CITY OF CHICO MEMORANDUM

TO:	"[TO: CLICK HERE FOR RECIPIENTS]"	DATE:	6/1/15
FROM:	DAN EFSEAFF	FILE:	
SUBJECT:	STATUS OF CHICO STREET TREES DURING DROUGHT - MONITORING ANALYSIS (DRAFT)		

Note: this is a draft document subject to revision. Provided for comments.

Introduction

Staff are concerned about the impacts of the now 4-year drought on the City's Street Trees over the past decade. Many trees in parts Chico are exhibiting the long-term effects of drought. Recent observations, reveal that mortality and dead branches have increased around the community. In addition, even if rain returns this winter, the effects of drought stressed may linger as the trees may have a reduced ability to respond to wounds or pathogens.

The City has a tree database system that is currently updated as staff work on individual trees. The City can use indirect measures to assess the status of trees such as service requests. However there's not a real time way to assess the status of trees.

Staff wanted to answer the question what is the current status of trees across Chico, do they need current maintenance, and what would be the costs to remedy them? Would a systematic/proactive approach to pruning result in cost savings to the City?

Methods

To provide an unbiased sample of tree status and arrive at some costs and strategies, staff completed a sampling of trees as follows: In each of the City's 7 urban zones (the 8th is Bidwell Park, select stratified random samples of 2 sets of 20 trees. Staff developed a numbered grid overlay for Chico and using MS Excel randomly selected points from each area. Staff would select the closest street to those points and then in the field, evaluate the first 10 trees or tree locations (based on the street tree database) on each side of the street.

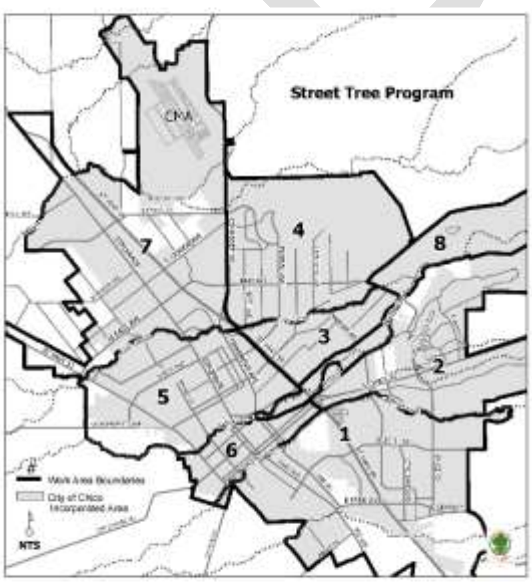

Figure 1. Work Zones Map of Chico.

The Tree Field Supervisor then completed the data collection if they were in the area on other projects and time allowed. The data collection occurred in October 2014. In the field, staff would collect the following information (Attachment A):

1. Tree Species/Type of tree
2. Position
3. Address
4. Maintenance type
5. Maintenance year
6. Date
7. Tree DBH – Diameter at Breast height (measured at 4.5 feet from the ground on the uphill side of the tree),
8. Height – Estimate of tree height from the ground level to the top of the bole or highest living foliage.

9. Vigor/Status – Tree status describes the general health of the tree (vigor score in parenthesis)
    a. A – Excellent. Healthy tree with very little damage (1)
    b. B – Good (2)
    c. C – Fair (3)
    d. D – Poor (4)
    e. E – Dead or Dying (5)
10. Dead or broken branches in canopy
11. Recommended actions
    a. Plant
    b. Formative prune
    c. Elevate
    d. Thin
    e. Clean
    f. Routine prune
    g. Remove
    h. Stump
    i. Water
12. Notes

Table 1 provides a sense of the number of trees in each zone and occupancy rates. Please note that while the removal of trees has been updated, the data below is essentially frozen at 2009-2012 rates for new plantings. New plantings may include requests thru the permit system or for new sub-divisions.

Table 1. Street Tree Summary (as of 2/18/14).

