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Prepared for:

Taronga Conservation Society Australia

Arboricultural Assessment

Sumatran Tiger Adventure

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April 20, 2015.

1 Summary

This report was commissioned by Taronga Conservation Society Australia for the Sumatran Tiger Adventure Project.

Architectural drawing SK-06 was used to establish the trees which require removal for the project, which trees are to be retained and which trees are to be relocated. Seventy seven trees have been marked and any tree which has not been specifically marked or discussed are proposed for removal.

There are thirty nine (39) trees proposed for retention, tree protection measures must be implemented and a specific tree protection plan should be devised.

Eighteen trees are proposed for relocation within the site. Most of these trees are monocots and can be reliably transplanted; the remaining trees will prove more difficult but have a reasonable chance of success given their size and locations.

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2 Introduction & Aim

The report is to discuss the requirements for tree removal, retention and transplantation in relation to a proposed new development known as the Sumatran Tiger Adventure at Taronga Zoo, Mosman NSW.

The Architectural maps have been provided and comments are made regarding any significant impacts which may be imposed upon trees which are desired for retention.

Transplanting methodologies have also been provided to highlight specific requirements which may be necessary.

3 Method

Assessments of the trees were made using some elements of the *Visual Tree Assessment* (VTA)[1] procedure (see Section 3.1). The trees were assessed from ground level on Friday 10th April, 2015. The determinations will be reached through the assessment of the trees' health, vigour, and structural condition at the time of inspection.

- No diagnostic testing has been completed;
- No sub surface root testing has been completed;
- No soil testing has been completed;

The Architectural plans that have been referenced during the development of this report (SK-06) do not show all the trees within the development area. Trees which are not specifically referenced within the plans and this report are proposed for removal.

[1] Mattheck & Breloer. 1994. *The Body Language of Trees.*

3.1 Visual Tree Assessment (VTA)

The VTA system is based on the theory of tree biology and physiology, as well as tree architecture and structure. This method is used by arborists to identify visible signs on trees that indicate good health, or potential problems. Symptoms of decay, growth patterns and defects are identified and assessed as to their potential to cause whole tree, part tree or branch failure. This system is based around methods discussed in `*The Body Language of Trees*'[1]. For the purpose of this report, parts of the VTA system will be used along with other industry standard literature and other relevant studies that provide an insight into potential hazards in trees. This assessment is a snapshot of what could be reasonably seen or determined from a basic visual inspection. The VTA system is generally used as a means to identify hazardous trees; however it is important to realize that for a tree to be hazardous there must be a target. In this case it should be noted that this is not a hazard assessment report so whilst tree defects will form part of the Tree Significance Assessment and therefore affect the retention values, the hazards are not the main focus of the assessment.

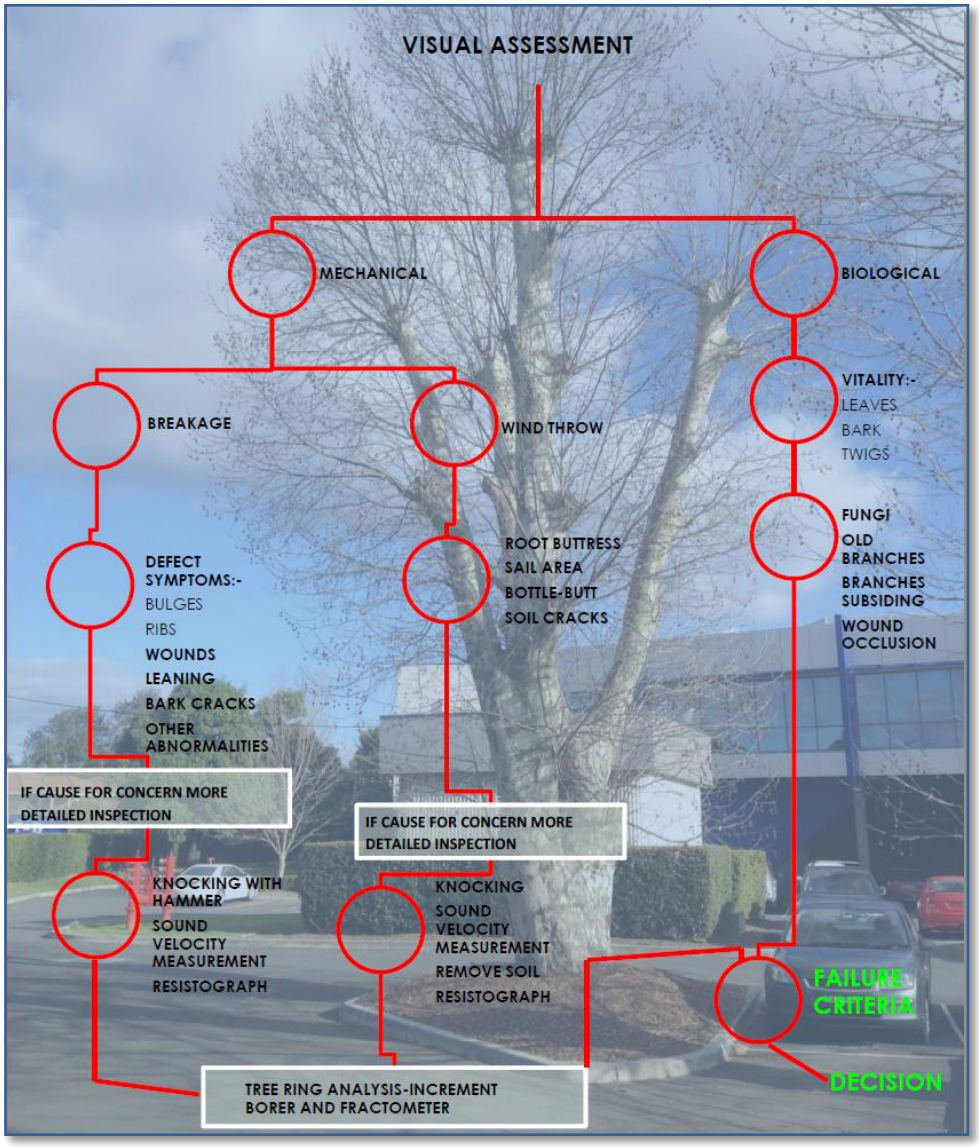

Figure 1 - An interpretation of the Visual Tree Assessment (VTA) procedure as described by Claus Mattheck in 'The Body Language of Trees' (1994)[1].

