Trees and Sidewalks, Infrastructure Co-existing Side by Side

ISA Annual Conference

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Toronto

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OUTLINE

- Scope of the challenge
- Value of trees as **INFRASTRUCTURE**
- Cause of the Challenge
- Considerations to do things differently

Trees Required for Project Approval

- People want trees where they live
- Design brochures show mature trees
- The typical site doesn’t support long-lived trees
- Trees are removed before they reach brochure size
- It is expensive!


06/26/2012


06/05/2012


06/26/2012

Perception Challenges

- We've always done it this way
- This is the Engineer's standard
- We don't have the space to make the project economical
- We don't have the money to purchase quality trees
- I've kept clear of the trunk during construction
- The trees didn't die (yet)


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Perception Mindsets

- When trees are in the way, we remove them. But we do replant a new one.
- The design of straight sidewalks are important. The original grade must be retained!
- The trees are a nice thing added after all the important infrastructure – sidewalks, curb and gutters, lights, and streets are done.


2011/04/05


2011/04/05

Scope of the Challenge

- Over $70 Million Dollars estimated in CA
- $20 Million projection in San Ramon, CA
- $2.25 Million for an HOA in Phoenix, AZ
- $24 Million in Redwood City (1984 for 24 yrs)

Urban Forestry

- The management of trees where people (we) live for the benefits to people

Trees

TREES ARE INFRASTRUCTURE

- Trees grow/exist in the same location as other community assets – buildings, utilities, traffic control devices, street lights, streets, sidewalks, etc.
- The services trees provide – air quality, storm water interception, energy conservation, etc. - are considered benefits that increase over time (as trees increase in size).

Trees are community assets

What assets do we own that we don't provide maintenance for?

Maintenance improves health and long term viability of trees.

Maintenance is an investment in our assets.

Trees are important

Trees perform valuable roles in:

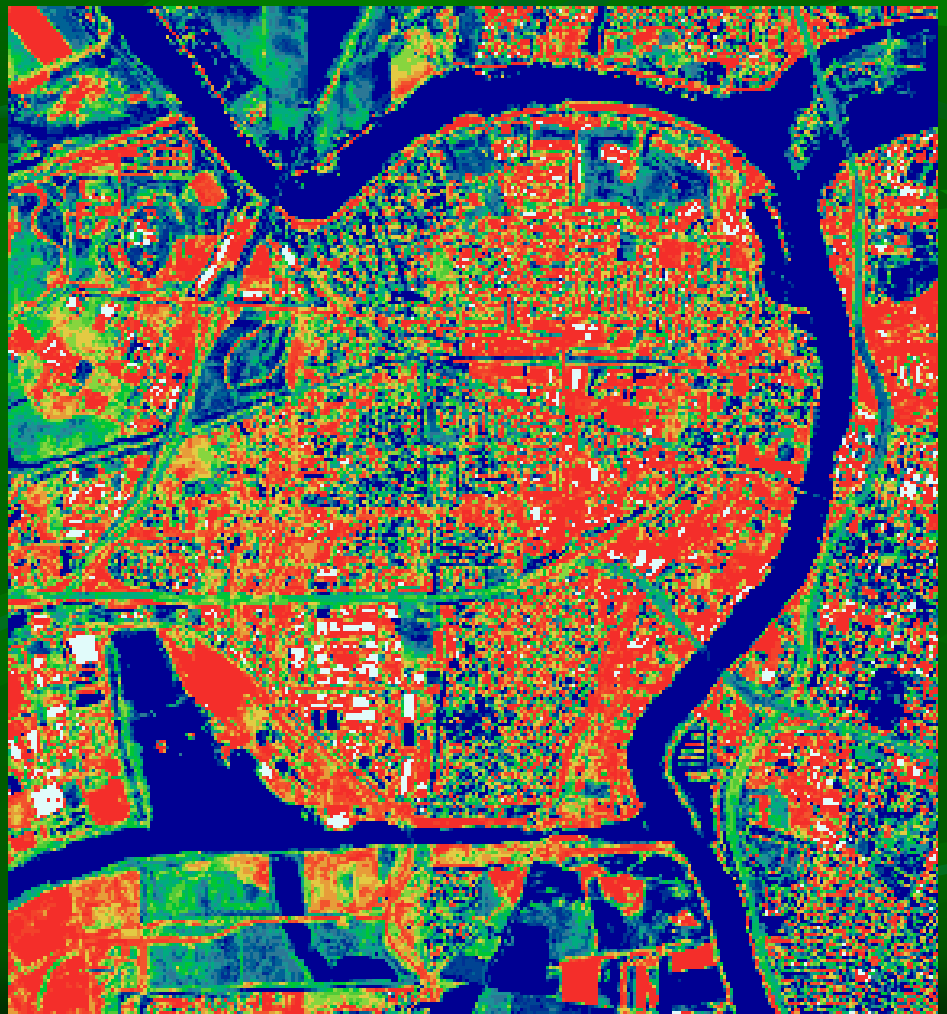
- Air quality
- Soil stability
- Ground water re-charge
- Stormwater mitigation

