Client:	Reporting Company:
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Client Contact:	Report Writer
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Report Type:	Feasibility Study	**External Consultant:**
Report Topic:	Tree Restraint	Structural Engineer
Subject Site:	Laman Street	Peter Allsopp
Site Meeting Date:	Friday the 18th June 2010	02 9906 2600
Report Date:	9th July 2010	peter@peterallsopp.com.au

Client Scope of Works:

1. To review the technical reports as background to your investigations into the feasibility of using a cable system to reduce or eliminate the risk of whole tree failure so that the precinct can return to normal traffic, parking and pedestrian use;
2. To conduct a site inspection of the Laman Street trees in conjunction with Mr Lindsay Field
3. To provide a preliminary report on the feasibility of using a cabling system to return the precinct to normal usage.
4. Should you find that such a cabling system is a feasible option, provide an indication of cost for the full design, installation and certification of such system

Background Information Documents

The following documents were provided as background information:

1. Tree Logic Report Dated 2nd September 2009
2. The Sugar Factory Report Dated 7th August 2009

Site Meeting:

I attended a site meeting on Friday the 18th June 2010 in the presence of Mr Lindsay Field and Mr Philip Hewett. The meeting provided background information and highlighted the situation concerning to the trees. It is understood that the council is reviewing all possible options for the safe and effective retention of the existing street trees. The primary focus of the meeting was to look at the feasibility of installing structural tree restraints to greatly reduce the risks associated with total tree failure.

Tree Restraint:

Tree restraint is a general term that describes the process of installing synthetic or steel cables in a tree to improve the structural strength or stability of a tree or tree sections. In this case it would be four synthetic fibre rope restraints leading from steel post structures that surround the tree. The steel post structures would be evenly spaced around the tree and at a distance of approximately 6m from the tree. The steel posts would be placed down the center of the road and within the verge next to the footpath. The synthetic ropes would be manufactured from 12 strand hollow Dyneema® fibre. The restraints would be spliced around branch junctions within the trees crown and then lead to the top of the pole structures.

This type of tree restraint is not normally load bearing under normal conditions and it only becomes load bearing should the tree or tree section move beyond its natural range of movement. The common term for this type of restraint is a “Lazy Cable”. It is designed to support the tree during overloading or failure of the tree or tree section.

Feasibility Factors:
The factors that make this restraint system feasible or not are as follows:
1. The rated strength of the restraint system
2. The footprint of land each structural connection to the ground occupies
3. The location of each structural connection to the ground
4. The restriction or loss of access to the street or footpath
5. The visual impact of the installed restraint system
6. The effectiveness of the restraint system to prevent total tree failure
7. The cost of the project

System Strength
As identified in the Sugar Factory Report Section 8 (Risk Management Options) a selection of the trees exhibit a large sail area. Calculations by our structural engineer on the possible wind loading of the sail area generate figures of up to 65,000 Tonnes. All loading calculations were based on Australian Standard 1170.

The restraint system would need to be designed for the worst-case scenario. Wind loading on the sail area of the largest tree in the most exposed location provides us with the required rated strength. The rated strength then dictates the steel size requirements and the connection to the ground. In this case the steel sizes would exceed a size that could be defined as low visual impact. The sizes would also impact on the ground footprint that would prevent easy pedestrian or vehicle access to the street. The possible applied load is the greatest limiting factor for the design of an effective and practical tree restraint system.

The Footprint
The footprint of the post structures is likely to be no smaller then 3.5m x 3.5m. Three posts of 250mm Diameter would be required in a triangle formation. Franki Piles to a depth of 7.5m would be required to achieve the structural stability for the posts. The footprint of 3.5m x 3.5m would be restrictive as it would limit the locations of the posts and would require the loss of footpath and road access.

Location of Post Structures
The location of the post structures around each tree becomes extremely difficult when we need to allow a 3.5m x 3.5m footprint. For example the posts down the centre of the street would need to be located in an island that would be 4.0m wide. The width of these islands would prevent normal vehicle movement in the street.

Finding locations for the footings along the building side of the road also becomes restrictive at various points along the frontage. The park side of the road also has the added complication of the sloping embankment that would mean taller post structures. The post structures would also have a large visual impact on the street and park scape.

Loss of Access
Part of my brief was to consider a restraint system that would return the street back to normal traffic, parking and pedestrian use. The loading on the restraint system dictates the size requirements of all the components that make up the restraint system. The size of the post structures will prevent normal vehicle movent through the street. It would be possible to have pedestrian access around the post structures if required.

Visual Impact
It is my view that the post structures present the greatest visual impact. I was hoping that a single post structure would be sufficient to support the tree restraints but our calculations proved that wrong. The visual impact of the posts would be dramatic and intrusive to the streetscape. The steel structures would dominate over the trees and reduce the softness the trees provide to the streetscape.

Effectiveness of the Tree Restraint System
The proposed design would be effective at limiting the trees movement during total tree failure. Multiple restraints would carry load and prevent the tree moving in any direction. Each post structure would have multiple restraints leading to a number of branch junctions within the tree. Each restraint would help to distribute the load over the crown of the tree. It is with no doubt that the restraint system would be effective and practical if the post structures were not so intrusive in the environment.

Project Cost:
The cost of each post structure with restraints is estimated at $30,000.00 + GST. The first and last tree in a row would require four posts and each adjoining tree would require two posts. The internal trees within the rows would share posts with each other. The post design, fabrication and installation contribute to a large portion of the cost. The Dyneema® rope restraints cost $37.20 + GST per meter and an estimated 100m would be required per tree.

Other Options
Other options were explored such as an arch shaped canopy frame extending down the whole street. This frame would span the street from footpath to footpath and would need to be over 5.5m high to allow for vehicle clearances. Due to the different tree canopy sizes and tree spacing the frame would not have consistent frame spacing along the street. Some of the trees have extremely wide canopies and others very small. This means that the frame spacing and size could not be a consistent. The frame could not pass through the canopy. The size of the steel sections would still need to be 250mm Diameter round hollow section or similar. The arch style frame would again dominate the street and detract from the leafy tree look of the street.

The general crown shape of the trees makes it very hard to install a frame around the trees at 6.0m above ground. The short trunk divides into multiple stems that have a horizontal habit and this means that the frames could be up to 25m wide. Should tree failure occur the soft outer branches would bend and break against the frame and the whole tree may end up sitting on top of the frame. This is why the frame needs to be so strong as it may need to support the whole tree weight during a time of failure. I do not recommend this concept as a practical solution to the problem.

In Summary
I would deem the concept of tree restraint not feasible due to the visual impact, the cost of the project and the restricted access that will apply to vehicles. The visual beauty of the street would be compromised by the installation of the steel structures required to support the trees. Site access for boring equipment, concrete trucks and cranes would all impact on the trees during the construction period. Damage could be expected to the road surface, drainage and footpaths. Boring the holes for the piles may impact on root systems and possible underground services.

The embankment leading down to the park presents a number of problems when installing the post structures. Geo Technical studies would be required to determine the level of fill and the type of soil structure before footing designs could be determined. The increased post heights will require additional structural engineering detail to determine the post and footing design. In conclusion I do not recommend proceeding with tree restraint as risk management option.

Please phone or email if you require additional information or clarification of any of the document content.

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