For the purpose of this report, parts of the VTA procedure will be used along with other industry standard literature and relevant studies that provide an insight into potential hazards in trees. This assessment is a snapshot of what could be reasonably seen or determined from a basic visual inspection. As per the VTA procedure, if defects are suspected further investigation may be required and recommended. "[When using] *the Visual Tree Assessment (VTA) procedure for assessing trees, as the suspicion increases that defects are present, the examination becomes more thorough and searching."*[1]

"Some defects, especially some forms of decay, do not give rise to external signs and therefore tend to escape detection in a purely visual survey. If there is no reason for suspecting a hidden defect to occur within a particular part of the tree, there is no reasonable basis for carrying out a detailed internal assessment. Although in theory an unsuspected defect might be detectable by the use of specialized diagnostic devices, this would be impracticable in the absence of some external sign to indicate the place which should be probed. Also, internal examination without good reason is undesirable, as it usually causes injury to the tree and is unreasonably time consuming and costly."[2] The VTA system is generally used as a means to identify hazardous trees, however it is important to realize that for a tree to be hazardous there must be a target. A hazard poses no risk if there is no exposure to the hazard.

[2] Lonsdale. 1999. *Principles of Tree Hazard Assessment and Management.*

3.2 Calculating Tree Protection Zones (TPZ) & Structural Root Zones (SRZ)

According to the Australian Standard[3], Tree Protection Zone (TPZ) radius is calculated using the following procedure. Diameter of the trunk is measured at approximately 1.4m above ground level; this measurement is referred to as ***DBH*** (Diameter at Breast Height).

$$R_{TPZ} = DBH \times 12$$

For multi-stemmed trees the formula used is

$$R_{TPZ} = \sqrt{[(DBH1)^2 + (DBH2)^2 + (DBH3)^2]}$$

The TPZ is measured radially from the centre of the stem and must be protected on all sides.

The Structural Root Zone (SRZ) radius is calculated by measuring the diameter of the stem close to ground level, just above the basal flare. This measurement is taken as ***D*** and then used in the following formula:

$$R_{SRZ} = (Dx50)^{0.42} \times 0.64$$

This becomes the Structural Root Zone, measured radially from the centre of the stem.

It is important to realize that these calculations provide a notional figure only and tree dynamics, form and site conditions will greatly affect these zones, and it is the job of the arborist to interpret the information correctly.

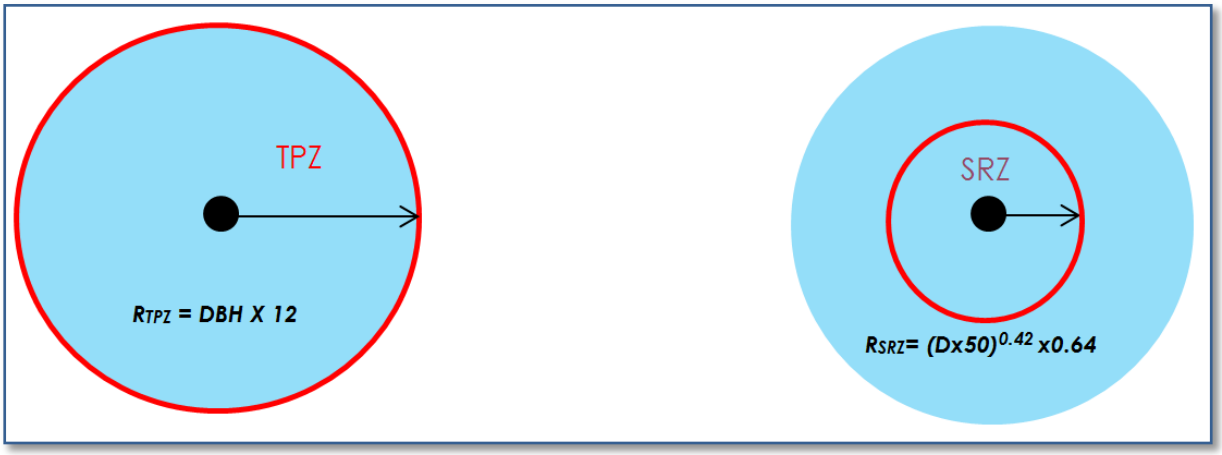

Figure 2 - The calculations for TPZ and SRZ respectively, in accordance with AS4970-2009.

[3] Australian Standard AS4970-2009, The Protection of Trees on Development Sites.

4 Site Details/Location

The site is located at Taronga Zoo and lies within the Mosman local government area (LGA).

