp. caused by *Graphiola phoenicius*

The false smut or graphiola leaf spot fungus has fruiting bodies that produce bumpy hard welts on the leaf, which resemble a scale insect or mealybug infestation. They exude powdery yellow spores on whitish filaments. This fungus is most evident on older fronds and is not usually a concern, especially in drier desert climate in which these palms are native, however, in more humid climates this disease can take its toll on the *Phoenix* palm group.

G. phoenicis is the causal agent of Graphiola leaf spot or false smut of palms. This pathogen is widely distributed with numerous palm species affected. There are varying reports on the seriousness of this pathogen. In some palm growing regions it is considered primarily a cosmetic disease. However, heavy infestations can cause premature frond senescence, a reduction in the photosynthetic area and as a consequence, reduced palm vigour. Graphiola leaf spot symptoms are similar to potassium or magnesium deficiencies, which are a more serious palm health problem. It is therefore important to rule out nutrient deficiency before attempting to manage this disease. (RBGS – Plant Disease Diagnostic Unit Report, 2019)

If abundant, the disease can shorten the life of fronds to only 3 years. Since fronds on date palms should be functional for 6 to 8 years, premature loss of fronds means less energy (carbohydrates) will be produced for the plant's survival. Other palm species are also known to be affected by this disease, but not as severely as the *Phoenix* (date) palm group.

The potential management is to remove severely infected fronds; those that have 30% or more of the surface area infected. It is not necessary to remove every frond that has a few bumps. It is also to try and minimize conditions that favor disease development such as high humidity in the canopy from misdirected irrigation heads, excessive shade or poor air flow. Fungicides, such as propicaonazole or thiophanate methyl may abate the disease, but applications should only be conducted during the infection period. Three to four applications, at three week intervals, may help. Ideally, applications should be started just before spore release, which can be detected as a yellow dust when the fronds are struck with a pole. (Information obtained from University of Florida/ Caldwell, D and Elliot, Monica, Undated, IFAS Extension – Fasle Smut Disease of Palm Fact Sheet).

Figure 2.3– Sample of the unidentified scale on T19 sent that was sent for analysis. This has been subsequently identified by the RBGS as Graphiola false smut / leaf spot, most likely G. phoenicis. (Photo Arterra – Left using a 200x digital microscope and to the right a Lumix Digital camera in the field during sampling).

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Test Results

As detailed in Table 1, only one *Phoenix canariensis* (T01) returned a positive result for FOC. It should be noted that this particular palm showed no significantly obvious or normal symptoms to suggest the presence of FOC.

The general fungal identification (FID) testing results also confirmed the presence of other fungal pathogens within the palm population. Some of these present with visible symptoms very similar to those that occur with FOC. These current test results show a similar pattern to the results from the previous testing undertaken by SCC, in that many palms may display macro symptoms consistent with those of Fusarium Wilt, however the visible symptoms bore very little correlation to the laboratory test results.

In this current population, palm (T01), showed no visible sign of FOC infection yet was the only one to return a positive result, while Palm 17 displayed very obvious macro symptoms consistent with FOC, being:

- poor overall visible condition of the crown
- numerous lower and mid-canopy fronds dead and collapsing
- definite single sided death and vascular staining to leaf and rachis.

This palm (T17), however, subsequently returned a negative FOC and FID test result.

A similar situation appears to have occurred with the palms sampled in 2014. Review of current aerial photography indicates that the three (3) palms that returned a positive result for FOC in 2014, still appear in relatively good condition, while two other palms that showed no symptoms in 2014 and returned a negative test result, are now in very poor condition, and showing clear signs of crown collapse.

Based on the evidence above:

- Palm 01, the southern-most palm on the Kingsway should have its retention value downgraded to Very low / Remove due to the positive FOC test result.
- Palm 17 may have its retention value upgraded to Moderate, based on the negative FOC test result. Its condition may possibly be improved via the provision of more adequate watering and fertilising.
- No further adjustments to the palms' retention values are warranted based on the test results.
- It seems that the visible conditions and symptoms of the palms at a point in time cannot be considered a truly accurate indicator of the presence of FOC, or otherwise.