Trees are important

Trees also perform valuable roles in:

- Energy conservation
- Economic development
- Stress reduction
- Property values
- Jobs and employment / customers

What does a Heat Island Look Like?
West Sacramento's Heat Islands



Thermal image of West Sacramento from NASA flyover in **June 1998** –

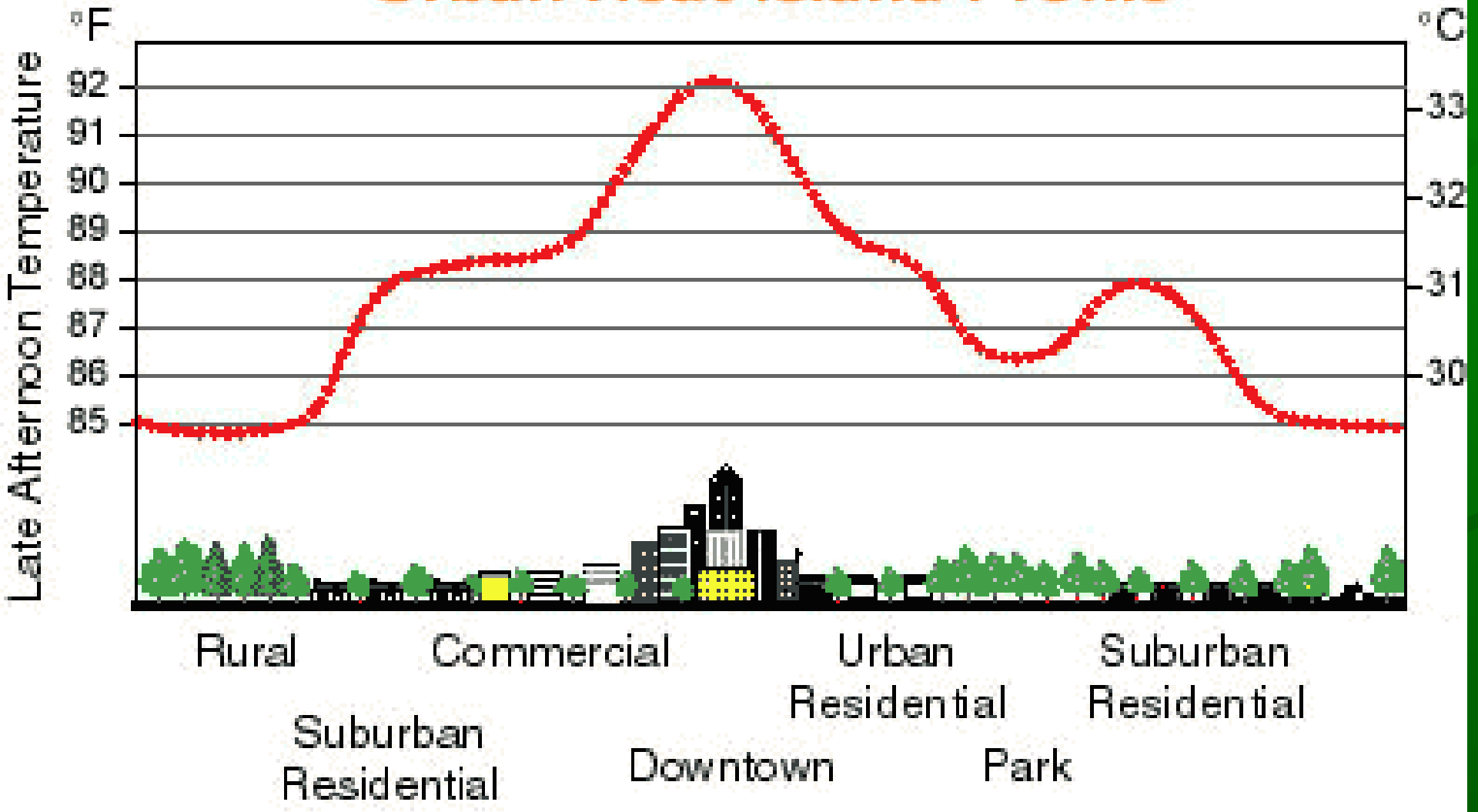
Air temperature 75°F

Wind speed 6 knots

Rooftops 135°F+

Parking lots 115°F+

Urban Heat Island Profile



from EPA Heat Island Reduction Initiative

The Benefits from Trees Come from the Leaves

- Size of Crown/Canopy
- Shade cooling
- Photosynthesis
- Transpiration
- Air Quality – Particulates and absorption of pollutants during photosynthesis
  - Ozone requires sunlight in the ‘Ozone Triangle’