Figure 3 - Site with approximate site location plotted. Image from Google Maps.[4]

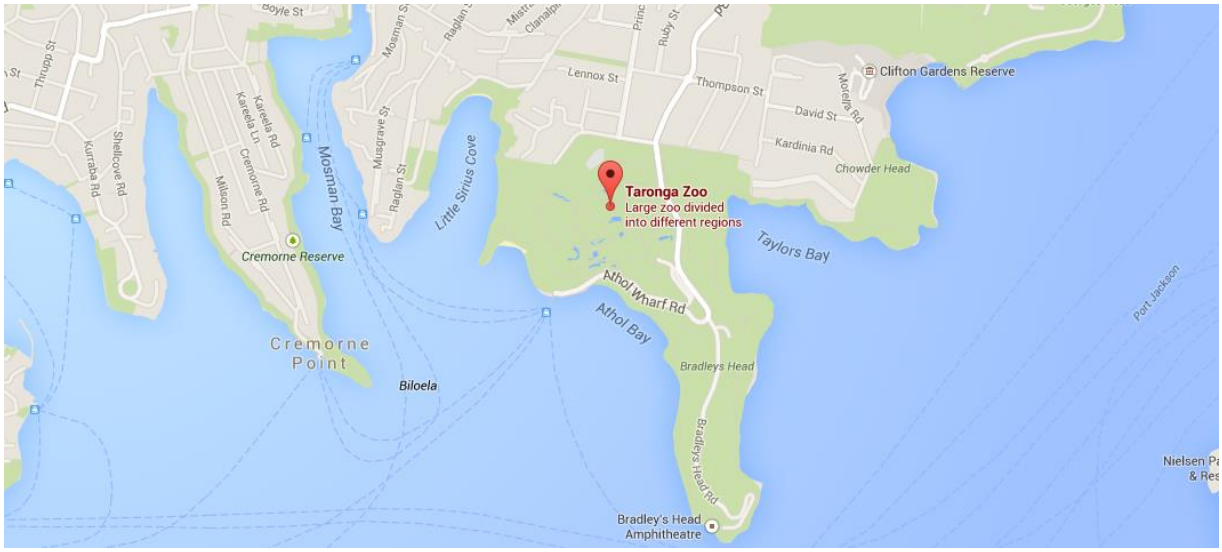

Figure 4 - The location of the site relative to the local area. Taken from Google Maps