3.2 Palm and Site Conditions

Urban trees are extremely valuable assets and create many aesthetic and environmental benefits but are often growing in conditions that are not conducive to their health and longevity. Despite Canary Island Date Palms being a very hardy species, like any plant, they will typically be healthier and more resilient to pest and disease if they are provided with good growing conditions. Many of the palms however, appear to be in relatively good health despite the environmental challenges they face, apart from potentially reduced growth rates since being transplanted and minor frond edge burn.

The Cronulla Mall and Kingsway palms are still considered to be growing in quite challenging conditions. The coastal environment results in almost constant exposure to sea breezes and potential salt spray. As is quite common for urban trees planted during similar times, they have been provided with highly constrained soil volumes, little supplementary watering, and exposed to radiated heat from hard-pavements and building surrounds. This is all likely to add to general environmental stresses impacting on the palms' and therefore there overall conditions.

It is likely that with improved growing conditions, such as access to more appropriate soil volumes, supplementary and adequate water and fertiliser applications, the condition of the palms could be substantially improved and their safe useful life as urban trees, considerably extended.

3.3 Recommended Actions

The palms are visually significant, mature specimens, with most currently displaying reasonable vigour and vitality. The primary question relates to their potential ongoing health and longevity, and specifically whether their expected lifespan warrants their retention and incorporation within the proposed Cronulla Town Centre Upgrade.

Phoenix canariensis are typically a long-lived species capable of surviving in the range of 100-150 years. In the absence of any serious pest or disease or serious construction related impacts it is the authors opinion that the current trees would reasonably be expected to live at least another 40 years.

As noted earlier in this document, this assessment of the FOC test results represent a snapshot of a given palm at a specific point in time. While a positive DNA test result for FOC confirms the presence of the lethal pathogen in

the sampled palm, the opposite cannot be said for a negative result, as the variables involved may result in a test returning a 'false negative' for a palm in which the FOC pathogen may still be present. It is therefore not guaranteed that the palms will not succumb to FOC in the future. On balance, however, it would be the author's recommendation to retain as many of the palms as possible within the future upgrade, as they are providing:

- A hardy urban tree suitable to the coastal environment and urban condition.
- Historical links to the development of Cronulla and connection to the use of similar palms around the Town centre.
- Provide a recognisable landscape feature and character signifying a sense of entry and arrival at Cronulla.

Recommendations for the palms may be summarised as follows:-

1. Remove Palm T01 at the southern end of Kingsway due to its positive test result for FOC.
2. For the palms infected with *Neodeightonia phoenicum* (Botryosphaeriaceae) undertake minor pruning to remove the most infected fronds, while maintaining strict hygiene protocols.
3. For all palms to be retained, improve their planting conditions via transplanting to a new improved planting pit or utilise other methods during the upgrade to provide expanded and appropriate soil volume, water and nutrients as required, to improve and enhance their overall condition and disease resilience. (eg. remove pavements around the base of the palms, expand available soil volumes, fertilise and mulch the palms and provide supplementary irrigation).
4. Remove any self-sown plants that may be growing with the canopy of the palms.
5. Maintain the strictest hygiene protocols when working on any palms within Cronulla.