		Street Tree Locations			%
Zone	**Area**	**Total**	**Live Trees**	**Open**	**Occupancy**
1	south	6747	6128	619	91%
2	south-east	2701	2343	358	87%
3	central-east	1339	1004	335	75%
4	north-east	4651	4085	566	88%
5	central-west	6673	5930	743	89%
6	south-west	4486	3950	536	88%
7	north	5037	4662	375	93%
Misc.	no zone specified	666	578	88	87%
Est. Inventoried Trees		**32300**	**28,680**	**3620**	**89%**
Est. Uninventoried Trees (new subdivisions, etc.).			5000		
Totals		**37,300**	**33,680**	**3620**	**90%**

Results

The data collected provided the basis of the following pivot tables and summaries (Tables 2-5, Figure 2) (data and locations available upon request).

Table 2. Summary of Planting Site Locations.

Zone	Number (n)	Number of Planting sites	% Occupancy
1	40	3	93%
2	40	6	85%
3	40	4	90%
4	40	4	90%
5	40	6	85%
6	40	5	88%
7	40	2	95%
Grand Total	**280**	**30**	**89%**

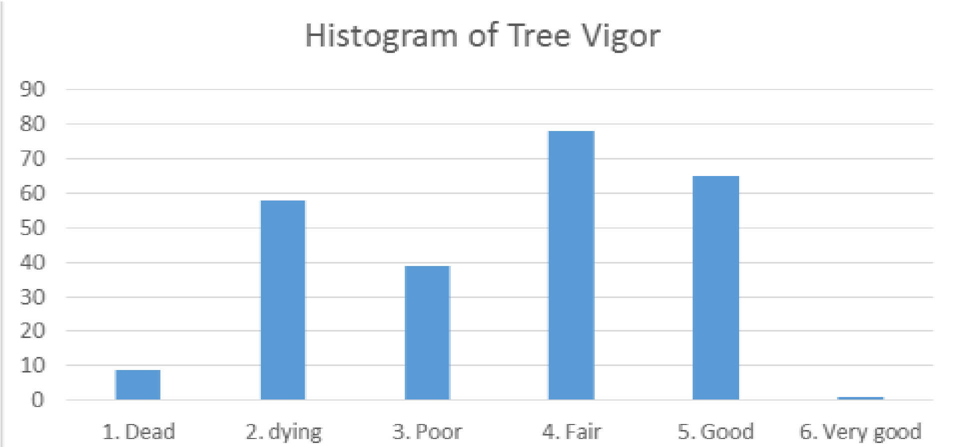

Figure 2. Distribution of Vigor for All Areas Sampled.

Table 3. Top Ten Tree Species with Highest and Poorest Vigor Scores.

Tree	Number (n)	Average DBH	Average Vigor Score
Highest Vigor			
Ponderosa Pine	1	2.00	1.00
Little Gem Magnolia	7	3.33	2.00
Coast Redwood	3	18.67	2.00
Scarlet Oak	1	5.00	2.00
October Glory maple	3	2.00	2.00
Green Ash	1	8.00	2.00
Paulownia	1	8.00	2.00
Crimson Spire Oak	5	3.00	2.00
Autumn Purple ash	1	4.00	2.00
Shumard Oak	4	6.75	2.00
Poorest Vigor			
Silver Maple	9	35.56	5.00
Incense Cedar	1	22.00	5.00
Black Walnut	37	34.84	4.57
English Walnut	4	25.00	4.50
Alder	4	17.50	4.50
Birch	2	10.00	4.50
Idaho Locust	6	14.67	4.17
Cork Oak	1	35.00	4.00
Shingle Oak	20	8.65	3.70
Chinese Elm	23	9.83	3.70

Table 4. Species, DBH, and Vigor of Sampled Trees.

Tree	Number (n)	Average DBH	Average Vigor Score
Black Walnut	37	34.84	4.57
Yarwood sycamore	23	12.38	3.13
Chinese Elm	23	9.83	3.70
Shingle Oak	20	8.65	3.70