[4] Google Maps. 2015. *The location of Taronga Zoo*

5 Site Map

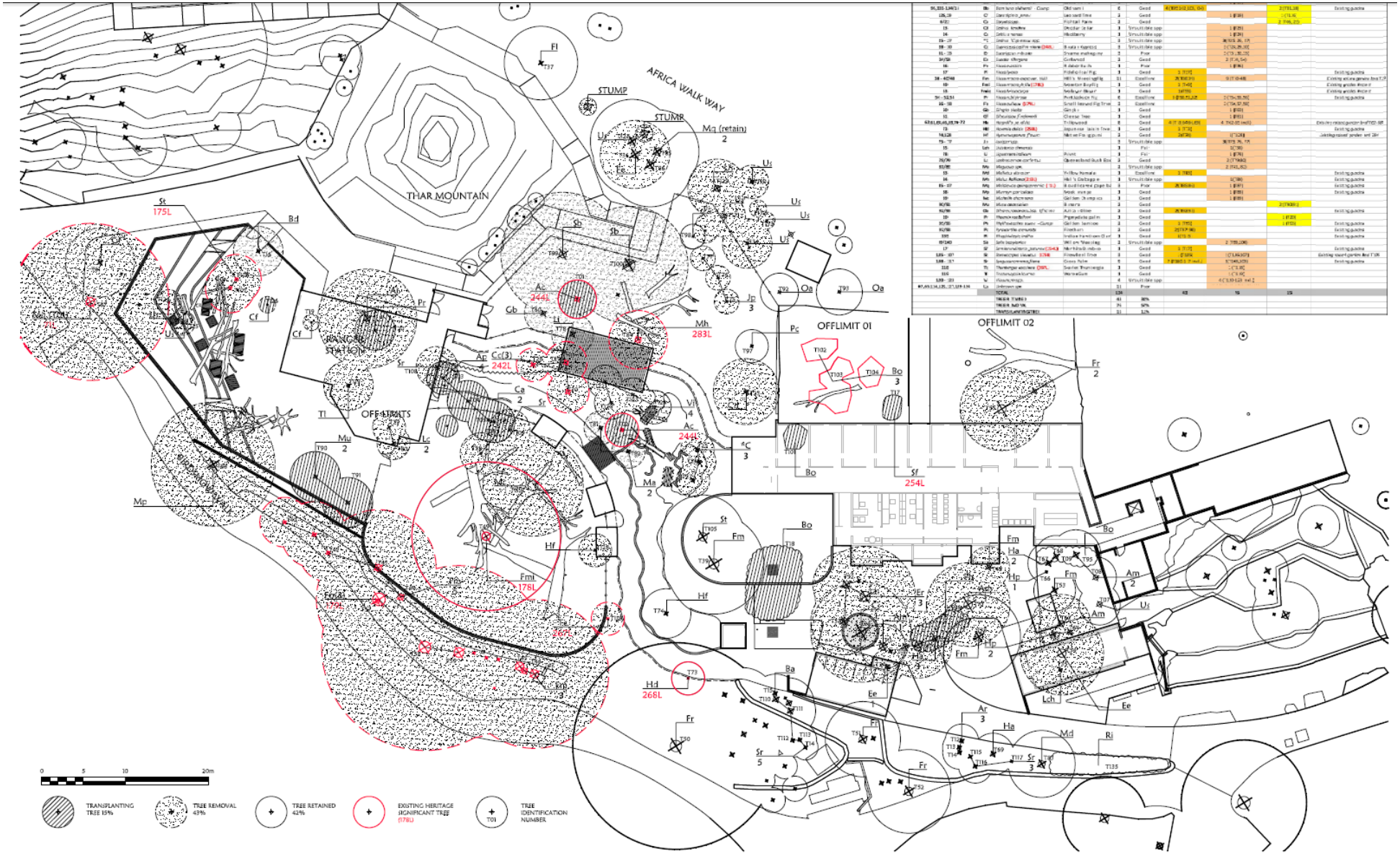

Figure 5: Drawing SK-06. APRIL 2015

6 Tree details

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
07	US	Unknown species	Unknown	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
08	AM	Aleurites moluccana	Candlenut Tree	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
95	BO	Bambusa oldhamii	Giant Timber Bamboo	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
09	AM	Aleurites moluccana	Candlenut Tree	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
68	AM*	Aleurites moluccana *	Candlenut Tree	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
67	AM*	Aleurites moluccana *	Candlenut Tree	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
66	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
53	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	Chicken Coup	RETAIN	RETAIN	Will be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
62	AM	Aleurites moluccana	Candlenut Tree	GOOD	GOOD	Chicken Coup, building	REMOVE	REMOVE	
64	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	Chicken Coup, building	REMOVE	REMOVE	
63	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	Chicken Coup, building	REMOVE	REMOVE	
54	EE	Euodia elleryana	Corkwood	GOOD	FAIR	Chicken Coup, building	REMOVE	REMOVE	
35	LCH	Livistona chinensis	Chinese Fan Palm	GOOD	GOOD	Building	REMOVE	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
135	RI	Rhaphiolepis indica	Indian Hawthorn	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
83	MD	Mallotus discolour	Yellow Kamala	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
117	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
69	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
116	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
115	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
14	AR	Archontophoenix cunninghamiana	Bangalow Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
13	AR	Archontophoenix cunninghamiana	Bangalow Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
12	AR	Archontophoenix cunninghamiana	Bangalow Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
38	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New paving and retaining walls	RETAIN	RETAIN	Will be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
10	AM	Aleurites moluccana	Candlenut Tree	GOOD	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
48	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
96	BO*	Bambusa oldhamii	Giant Timber Bamboo	GOOD	GOOD	New paving, building and retaining walls	TRANSPLANT	TRANSPLANT	Will be affected by design- **REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
72	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
71	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
70	HP*	Harpullia pendula	Tulipwood	GOOD	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
37	FL*	Ficus lyrata*	Fiddle-lead Fig*	GOOD	FAIR	New paving, building and retaining walls	RETAIN*	RETAIN	
34	EE*	Euodia elleryana*	Corkwood*	GOOD	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
11	AM	Aleurites moluccana	Candlenut Tree	GOOD	FAIR	New paving and building	RETAIN	RETAIN	Will be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
52	FR	Ficus rubiginosa	Port Jackson Fig	GOOD	FAIR	NO	RETAIN	RETAIN	Unaffected by design
51	FR	Ficus rubiginosa	Port Jackson Fig	GOOD	FAIR	New building under canopy	RETAIN	RETAIN	Significant pruning will be required to enable construction of building under canopy.
24	CS	Celtis sinensis	Chinese Hackberry	FAIR	POOR	New paving, building and retaining walls	REMOVE	REMOVE	Class 4 Locally controlled Weed- The growth of the weed must be managed in a manner that continually inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed
33	ER	Eucalyptus robusta	Swamp Mahogany	FAIR	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
31	ER	Eucalyptus robusta	Swamp Mahogany	FAIR	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
32	ER	Eucalyptus robusta	Swamp Mahogany	FAIR	FAIR	New paving, building and retaining walls	REMOVE	REMOVE	
18	BO	Bambusa oldhamii	Giant Timber Bamboo	GOOD	GOOD	New paving, building and retaining walls	TRANSPLANT	TRANSPLANT	Will be affected by design- **REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
15	BA	Brachychiton acerifolius	Illawarra Flame Tree	GOOD	FAIR	Possible impacts from resurfacing	RETAIN	RETAIN	Will be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
110	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
111	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
112	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
113	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
114*	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design
50	FR	Ficus rubiginosa	Port Jackson Fig	GOOD	FAIR	Possible impacts from resurfacing	RETAIN	RETAIN	May be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
73	HD	Hovenia dulcis	Oriental Raisin Tree	FAIR	POOR	Will be heavily impacted by resurfacing	RETAIN	REMOVE	Tree is a **Heritage Item 268L**. The re-configuration of the pedestrian restraint fence and the installation of `Forest Trail Paving' will pose significant impacts upon tree health.
74	HF	Hymenosporum flavum	Native Frangipani	FAIR	POOR	Will be heavily impacted by resurfacing on both side of the tree.	RETAIN	REMOVE	Tree has poor structure and will be heavily impacted by design- Not suitable for retention
39	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New paving, building and retaining walls	RETAIN	RETAIN	May be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
105	ST	Stenocarpus sinuatus	Firewheel Tree	GOOD	FAIR	New paving, building and retaining walls	RETAIN	RETAIN	May be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
27	C*	Cedrus/ Cupressus spp.	Cedar/Cupressus	GOOD	FAIR	New paving and exhibit	REMOVE	REMOVE	
26	C*	Cedrus/ Cupressus spp.	Cedar/Cupressus	GOOD	FAIR	New paving and exhibit	REMOVE	REMOVE	
25	C*	Cedrus/ Cupressus spp.	Cedar/Cupressus	GOOD	FAIR	New paving and exhibit	REMOVE	REMOVE	
23	CD	Cedrus deodara	Himalayan Cedar	GOOD	FAIR	New paving and exhibit	REMOVE	REMOVE	
101	BO	Bambusa oldhamii	Giant Timber Bamboo	GOOD	GOOD	New paving, building and retaining walls	TRANSPLANT	TRANSPLANT	Will be affected by design- **REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
102	BO*	Bambusa oldhamii	Narihira Bamboo	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design- **Heritage Item 254L**
103	BO*	Bambusa oldhamii	Narihira Bamboo	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design- **Heritage Item 254L**
104	BO*	Bambusa oldhamii	Narihira Bamboo	GOOD	GOOD	NO	RETAIN	RETAIN	Unaffected by design- **Heritage Item 254L**