Tree Benefits are in the Leaves and Crown Size

A large tree cannot be replaced by a small tree

- Time investment in growth
- Size difference in width, height, and breadth

Value Proposition

We get all the different services and benefits - even though we may have planted the trees for one or two in particular

i-Tree ECO Findings - Canada

- Kelowna 2007 – 3.3 Million trees

  Replacement Value $1.1 Billion; Pollution $1.1 M

  Energy savings 19.4 M

- Oakville 2009 – 1.9 Million trees

  820,000 (43%) City trees; Replacement Value $878 M;

  Energy savings $840,000; Pollution 1.12 M; Pest Threat EAB $6.1 M

- Edmonton 2009 – Pollution 531 mtons $3.1 M
- Toronto – 10.2 Million trees Air Quality $9.7 M

  Energy savings $9.7 M, Carbon sequestration $1.3 M

  Stormwater interception 23.8%

i-Tree Finding - USA Replacement and Benefits Values

- Davis, CA $35 Million; Benefit to Cost $3.37
- Orlando, FL – $181 Million; Benefit to Cost $1.87
- Bowling Green, OH – $ 4.16 Million (8,200 trees); Benefit to Cost $2.58
- New York, NY – Annual Benefit $122 million from 600,000 street trees

USA Replacement Costs, Benefits and ROI (cont.)

- San Mateo, CA - 22,817 trees, $57.4 Million, $2,690,544 annual benefits, $2.23:1 ROI

- Portland, OR – Capital Value $1.1 Billion; $45 Million in annual benefits; $15.3 Million Property Tax revenue enhancement; $4.6 Million for Maintenance

Denver, CO

2001 – 6.2% canopy returns $13 million in annual benefits:

Increasing Denver metro canopy cover from 6.2% to 25% (in cities) would provide:

- $45.5 stormwater benefits
- $4.4 Million air pollutant removal benefits
- 850,000 tons in Carbon storage
- $5 Million summer energy savings

Sacramento Greenprint Region 2008 UFORE / ECO Study

- 7 million trees
- Replacement cost is over $14.4 billion.
- Annual environmental benefits estimated at $11.6 million.
- Urban forest also stores $25.8 million worth of carbon.

Size Matters

Size Matters

- Large Scale trees provide greater benefits than small trees
- 16 Guides - CUFR guide for Northern California Regional Average benefits over 40 years

  Deciduous reference trees
  - Large Tree Ave. Pvt $102-$122 per year; Pub $101
  - Medium Tree Ave. Pvt $45-$60 per year, Pub $42
  - Small Tree Ave. Pvt $31-$41 per year, $29