Tree	Number (n)	Average DBH	Average Vigor Score
Modesto Ash	13	35.00	3.69
Crape Myrtle	12	2.42	2.42
Female Pistache	10	18.30	3.20
Tupelo	10	3.43	3.30
Silver Maple	9	35.56	5.00
Male Pistache	9	13.33	2.11
Little Gem Magnolia	7	3.33	2.00
Camphor	6	19.83	3.33
Liquidambar	6	15.83	3.00
Idaho Locust	6	14.67	4.17
Crimson Spire Oak	5	3.00	2.00
London Plane sycamore	5	15.20	3.00
English Walnut	4	25.00	4.50
Shumard Oak	4	6.75	2.00
Zelkova	4	14.50	3.00
Alder	4	17.50	4.50
Valley Oak	3	48.00	3.33
Coast Redwood	3	18.67	2.00
October Glory maple	3	2.00	2.00
Privet	3	5.33	2.67
Birch	2	10.00	4.50
Rocky Mt. maple	2	3.00	3.00
European Hornbeam	2	14.50	3.00
Calif. Sycamore	2	18.00	3.00
Italian Cypress	2	12.00	3.00
Autumn Purple ash	1	4.00	2.00
Raywood Ash	1	4.00	2.00
Ponderosa Pine	1	2.00	1.00
Gray Pine	1	58.00	3.00
Incense Cedar	1	22.00	5.00
Sawtooth Oak	1	4.00	3.00
Paulownia	1	8.00	2.00
Scarlet Oak	1	5.00	2.00
Fig	1	4.00	3.00
Green Ash	1	8.00	2.00
Cork Oak	1	35.00	4.00
Grand Total	**250**	**17.49**	**3.42**

Table 5. Estimate of Costs Associated Recommended Action and Current Status.

Recommended Action	Number (n)	Average DBH	Est. Unit Price	Est. Cost
Remove	81	24.53	$ 500	$ 40,500
Elevate	64	13.67	$ 150	$ 9,600
Formative	53	3.60	$ 45	$ 2,385
Reduce	36	26.97	$ 350	$ 12,600
Plant	29	0.00	$ 250	$ 7,250
Clean	6	21.67	$ 250	$ 1,500
Stump	4	28.00	$ 250	$ 1,000
Water	3	8.33	$ 50	$ 150

Thin	3	13.00	$ 150	$ 450
	279			**$ 75,435**

Just a few notable observations:

- Occupancy in all samples were greater than 85% in all areas and the mean occupancy was 89% (11 % of the locations provide planting opportunities).
- The sample size is small for evaluating the trees with the best vigor, but smaller (presumably younger) trees occupy most of the positions (Table 3). The poorest performers include trees that are drought sensitive (alder and birch) or larger, presumably mature trees (black and English walnut, cork oak, etc.). Silver maple falls into both categories. The larger trees are of the most concern from a safety standpoint. Black Walnut occurs in zones 5, 6, and 7.
- The distribution shows the number in each category, another way to view it is that staff observed 106 (42%) of the trees in poor or worse condition, while 144 (58%) of the trees were in fair or better condition.
- The sample reveals a wide diversity of trees (39) in the areas sampled (Table 4).
- Utilizing the recommended action for each tree and the average dbh, we applied the current rates for individual trees under the pruning contract (Table 5). In other words, if a tree required formative pruning this applies the rate as if each tree was independent. Now this is a somewhat artificial assumption, because staff tries to bundle the individual tree work as much as possible, but it does allow some comparison of strategies. The alternative is to estimate an hourly rate to care for the 20 trees. For example, Sample 12 contains 13 trees that require formative pruning. This is work that likely can be completed at ground level with pruners, vs Sample 3 which has 11 removals that will likely require a boom truck and backhoe to remove the stump.
- Formative pruning has the lowest per unit cost and is the 3 most frequent recommended action. As current problems with the structure of small trees will translate into larger problems that require more intensive pruning and potentially limb or trunk failures (at a much higher cost). Formative pruning is the most cost effective action on the list.
- The estimate of costs (Table 5) are not the full costs, for example, tree removal ($500) does not include planting ($250).

A. Uncertainty

We should note some key limitations with this study. We caution against extrapolating this to the entire City as the samples represent less than 0.8% of the City's trees, we did not assess the sufficiency of the sample size to represent the City. Trees provide numerous benefits and we do not attempt to assess the benefits that trees provide the City associated with trees. An increased number of trees with structural problems will result in increased risk of failure and limb drop; the rate of failure and costs associated with this situation was not estimated. These data may lend themselves to a scenario forecasting (developing estimates of tree "graduating" to other required work over time), but staff did no further analysis in that area. Finally, while the cost per tree are standard, the estimates for the per block approach are based on a staff estimate of the work required in that area. These more subjective estimates are based on professional knowledge and knowledge of the street, situation, and logistics. Still, they likely provide an order of magnitude estimate.