3.4 References

- RBGS Plant Clinic – Plant Disease Diagnostic Unit – FOC Testing Report E19_189, UID537973620, commissioned by Arterra Design Samples Received 24/9/2019.
- RBGS, Fusarium Wilt Fact Sheet – RBGS (accessed and copied from website 16 September 2019)
- University of Florida/ Elliot, Monica.L, March 2019, IFAS Extension PP215 – Fusarium Wilt of Canary Island Date Palm Fact Sheet.
- University of Florida/ Caldwell, D and Elliot, Monica, Undated, IFAS Extension – Fasle Smut Disease of Palm Fact Sheet.
- University of Florida/ Elliot, Monica.L, January 2018, IFAS Extension PP221 – Petiole (Rachis) Blight of Palm Fact Sheet.
- Draper, D.B. and Richards, P.A. 2009, *Dictionary for managing trees in urban environments*. Institute of Australian Consulting Arboriculturists / CSIRO Victoria.
- Harris, R.W, Clark, J.R & Matheny, Nelda P, 1999*, Arboriculture : Integrated management of landscape trees, shrubs and vines*. 3rd Ed. Prentice Hall. New Jersey, US

- end of report -

4. APPENDICES

4.1 RBGS – Plant Disease Diagnostic Unit Testing Methodology

Extract from RBGS testing report – Outlining Testing Methodologies Used by RBGS

FOC Test
The detection of *F. oxysporum* f.sp. *canariensis* (FOC), the causal agent of Fusarium wilt of Phoenix palms, uses twodiagnostic approaches. Further, a Sanger sequencing method using fungal specific ITS primers (Gardes and Bruns 1993; Manter and Vivanco 2007) is also used to detect palm pathogens other than FOC.

The first approach involves total DNA extraction from the symptomatic rachis tissue followed by a PCR test to differentiate pathogenic 'canariensis' strains from any non-pathogenic *F. oxysporum* endophytes. The DNA is extracted using a modified version of the FastDNA® Kit (Q-biogene Inc.) according to the manufacturer's instructions. PCR detection is based on primers and PCR conditions described in (Plyler et al. 1999; Laurence et al. 2015).

The second approach uses a fungal isolation and morphological identification approach followed by the aforementioned PCR test. Rachis tissue is surface sterilised with 70% ethanol for one minute and internal sections are plated onto a *Fusarium* specific isolation medium (PPA) (Leslie et al. 2008).

The PPA plates are incubated under alternating 12h light and 12h darkness for up to 5 days. Resulting *Fusarium* colonies are subcultured onto carnation leaf agar (CLA) for morphological identification. *Fusarium oxysporum* is identified based on the morphological characters described in Leslie et al. (2008). Genomic DNA is extracted from any *F. oxysporum* isolates and the previously described PCR test is used to differentiate pathogenic 'canariensis' strains from any non-pathogenic *F. oxysporum* endophytes.

FID Test
Genomic DNA is extracted from the fungal specimen(s) using a modified version of the FastDNA® Kit (Q-biogene Inc.) according to the manufacturer's instructions. Fungal specific ITS primers are used to amplify the nuclear ITS region using PCR primers and amplification conditions described in (Gardes and Bruns 1993; Manter and Vivanco 2007).

PCR amplicons are purified using ExoSAP-IT (USB Corporation) following the manufacturer's instructions and sequenced using the aforementioned PCR primers. The purified amplicons are then sent to the Ramaciotti Centre for Gene Function Analysis at the University of New South Wales where DNA sequences are determined using an ABI PRISM® 3700 DNA Analyser (Applied Biosystems Inc.).

The Basic Local Alignment Search Tool (BLAST) algorithm is used to match DNA sequences to species (Altschul et al. 1990). This algorithm compares the similarity of the sample DNA sequence with all samples in the National Centre for Biotechnology Information database (International online database). The BLAST then returns a list of species that are most similar to the sample DNA based on sequence identity (similarity) and assigns a probability value (E) that gives an indication of the reliability of the match. Because of this, BLAST usually returns multiple species and we include only the top three matches.

4.2 Individual Palm Sampling – Arterra Record Sheets

Tree Id Number **Art CM-001**

Sample: **S1**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Generally good health and vigour. Only minor symptoms but on several fronds. Very exposed to ocean winds.