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
17	SF*	Semiarundinaria fastuosa	Giant Timber Bamboo	GOOD	GOOD	New building	TRANSPLANT	TRANSPLANT	Will be affected by design- **REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
55	FR	Ficus rubiginosa	Port Jackson Fig	GOOD	FAIR	New building	REMOVE	REMOVE	Will be heavily affected by design
56	FR	Ficus rubiginosa	Port Jackson Fig	GOOD	FAIR	New building	REMOVE	REMOVE	Will be affected by design
93	OA	Olea europaea subsp. Africana	African Olive	GOOD	FAIR	May receive impacts from fence lines, building	REMOVE *	REMOVE	Class 4 Locally controlled Weed- The growth of the weed must be managed in a manner that continually inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed
92	OA	Olea europaea subsp. Africana	African Olive	GOOD	FAIR	May receive impacts from fence lines, building	REMOVE *	REMOVE	Class 4 Locally controlled Weed- The growth of the weed must be managed in a manner that continually inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed
97	PC	Pyracantha crenulata	Firethorn	GOOD	FAIR	May receive impacts from fence lines, building of new exhibit	RETAIN	RETAIN	May be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
75	JP	Juniper sp.	Juniper	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
76	JP	Juniper sp.	Juniper	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
77	JP	Juniper sp.	Juniper	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
134	US	Unknown species	Unknown	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	
133	US	Unknown species	Unknown	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	
132	US	Unknown species	Unknown	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	
130	US	Unknown species	Unknown	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	
129	US	Unknown species	Unknown	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	
131	US	Unknown species	Unknown	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	
98	PC	Pyracantha crenulata	Firethorn	GOOD	FAIR	May receive impacts from fence lines, building of new exhibit	RETAIN	RETAIN	May be affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
86	MQ	Melaleuca quinquenervia	Paperbark	FAIR	FAIR	NO	RETAIN	RETAIN	Unlikely to be affected-Outside of area of disturbance
85	MQ	Melaleuca quinquenervia	Paperbark	FAIR	FAIR	NO	RETAIN	RETAIN	Unlikely to be affected-Outside of area of disturbance

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
127	US	Unknown species	Unknown	GOOD	FAIR	NO	REMOVE	REMOVE	Unlikely to be affected-Outside of area of disturbance
36	FE	Ficus elastica	Rubber Tree	GOOD	FAIR	NO	REMOVE	REMOVE	Unlikely to be affected-Outside of area of disturbance
100	SB	Salix babylonica	Weeping Willow	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	Class 4 Locally controlled Weed- The plant must not be sold, propagated or knowingly distributed
99	SB	Salix babylonica	Weeping Willow	GOOD	FAIR	New exhibit, fence lines	REMOVE	REMOVE	Class 4 Locally controlled Weed- The plant must not be sold, propagated or knowingly distributed
01	AC	Acer pentaphyllum	Chinese Maple Tree	GOOD	GOOD	New exhibit	TRANSPLANT	TRANSPLANT	**Heritage Item 244L**
60	GB	Ginkgo biloba	Maidenhair tree	GOOD	GOOD	New exhibit	REMOVE	TRANSPLANT	Juvenile specimen with good chance of transplant success. **REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
78	LI	Ligustrum indicum	Privet	GOOD	GOOD	New exhibit	REMOVE	REMOVE	
84	MH	Malus halliana	Halls Crab Apple	FAIR	FAIR	New exhibit	REMOVE	REMOVE	**Heritage Item 283L**
122	VI	Viburnum spp.	Viburnum	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
120	VI	Viburnum spp.	Viburnum	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
123	VI	Viburnum spp.	Viburnum	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
124	VI	Viburnum spp.	Viburnum	GOOD	FAIR	New exhibit	REMOVE	REMOVE	
02	AC	Acer pentaphyllum	Chinese Maple Tree	GOOD	GOOD	New exhibit	TRANSPLANT	TRANSPLANT	**Heritage Item 244L**
82	MA	Magnolia sp.	Magnolia	FAIR	FAIR	New exhibit	REMOVE	REMOVE	
81	MA	Magnolia sp.	Magnolia	FAIR	FAIR	New exhibit	REMOVE	REMOVE	
30	CC	Cupressus cashmeriana	Bhutan Cypress	GOOD	POOR	New exhibit	REMOVE	REMOVE	**Heritage Item 242L**
29	CC	Cupressus cashmeriana	Bhutan Cypress	GOOD	FAIR	New exhibit	REMOVE	REMOVE	**Heritage Item 242L**
28	CC	Cupressus cashmeriana	Bhutan Cypress	GOOD	FAIR	New exhibit	REMOVE	REMOVE	**Heritage Item 242L**
108	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	New exhibit, building	REMOVE	REMOVE	Heavily impacted by building
03	AP	Arenga pinnata	Sugar Palm	GOOD	GOOD	New exhibit, fence line	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
04	AP	Arenga pinnata	Sugar Palm	GOOD	GOOD	New exhibit, fence line	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
05	AP	Arenga pinnata	Sugar Palm	GOOD	GOOD	New exhibit, fence line	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
21	AP	Arenga pinnata	Sugar Palm	GOOD	GOOD	New exhibit, fence line	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
109	SR	Syagrus romanzoffiana	Cocos Palm	GOOD	GOOD	New exhibit, building	REMOVE	REMOVE	Heavily impacted by building
06	CA	Caryota sp.	Fishtail Palm	GOOD	GOOD	New exhibit	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
22	CA	Caryota sp.	Fishtail Palm	GOOD	GOOD	New exhibit	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
89	MC	Michelia champaca	Himalayan Magnolia	FAIR	FAIR	New exhibit	REMOVE	REMOVE	
49	FMI	Ficus macrophylla	Moreton Bay Fig	GOOD	GOOD	Removal of existing structures and construction of new exhibit	RETAIN	RETAIN	May be heavily affected by design- **REFER TO TREE RETENTION SCHEDULE AND TREE PROTECTION MEASURES**
80	LC	Lophostemon confertus	Brush Box	GOOD	GOOD	Removal of existing structures and construction of new exhibit, Ranger station	REMOVE	REMOVE	
79	LC	Lophostemon confertus	Brush Box	GOOD	GOOD	Removal of existing structures and construction of new exhibit, Ranger station	REMOVE	REMOVE	
119	TL	Tristaniopsis laurina	Water Gum	GOOD	FAIR	Removal of existing structures and construction of new exhibit, Ranger station	REMOVE	REMOVE	
94	AJ	Albizia julibrissin	Pink Silk Tree	GOOD	FAIR	Removal of existing structures and construction of new exhibit, Ranger station	REMOVE	REMOVE	
20	PR	Phoenix roebelenii	Pygmy Date Palm	GOOD	GOOD	Removal of existing structures and construction of new exhibit, Ranger station	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
19	CF	Caesalpinea ferrea	Leopard Tree	POOR	FAIR	Removal of existing structures and construction of new exhibit, Ranger station	TRANSPLANT	REMOVE	Tree is in poor condition and is unsuitable for transplant
126	CF	Caesalpinea ferrea	Leopard Tree	GOOD	FAIR	Removal of existing structures and construction of new exhibit, Ranger station	REMOVE	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
16	BD	Brachychiton discolor	Lacebark	GOOD	FAIR	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	
106	ST	Stenocarpus sinuatus	Firewheel Tree	GOOD	GOOD	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	**Heritage Item 175L**
107	ST	Stenocarpus sinuatus	Firewheel Tree	GOOD	GOOD	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	**Heritage Item 175L**
61	GF	Glochidion ferdinandii	Cheese Tree	FAIR	FAIR	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	