  Large Evergreen reference tree – Pvt $146 , Pub $142

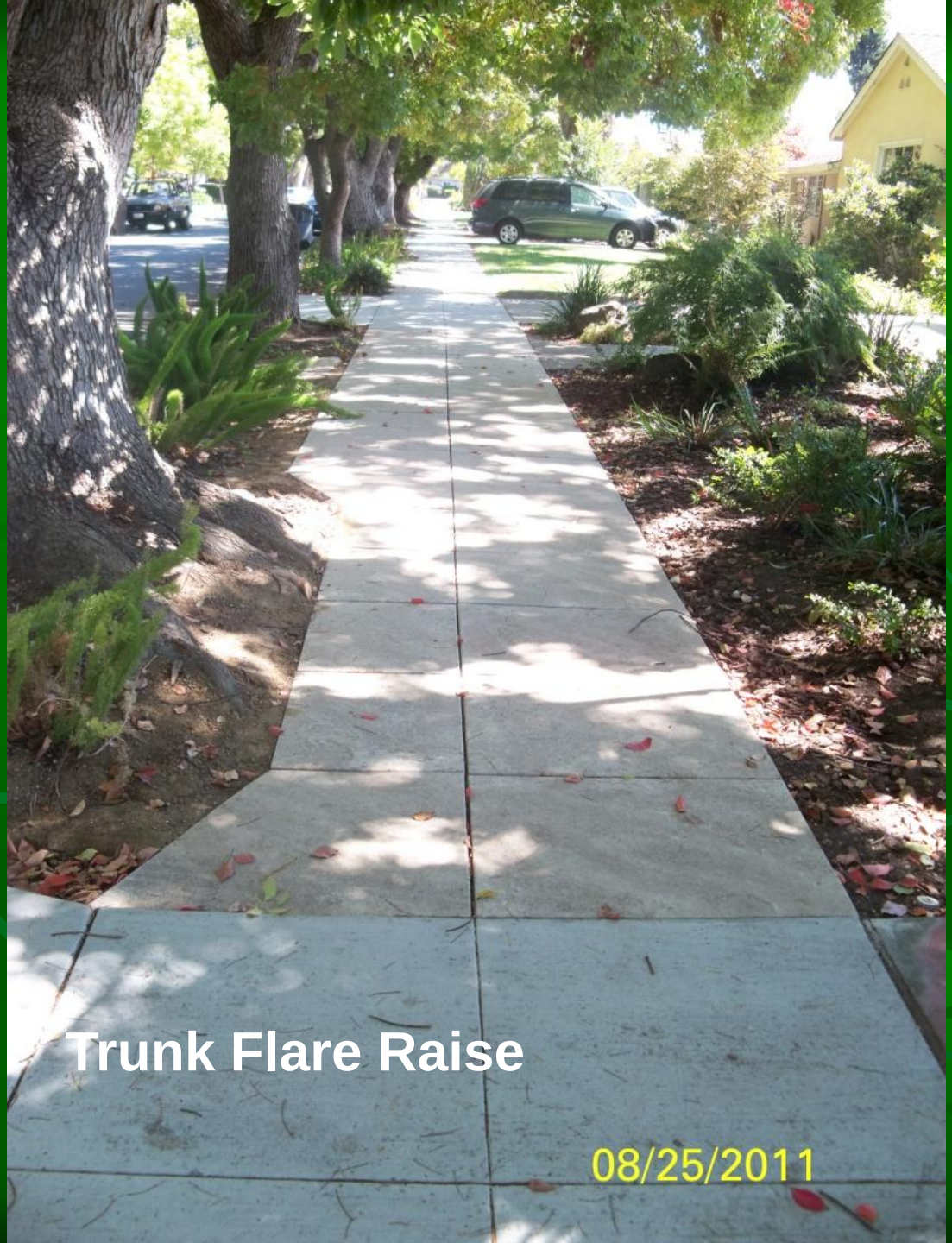

CHEVROLET
Z71

Cause of the problem

- Tree roots
- Root crown swell
- Trunk flare

- Root lift


Root Crown Swell
08/12/2012


Trunk Flare Raise
08/25/2011

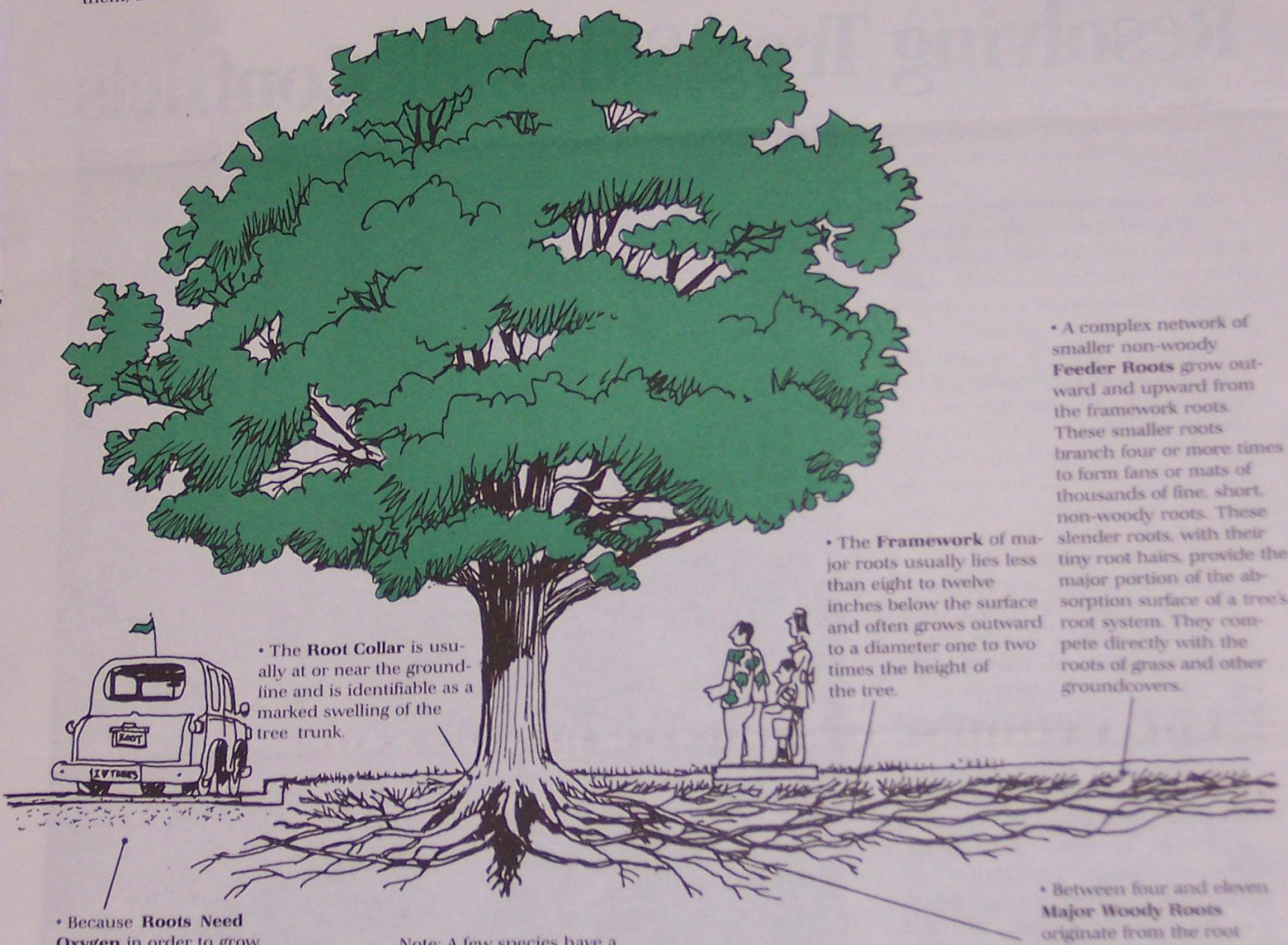
Existing Design Challenges

Limited Planting space, overhead wires, rental properties

Trees designed into downtowns

The woody transport roots increase [illegible] diameter, and even display annual rings. It is this increase in size that swells the base of trees, raises the earth around them, and lifts sidewalks.

soil compaction, flooding, or construction of large, impervious pavement areas on the ground surface.



• The **Framework** of major roots usually lies less than eight to twelve inches below the surface and often grows outward to a diameter one to two times the height of the tree.

• A complex network of smaller non-woody **Feeder Roots** grow outward and upward from the framework roots. These smaller roots branch four or more times to form fans or mats of thousands of fine, short, non-woody roots. These slender roots, with their tiny root hairs, provide the major portion of the absorption surface of a tree's root system. They compete directly with the roots of grass and other groundcovers.

• The **Root Collar** is usually at or near the groundline and is identifiable as a marked swelling of the tree trunk.

• Because **Roots Need Oxygen** in order to grow, they don't normally grow in the compacted, oxygen-poor soils under paved streets.

Note: A few species have a **Taproot** that grows straight down three to seven feet or more until they encounter impenetrable soil or rock layers, or reach layers with insufficient supplies of oxygen.

• Between four and eleven **Major Woody Roots** originate from the root collar and grow horizontally through the soil. These major roots branch and taper over a distance of three to fifteen feet from the trunk to form an extensive framework of long, rope-like roots which are 1/4 to one inch in diameter. These are important structural roots, supporting the tree against wind, etc.

National Arbor Day Foundation Bulletin #3 Resolving Tree Sidewalk Conflicts
http://www.arborday.org/Shopping/Merchandise/MerchDetail.cfm?id=77