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Tree Id Number **Art CM-002**

Sample: **S2**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No significant fusarium symptoms, except for one frond which was sampled. Very exposed to ocean winds.

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Tree Id Number **Art CM-003**

Sample: **S3**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Minimal symptoms of fusarium noted. No particularly oneside dieback noted on fronds. Worst looking lowest living frond taken as sample.

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Tree Id Number **Art CM-004**

Sample: **S4**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No significant onesided frond dieback noted on the tree, but many fronds suffering tip burn. Very exposed to ocean winds.

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Tree Id Number **Art CM-005**

Sample: **S5**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Only minimal signs of any fusarium related symptoms. Similar to nearby palms with general tip burning to leaf edges. Very exposed to ocean winds.

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Tree Id Number **Art CM-006**

Sample: **S6**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No notable onesided dieback of fronds but canopy appears sparse and general frond decline is occurring well into mid-to-upper canopy. Generally worst looking living lower frond sampled.

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Tree Id Number **Art CM-007**

Sample: **S7**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Minimal symptoms if any. Mostly healthy looking fronds even in lower canopy. Worst looking lower living frond sampled.

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Tree Id Number **Art CM-008**

Sample: **S8**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No definitive symptoms of fusarium. One of the tallest palms on ridge top. Very exposed to ocean winds. Some signs of bark dysfunction just below fronds for 1.5m.

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Tree Id Number **Art CM-009**

Sample: **S9**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No significant symptoms of fusarium noted. Outer bark casing up the top of the trunk gone for approx 2-3m below fronds.

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Tree Id Number **Art CM-010**

Sample: **S10**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Worst frond mid canopy taken. Some other dead fronds noted in mid canopy. No definitive symptoms of fusarium noted.

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Tree Id Number **Art CM-011**

Sample: **S11**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No significant symptoms. Some minor unidentified plumed scale activity noted in sampled frond. Worst looking live frond sampled.

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Tree Id Number **Art CM-012**

Sample: **S12**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Some symptoms of one side frond dieback. Minor unidentified plumed scale activity on sampled frond. Trunk noted with several holes and leaf scars missing in outer bark. Palm appears relatively healthy.

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Tree Id Number **Art CM-013**

Sample: **S13**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Definite symptoms of one sided dieback on a few fronds. Appears relatively good vigour otherwise.

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Tree Id Number **Art CM-014**

Sample: **S14**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No clear symptoms of fusarium noted. Many lower fronds dead but no obvious signs of disease. Typically decline appears bilateral on fronds and simply senescence of lower fronds.

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Tree Id Number **Art CM-015**

Sample: **S15**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Some minor symptoms of fusarium-like dieback but on only a few fronds. Minor unidentified plume scale activity noted.

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Tree Id Number **Art CM-016**

Sample: **S16**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No fusarium symptoms noted. Worst looking living lower frond sampled.

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Tree Id Number **Art CM-017**

Sample: **S17**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Definite symptoms of fusarium wilt. Numerous lower fronds dead and collapsing. Definite single sided staining to rachis.

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Tree Id Number **Art CM-018**

Sample: **S18**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Significant dieback of lower fronds to about mid canopy, but very few showing signs of one sided die-back. One noted and sampled.

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Tree Id Number **Art CM-019**

Sample: **S19**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No significant symptoms of fusarium, generally most fronds looking relatively healthy and green. Quite sheltered position. Significant unidentified plumed scale activity noted on frond.

ARTERRA DESIGN PTY LTD ABN 40 069 552 610
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Tree Id Number **Art CM-020**

Sample: **S21**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No significant symptoms of fusarium. Most fronds looking relatively healthy. Worst looking living lower frond sampled. Relatively sheltered position.

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Tree Id Number **Art CM-021**

Sample: **S21**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

No obvious symptoms of fusarium noted. Worst looking lower living frond sampled. Self sown fig noted in canopy. Some mid canopy frond dieback and general tip burn to majority of fronds.