Ref #	Species code	Species	Common Name	Health + vigour	Structure	Impacts	Proposed	Recommended	Comments
87	MQ	Melaleuca quinquenervia	Paperbark	FAIR	FAIR	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	**Heritage Item 71L**
136*	US	Unknown species	Unknown	GOOD	GOOD	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	
125	US	Unknown species	Unknown	GOOD	GOOD	Removal of existing structures and construction of new exhibit,	REMOVE	REMOVE	
88	MP	Murraya paniculata	Mock Orange	GOOD	GOOD	New exhibit, paving	REMOVE	REMOVE	
90	MU	Ensete ventricosum	Abyssinian Banana	GOOD	GOOD	Removal of existing structures and construction of new exhibit,	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
91	MU	Ensete ventricosum	Abyssinian Banana	GOOD	GOOD	Removal of existing structures and construction of new exhibit,	TRANSPLANT	TRANSPLANT	**REFER TO TREE TRANSPLANT SCHEDULE AND METHODOLOGY**
40	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
41	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
42	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
43	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
57	FO	Ficus obliqua	Small leaved Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	**Heritage Item 179L**
44	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
58	FO	Ficus obliqua	Small leaved Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	**Heritage Item 179L**
59	FO	Ficus obliqua	Small leaved Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	**Heritage Item 179L**
45	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
46	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
47	FM	Ficus microcarpa var. hillii	Hills Weeping Fig	GOOD	FAIR	New exhibit, damaging Aboriginal Heritage wall	REMOVE	REMOVE	
118	TC	Thunbergia coccinea	Scarlet Thunbergia	GOOD	GOOD	Removal of exhibit	REMOVE	REMOVE	**Heritage Item 267L**
128	HF*	Hymenosporum flavum	Native Frangipani	GOOD	GOOD	New exhibit fence	REMOVE	REMOVE	

7 Discussion

Based upon recent site visits and analysis of the provided site plans including Architectural drawing SK-06 revision 20/4/15, the following seventy seven (77) trees have been nominated for removal due to being within the construction footprint or too close to construction to enable successful retention. It should be noted that the plans and this report do not identify all of the trees in the development area. Any trees which are not specifically identified or discussed are proposed for removal in addition to the trees numbered below.

REMOVAL			62	64	63	54	10	48	72	71	70	34	24	33	31	32	73	74	27
26	25	23	55	56	93	92	75	76	77	134	133	132	130	129	131	127	136	100	99
78	84	122	120	123	124	82	81	30	29	28	108	109	89	80	79	119	94	19	16
106	107	61	87	124	125	88	40	41	42	43	57	44	58	59	45	46	47	118	128

The following thirty nine (39) trees have been nominated for retention. These trees will be subject to tree protection measures to ensure they remain viable during construction and beyond. Refer to tree protection Appendix.

RETENTION				7	8	95	9	68	67	66	53	135	83	117	69	116	115	14	13
12	38	37	11	52	51	15	110	111	112	113	14	50	39	105	102	103	104	97	98
86	85	49																	

The following eighteen (18) trees have been nominated for relocation to allow construction to take place; these trees will be relocated to a designated location within Taronga Zoo, yet to be confirmed.