Considerations to Change Approaches

- Budget
- Value and benefits of trees
- Cannot replace trees in kind

Considerations to Change Approaches

- Public opinion
- Risk
- Continuity

Considerations to Change Approaches

- The value and benefits of trees often are greater than the cost of preserving

- It is usually impractical or too costly to replace a tree in kind

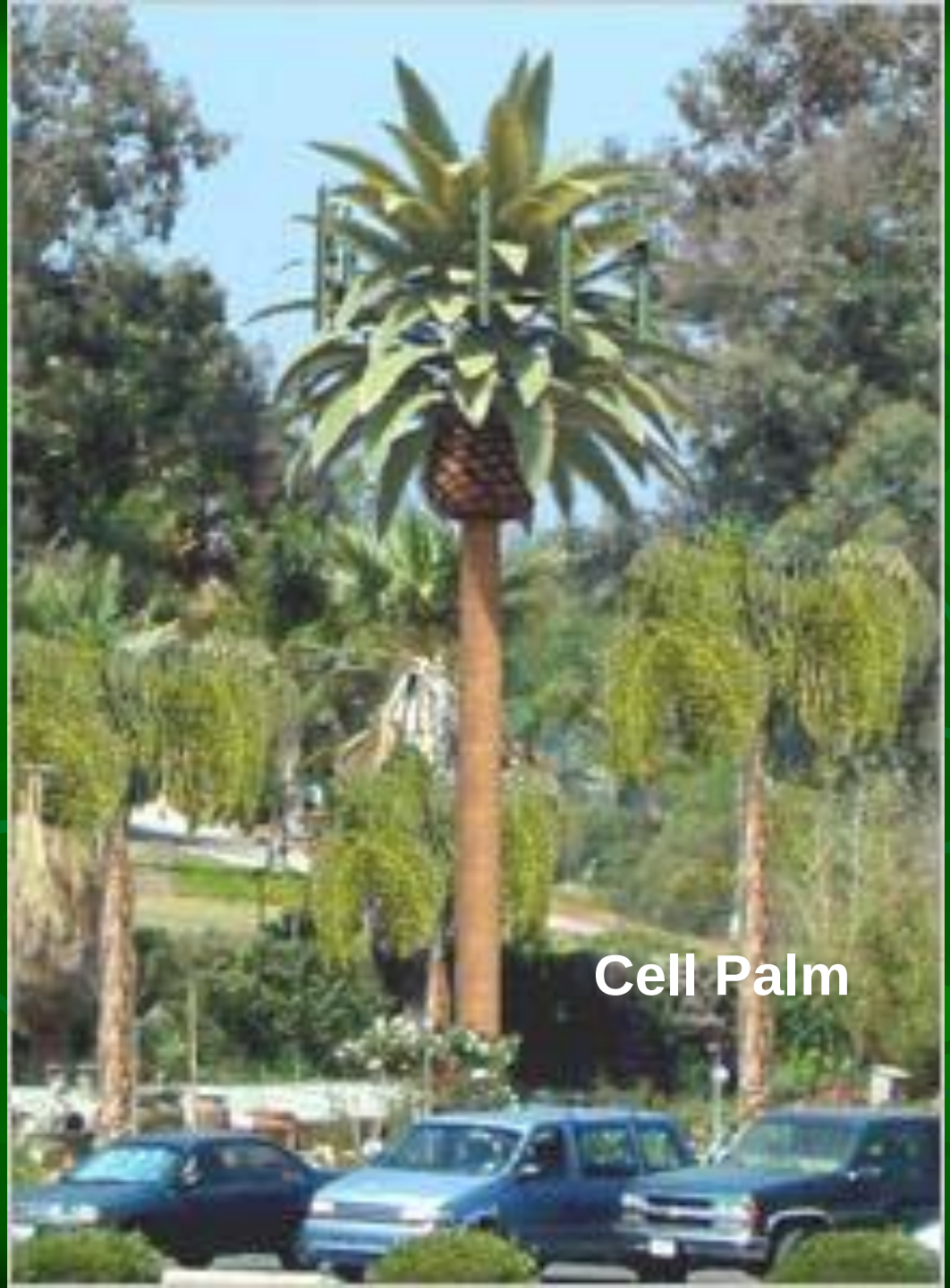
Considerations about Change

- Good notification - If the public wants large trees, they often don't know the program will remove them until its too late

- The benefits aren't missed until they are gone

  We can't put it back once it's cut (unless…..)