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Tree Id Number **Art CM-022**

Sample: **S22**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Some symptoms minor symptoms but no notable one sided dieback noted. Some mid canopy frond death noted. Worst looking living lower frond sampled. Bitou bush seedling self sown in canopy.

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Tree Id Number **Art CM-023**

Sample: **S23**

Species: ***Phoenix canarienesis***

Sample Taken: **19th September 2019**

Location: **Cronulla Mall, Cronulla NSW**

Photo of Tree

Photo of Frond

Comment or Notes:

Some minor symptoms but no notable one sided dieback noted. Some mid canopy frond death noted. Numerous lower dead fronds. Worst looking living lower frond sampled. Bitou bush seedling self sown in canopy.

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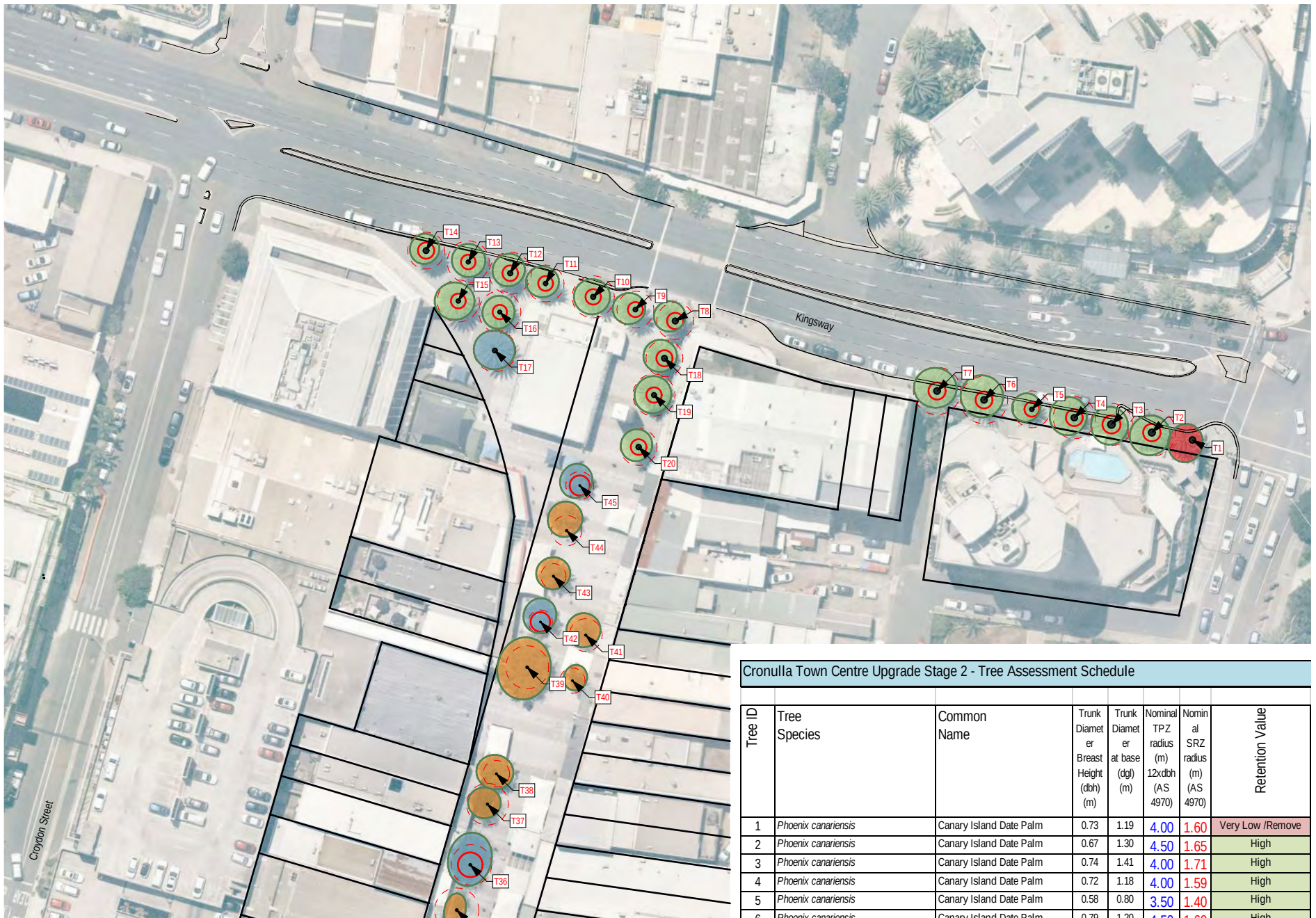
4.3 Updated Tree Retention Value Plan