TRANSPLANT				1	2	35	96	18	101	17	60	3	4	5	21	6	22	20	126
90	91																		

The trees which are to be removed may pose some significant impacts upon the trees which are to be retained through alteration of light patterns and increased wind exposure as well as the physical act and logistics involved in the tree removal process. Tree removals that are in close proximity to retainable trees must be managed in a sensitive manner and stump grinding will be restricted in these areas. The alteration of light patterns and wind exposure will be harder to manage and may need to be dealt with through monitoring of the retained trees following the development. One of the most obvious areas of concern would be the adverse effects that will be felt by tree forty nine (49) the large Ficus macrophylla which will become the centrepiece of the proposed new exhibit. This tree will be exposed to increased wind exposure through the removal of the large group of Ficus trees to the south of the tree which are damaging the Aboriginal heritage wall. There will also be increased ambient light levels throughout the canopy which is likely to result in epicormic growth *"When a portion of the canopy or an adjacent tree is removed, formerly shaded bark is exposed to sunlight, these dormant buds can activate forming branches called epicormic branches or watersprouts. These branches are not strongly attached and are easily broken until they become well established"* [5]. These sorts of problems will potentially be experienced by a number of the retained trees. Tree forty nine will require significant pruning of the low lateral branches and netting is to be installed within the canopy.

[5] Urban, 2008.

The trees which have been nominated for retention will require protection throughout development as they may be impacted upon by a number of factors, the table below provides details of the likely impacts and mitigation measures which may be appropriate.

Tree #	Impacts likely	Protection measures
53	Installation of Chicken coup	Non-destructive excavation will be required and the structure will need to be designed to allow for the roots which are discovered, this may require pier and beam construction or other less invasive construction methods.
38	New paving and retaining walls	Non-destructive excavation will be required and the structure will need to be designed to allow for the roots which are discovered, this may require pier and beam construction or other less invasive construction methods. The proposed paving will be Basalt stone slab paving, it is assumed that this will be permeable and as the tree is currently in a raised garden bed the root impacts may be minimised. Removal of existing retaining walls must be done by hand and not torn out with machinery. This should be done under supervision of a suitably qualified Arborist.
11	New paving and building	Non-destructive excavation will be required and the structure will need to be designed to allow for the roots which are discovered, this may require pier and beam construction or other less invasive construction methods. The proposed paving will be Basalt stone slab paving, it is assumed that this will be permeable and as the tree is currently in a raised garden bed the root impacts may be minimised. Removal of existing retaining walls must be done by hand and not torn out with machinery. This should be done under supervision of a suitably qualified Arborist.
51	New building under canopy	Significant pruning will be required to enable construction of the building. There may be roots under the current footpath which may become impacted by the new building; this will need to be assessed once the Bitumen has been removed.
15	Resurfacing	There may be roots under the current footpath which may become impacted by the resurfacing; this will need to be assessed once the Bitumen has been removed.
50	Resurfacing	There may be roots under the current footpath which may become impacted by the resurfacing; this will need to be assessed once the Bitumen has been removed but it is expected that there will be minimal impact.
39	Resurfacing and removal of existing retaining wall and installation of new wall.	Non-destructive excavation will be required and the new retaining wall will need to be designed to allow for the roots which are discovered, this may require pier and beam construction or other less invasive construction methods. The proposed paving will be Forest trail decorative concrete, it is assumed that this will not be permeable, however as the tree is currently in a raised garden bed the root impacts may be minimised. Removal of existing retaining walls must be done by hand and not torn out with machinery. This should be done under supervision of a suitably qualified Arborist.
105	Resurfacing and removal of existing retaining wall and installation of new wall.	Non-destructive excavation will be required and the new retaining wall will need to be designed to allow for the roots which are discovered, this may require pier and beam construction or other less invasive construction methods. The proposed paving will be Forest trail decorative concrete, it is assumed that this will not be permeable, however as the tree is currently in a raised garden bed the root impacts may be minimised. Removal of existing retaining walls must be done by hand and not torn out with machinery. This should be done under supervision of a suitably qualified Arborist.
97	New exhibit	May receive impacts from redesign of internal features of the exhibit however the amount of disturbance is unclear. Maintain Tree protection zones 12x trunk diameter as per AS4970-2009.
98	New exhibit	May receive impacts from redesign of internal features of the exhibit however the amount of disturbance is unclear. Maintain Tree protection zones 12x trunk diameter as per AS4970-2009.
49	New exhibit, removal of existing structures and installation of new structures. Exposure to wind and increased light levels. Proposed pruning, installation of netting.	Non-destructive excavation will be required to pothole for new fence post locations, the design must allow for the roots which are discovered. Removal of the existing water feature must be done by hand and not torn out with machinery. This should be done under supervision of a suitably qualified Arborist. The demolition of the rear walls of the exhibit must be conducted from outside the exhibit and machinery must be excluded from within the current enclosure. The entire enclosure will become the tree protection zone. The tree will require significant pruning to reduce the long lateral branches and there will be an alteration of light patterns and wind exposure, this tree will need to be regularly monitored following development.

There are eighteen (18) trees which have been nominated to be transplanted. Tree transplanting trees is a specialized process and requires significant care and resources to be successful. Some species and types of tree are generally more suitable for transplantation due to their genetic and structural make up and conversely some trees are less suitable for transplanting. The following trees have been nominated for transplantation and a guide to their requirements is also provided. General guidelines for tree transplanting have been provided.