Discussion/Conclusion

Long-term symptoms of drought include dieback of branches and death of the plant as the plant's capacity to absorb water is damaged. Secondary effects include susceptibility to disease and insect invasion. While the connection between drought and disease are often difficult, certain conditions (root rot, cankers, wood rot, bark beetles, etc.) are more likely to occur because of drought related stress.

Perhaps most surprising was the depressed state of the trees with over 40% of the sampled trees in poor condition. As recent winters have been very mild, staff have concern that the predicted El Nino may result in the potential for roadway impacts as storms would knock down weakened branches and trees. These may result in additional emergency costs and increased City liability claims associated with damage after these events.

While it may seem obvious to many observers that deferred pruning will result in additional costs over the long-term, quantitative studies and estimates are lacking. Ryder and Moore (2013) examined 5 street tree species and compared formative pruning when the tree is young to waiting 20 years for a structural pruning. The researchers found that over 75 % exhibited structural defects at 20 years if they did not receive formative pruning. They also determined that formative pruning cost 10 times less than the structural pruning. Furthermore a cycle is created where the unpruned tree impacts other trees nearby, poor trees are removed and replanted. The authors conclude that all young trees should be pruned on a cycle of 2-4 years at least 2-3 times when young to provide a strong structural framework that will reduce work in the future (Ryder and Moore, 2013). Prior to staffing cuts, the crew completed formative pruning on 1364 trees in the first 6 months of 2013, in comparison, the City completed 178 in 2014.

In Fiscal Year 2014-2015, the City allocated approximately $237,000 for tree pruning and removals (1 senior maintenance worker $87K and $150 K for contractual maintenance). While there are many caveats with extrapolating these data, the estimates above suggest that the cost to remedy the backlog on City street trees is approximately $270 per tree. Multiplying this value by the estimated total number of trees (37,300 excluding Bidwell Park and other City properties) and accounting for a 5 year pruning cycle amounts to a budget of approximately $2 million. Note that this is a very crude estimate and there may be some economies of scale associated with adequate staffing levels and coordination with the contractors on linking projects together.

A. Recommended Actions:

1. Maintain focus of current work on emergency and service requests.
2. Identify priority areas or corridors that would benefit from proactively pruning to address the larger trees that may pose a hazard (pruning more systematically rather than as issues are brought to our attention). While the budget may be limited, staff feels it important (and cost effective) that some funds are expended on the most important corridors to minimize impacts during storm events.
3. Survey the larger trees such as Black Walnut in zones 5, 6, and 7 for potential problems and remedies (many of these were annexed by the City in the last 5 to 10 years and have not evaluated since then).
4. There are some current measures that will save the City money in the long run: Invest in formative pruning to reduce future costs of maintenance and should be incorporated into strategies to reduce future costs. To maximize the "bang for the buck", the City should focus on cohorts (i.e. formative prune in neighborhoods with trees planted at the same time) for cost efficiencies. The tree database suggests that over 10,000 trees fall into the smaller DBH classes (these likely include smaller trees and not necessarily younger trees but it provides a ball-park figure). Following the recommendations from Ryder and Moore, these should be pruned at a rate of 2500 annually.
5. Investigate methods to update tree database on a regular basis and add trees during the development process.
6. Explore the use of Maintenance District funds to complete tree work. This is hampered by the different rules that govern each one and many of them do not include tree work. Currently, the City of Chico has over a hundred maintenance districts (in contrast, Sacramento has 1 overall district that covers the entire City (and 30 enhanced service districts).

References

C.M. Ryder and G.M. Moore. 2013. The Arboricultural and Economic Benefits of Formative Pruning Street Trees. Arboriculture & Urban Forestry 2013. 39(1): 17–24.

Attachments:

A) Data collection form. Chico Parks and Street Tree Division – Tree form.

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