Cronulla Town Centre Upgrade Stage 2 - Tree Assessment Schedule

Tree ID	Tree Species	Common Name	Trunk Diameter Breast Height (dbh) (m)	Trunk Diameter at base (dgl) (m)	Nominal TPZ radius (m) 12xdbh (AS 4970)	Nominal SRZ radius (m) (AS 4970)	Retention Value
1	*Phoenix canariensis*	Canary Island Date Palm	0.73	1.19	4.00	1.60	Very Low /Remove
2	*Phoenix canariensis*	Canary Island Date Palm	0.67	1.30	4.50	1.65	High
3	*Phoenix canariensis*	Canary Island Date Palm	0.74	1.41	4.00	1.71	High
4	*Phoenix canariensis*	Canary Island Date Palm	0.72	1.18	4.00	1.59	High
5	*Phoenix canariensis*	Canary Island Date Palm	0.58	0.80	3.50	1.40	High
6	*Phoenix canariensis*	Canary Island Date Palm	0.79	1.20	4.50	1.60	High
7	*Phoenix canariensis*	Canary Island Date Palm	0.66	1.23	4.50	1.62	High
8	*Phoenix canariensis*	Canary Island Date Palm	0.67	1.10	3.50	1.55	High
9	*Phoenix canariensis*	Canary Island Date Palm	0.59	0.83	3.50	1.42	High
10	*Phoenix canariensis*	Canary Island Date Palm	0.64	0.92	4.00	1.46	High
11	*Phoenix canariensis*	Canary Island Date Palm	0.65	0.80	3.50	1.40	High
12	*Phoenix canariensis*	Canary Island Date Palm	0.70	0.93	4.00	1.47	High
13	*Phoenix canariensis*	Canary Island Date Palm	0.65	0.75	4.00	1.38	High
14	*Phoenix canariensis*	Canary Island Date Palm	0.57	1.07	3.50	1.54	High
15	*Phoenix canariensis*	Canary Island Date Palm	0.64	0.79	4.00	1.40	High
16	*Phoenix canariensis*	Canary Island Date Palm	0.62	0.71	4.00	1.36	High
17	*Phoenix canariensis*	Canary Island Date Palm	0.52	0.87	4.00	1.44	Moderate
18	*Phoenix canariensis*	Canary Island Date Palm	0.68	1.06	3.50	1.53	High
19	*Phoenix canariensis*	Canary Island Date Palm	0.65	0.89	4.00	1.45	High
20	*Phoenix canariensis*	Canary Island Date Palm	0.62	0.96	3.50	1.48	High
21	*Phoenix canariensis*	Canary Island Date Palm	0.65	0.81	4.00	1.41	High
22	*Phoenix canariensis*	Canary Island Date Palm	0.58	0.75	4.00	1.38	High
23	*Phoenix canariensis*	Canary Island Date Palm	0.66	0.97	4.00	1.49	High
24	*Gleditsia triacanthos 'Shademaster'*	Honey Locust	0.19	0.28	2.28	1.94	Low
25	*Platanus x acerifolia*	London Plane	0.35	0.50	4.20	2.47	Moderate
26	*Livistona australis*	Cabbage Palm	0.22	0.46	3.00	1.23	High
27	*Cupaniopsis anacardioides*	Tuckeroo	0.22	0.31	2.64	2.02	Low
28	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.25	0.37	3.00	2.18	Low
29	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.25	0.38	3.00	2.20	Low
30	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.23	0.31	2.76	2.02	Low
31	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.22	0.30	2.64	2.00	Low
32	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.28	0.38	3.36	2.20	Low
33	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.21	0.31	2.52	2.02	Low
34	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.22	0.30	2.64	2.00	Low
35	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.35	0.45	4.20	2.37	Low
36	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.32	0.44	3.84	2.34	Moderate
37	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.33	0.35	3.96	2.13	Low
38	*Platanus x acerifolia*	London Plane	0.21	0.29	2.52	1.97	Low
39	*Platanus x acerifolia*	London Plane	0.34	0.43	4.08	2.32	Low
40	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.20	0.28	2.40	1.94	Low
41	*Gleditsia triacanthos 'Shademaster'*	Honey Locust Cultivar	0.26	0.34	3.12	2.10	Low
42	*Platanus x acerifolia*	London Plane	0.19	0.25	2.28	1.85	Moderate
43	*Platanus x acerifolia*	London Plane	0.20	0.32	2.40	2.05	Low
44	*Platanus x acerifolia*	London Plane	0.24	0.36	2.88	2.15	Low
45	*Platanus x acerifolia*	London Plane	0.22	0.27	2.64	1.91	Moderate