GENRERAL REQUIREMENTS:		**1. Consider species suitability.** **2. Calculate tree protection zone (TPZ) as per AS4970-2009. For woody trees (Dicots) this calculation is (12 x DBH) and should be no less than 2m in radius from the centre of the stem. For Monocots e.g. Palm trees, Ferns, Grasses etc. the TPZ should be not less than 1m outside the crown projection.** **3. Consider the access requirements for lifting machinery based on the mass and weight of the root ball required.** **4. Consider the new locations for the trees and endeavour to choose locations which present similar climatic conditions, i.e. if a tree has been in full shade do not move it into full sun and vice versa.** **5. Excavate around root ball at the extent of the TPZ wherever possible. This is best achieved with careful hand digging, air spade or other non-destructive means. If the TPZ is too large to be practically moved this area may need to be reduced.** **6. Roots which are discovered must be carefully pruned by hand and not torn out with heavy machinery.** **7. Trees must be slung and lifted in an appropriate manner so as to not damage the bark of the tree.** **8. Northing points should be marked on trees to ensure that after they are relocated they are facing the same way as in their previous location.** **9. Trees which have been transplanted are likely to suffer from transplant stress and will require increased maintenance to ensure their survival; this will mean regular watering or the installation of temporary/permanent irrigation systems.** 10. **Trees which are transplanted are commonly done due to historical, cultural or Environmental significance. Consider seed collection or propagation of important specimens prior to transplantation in case of transplant failure.**
Tree #	**Species**	**Requirements for transplantation**
1	Acer pentaphyllum	• Very unusual specimen and heritage item. • Consider taking cuttings for propagation • Maintain as large a root ball as possible • Consider climatic requirements • Ensure tree is slung appropriately to protect the bark. • Provide significant post-transplant care
2	Acer pentaphyllum	• Very unusual specimen and heritage item. • Consider taking cuttings for propagation • Maintain as large a root ball as possible • Consider climatic requirements • Ensure tree is slung appropriately to protect the bark. • Provide significant post-transplant care
35	Livistona chinensis	• TPZ should be no less than 1m outside crown projection
96	Bambusa oldhamii	• TPZ should be no less than 1m outside crown projection
18	Bambusa oldhamii	• TPZ should be no less than 1m outside crown projection

101	Bambusa oldhamii	• TPZ should be no less than 1m outside crown projection
17	Semiarundinaria fastuosa	• TPZ should be no less than 1m outside crown projection
60	Ginkgo biloba	• Maintain as large a root ball as possible • Consider climatic requirements • Ensure tree is slung appropriately to protect the bark. • Provide significant post-transplant care
3	Arenga pinnata	• TPZ should be no less than 1m outside crown projection
4	Arenga pinnata	• TPZ should be no less than 1m outside crown projection
5	Arenga pinnata	• TPZ should be no less than 1m outside crown projection
21	Arenga pinnata	• TPZ should be no less than 1m outside crown projection
6	Caryota sp.	• TPZ should be no less than 1m outside crown projection
22	Caryota sp.	• TPZ should be no less than 1m outside crown projection
20	Phoenix roebelenii	• TPZ should be no less than 1m outside crown projection
126	Caesalpinea ferrea	• Maintain as large a root ball as possible • Consider climatic requirements • Ensure tree is slung appropriately to protect the bark. • Provide significant post-transplant care
90	Ensete ventricosum	• TPZ should be no less than 1m outside crown projection
91	Ensete ventricosum	• TPZ should be no less than 1m outside crown projection

8 Conclusions

1. A total of seventy seven (77) trees which are identified on the Architectural drawings as well as several other specimens which are not captured on the drawings are proposed for removal to allow construction to take place.
2. The loss of these trees will be compensated for with new landscaping designs.
3. A total of thirty nine (39) trees which are identified on the Architectural drawings are proposed for retention. These trees will require tree protection measures to ensure their safe retention; this will necessitate tree protection zones to be calculated, implemented and maintained.
4. Specific tree protection plans should be drawn up and implemented to specify exclusion zones.
5. Arborist supervision will be required when works have the potential to impact upon trees to be retained.
6. Eighteen (18) trees have been nominated for transplantation and relocation to other locations within the site. These trees will require significant resources to enable successful retention and post-transplant after care will be required.

Figure 6: Livistona chinensis, this tree will be relocated to another area within the zoo.

Figure 7: Trees 39 + 105, these trees are nominated for retention, they will be impacted upon by the removal of the brick wall and installation of a new low wall in front of the trees. Tree protection measures will need to be implemented.

Figure 8: Caesalpinea ferrea (tree 126), this tree will be relocated to another area within the zoo.

Figure 9: Tree 49 is a mature Ficus macrophylla which will form the centrepiece of the new exhibit. This tree will require pruning to allow netting to be installed in the first order branch structure.

Figure 10: Tree 51, this tree will require significant pruning of the lower canopy to allow for the construction of a new building under the canopy.

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Disclaimer

The information contained within this report is to be used solely for the purposes that were specified at the time of engagement.

All attempts have been made to ensure the legitimacy of any information which has been gathered in the process of compiling this report, however Sydney Arbor Trees Pty. Ltd. cannot be held liable for inaccurate or misguiding information which has been provided by others.

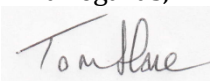
Any tree inspections or assessments which have been carried out the purposes of this report are valid only at the time of inspection and are based on what could reasonably be seen or diagnosed from a visual inspection carried out from ground level.

All inspections unless otherwise stated are based upon Visual Tree Assessment (VTA) techniques, industry best practice and applied knowledge. No internal diagnostic testing or below ground investigation has been carried out unless otherwise stated.

Trees are a dynamic living organism and as such they have a finite lifespan the end of which cannot always be predicted or understood, even apparently healthy trees can die suddenly or fall without warning. As such there is no warranty or guarantee provided, or implied regarding the future risks associated with any tree.

Please feel free to contact me either via telephone or email if you have any questions regarding this report.

Kind regards,



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