Pinus celltowerus

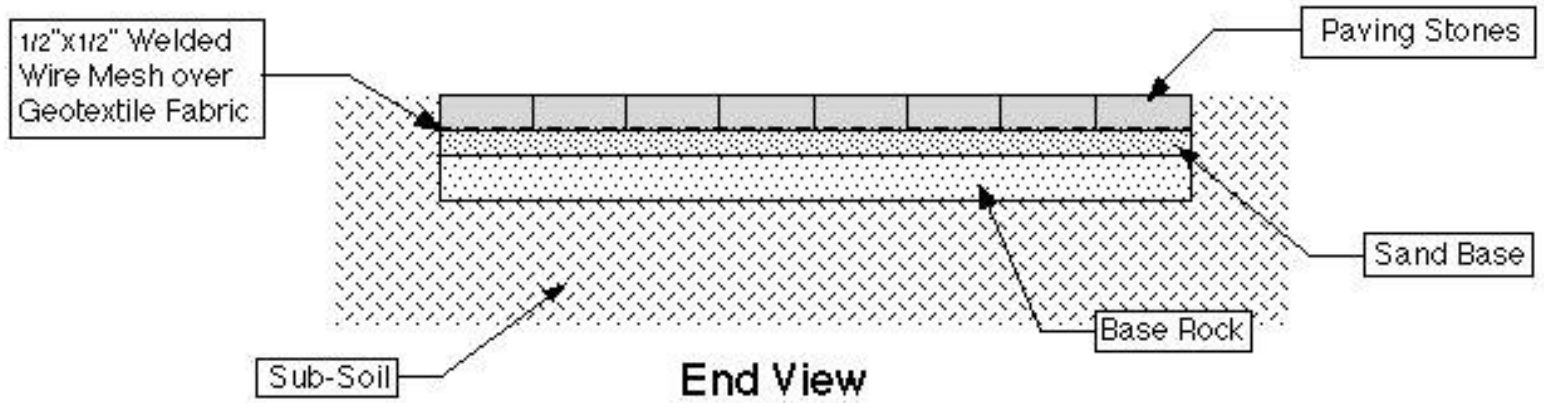

Cell Palm

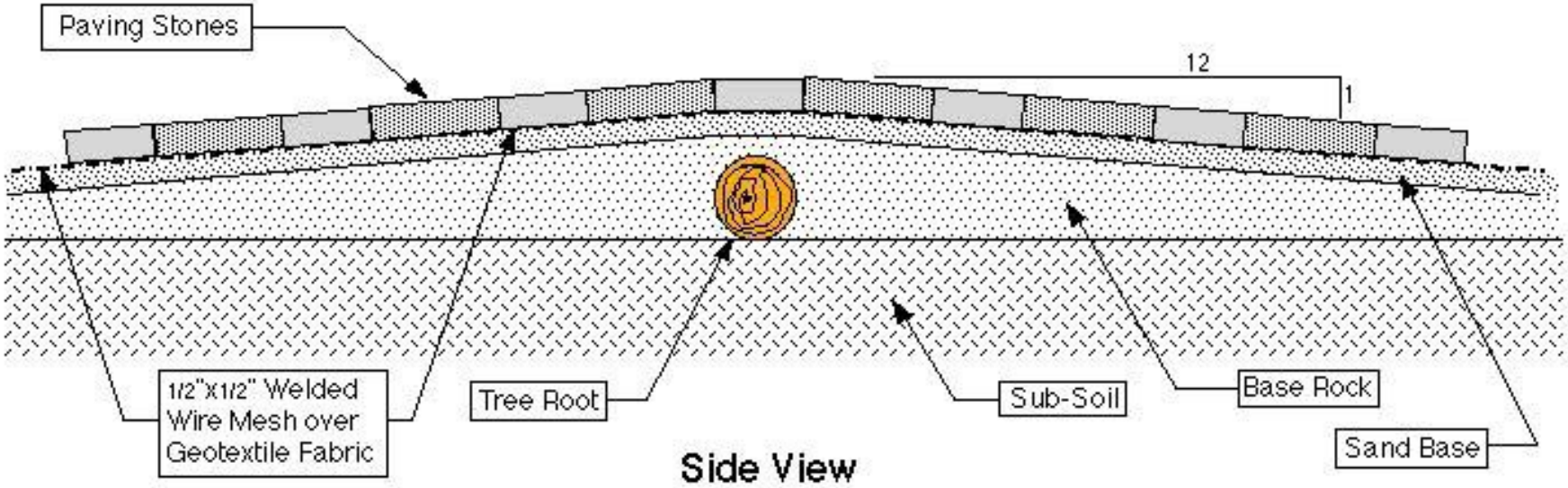
Other Options

Alternative materials

- Interlocking pavers
- Tree grates
- Decomposed Granite
- Pervious materials
- Rubber/Plastic Sidewalks
- Pier and Beams
- Steel Plates