Legend

- Cadastre
- High Retention value
- Moderate Retention value
- Low Retention value (Note: no SRZ's shown for these trees)
- Very Low Retention value (should remove) (Note : no TPZ's shown for these trees)
- Existing Tree Retained — Extent of canopy as verified by site measure and aerial
- Nominal Tree Protection Zone (TPZ)
- Nominal Structural Root Zone (SRZ)
- T26 — Tree Identification Number

NOTE

Refer to the accompanying Pre-Development Arboricultural Report for full description of trees, measurements and methods used to assess the trees, and potential tree protection measures.

TREE RETENTION VALUE NOTES

The proposed retention value of the trees was determined based on a considered combination of the size, age, condition and suitability of the tree. Each tree was then ranked according to one of 4 retention categories;

1. **"High" Retention Value** — these are trees that are typically in good or very good condition, large and visually prominent, historically or environmentally important. They should represent a serious physical constraint to development and their removal avoided where possible and feasible.
2. **"Moderate" Retention Value** — these are trees that are in good to reasonable condition, with no major structural defects and could be retained where possible and feasible to do so.
3. **"Low" Retention Value** — these are trees that are of poor condition or have structural defects, are particularly small or common place, are not historically, environmentally or socially significant and should not be considered as a constraint to development. They could be retained only if they are not likely to be impacted by or constrain potentially desirable development outcomes.
4. **"Very Low" Retention Value** — these are trees that are in very poor health, or poor form, or have serious structural defects, are considered weeds or combination of all these, and therefore should be considered for removal regardless of any development.

Consideration has also been given to the relationship of the trees to one another and their proximity to the likely development areas on the site. For example, trees that are part of a closely spaced group, or are likely to be significantly misshapen or unstable with the removal of surrounding trees and structures are considered with these factors in mind.

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0 10 20 50m

REVISION	DESCRIPTION	CHKD	DATE
B	Updated for Fusarium Testing Results	RWS	6/11/19
A	For Review / Information	RWS	30/10/19

PROJECT & CLIENT
Cronulla Town Centre Trees
Sutherland Shire Council

Project No : 19.12
Designed : RWS
Drawn : SK
Scale : 1:500@A1/1:1000@A3

DRAWING TITLE: Tree Retention Value Plan
DRAWING NUMBER: T-02
REVISION: B

Plotted at : 12:02 pm 6/11/19