Tree Grates



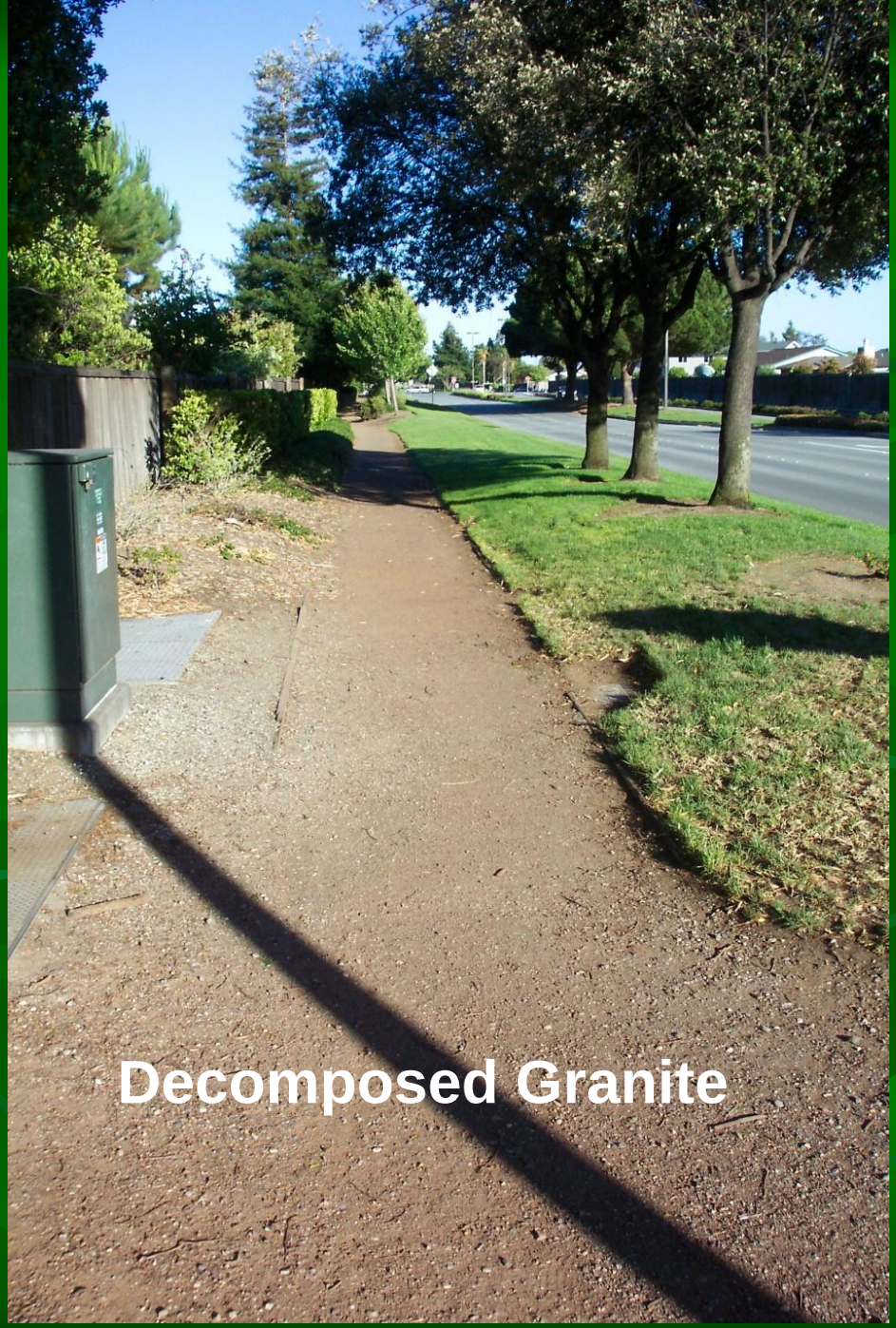


Interlocking Paving Stone Installation Detail

Section Views

Interlocking Pavers and Tree Grates

Interlocking Pavers


Decomposed Granite


Modular Rubber Sidewalk Panels

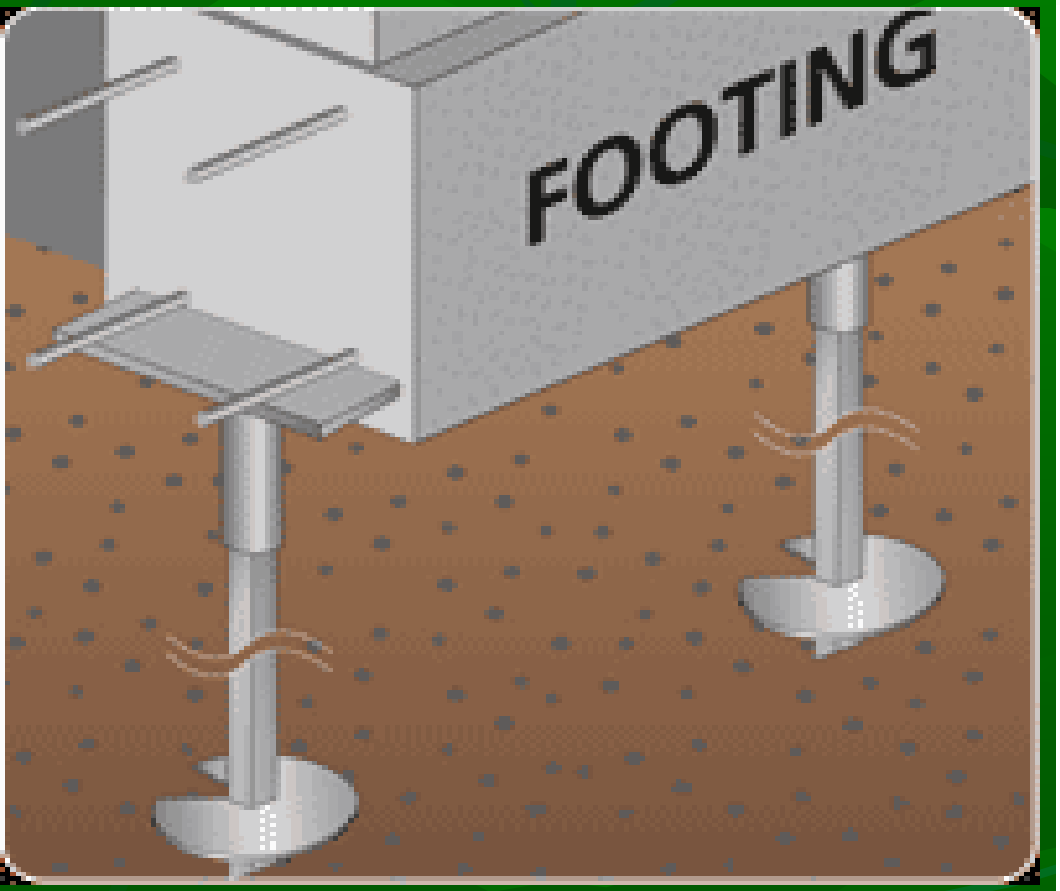

Modular Rubber
Sidewalk Panels
with Coating
(narrow width)

Poured in Place Rubber

Terrewalks

Modular
Plastic Panels

Pier support with Helical Anchors and elevated walking surface (not currently commercially available for sidewalks)



Steel Plates Over Roots

Design Changes

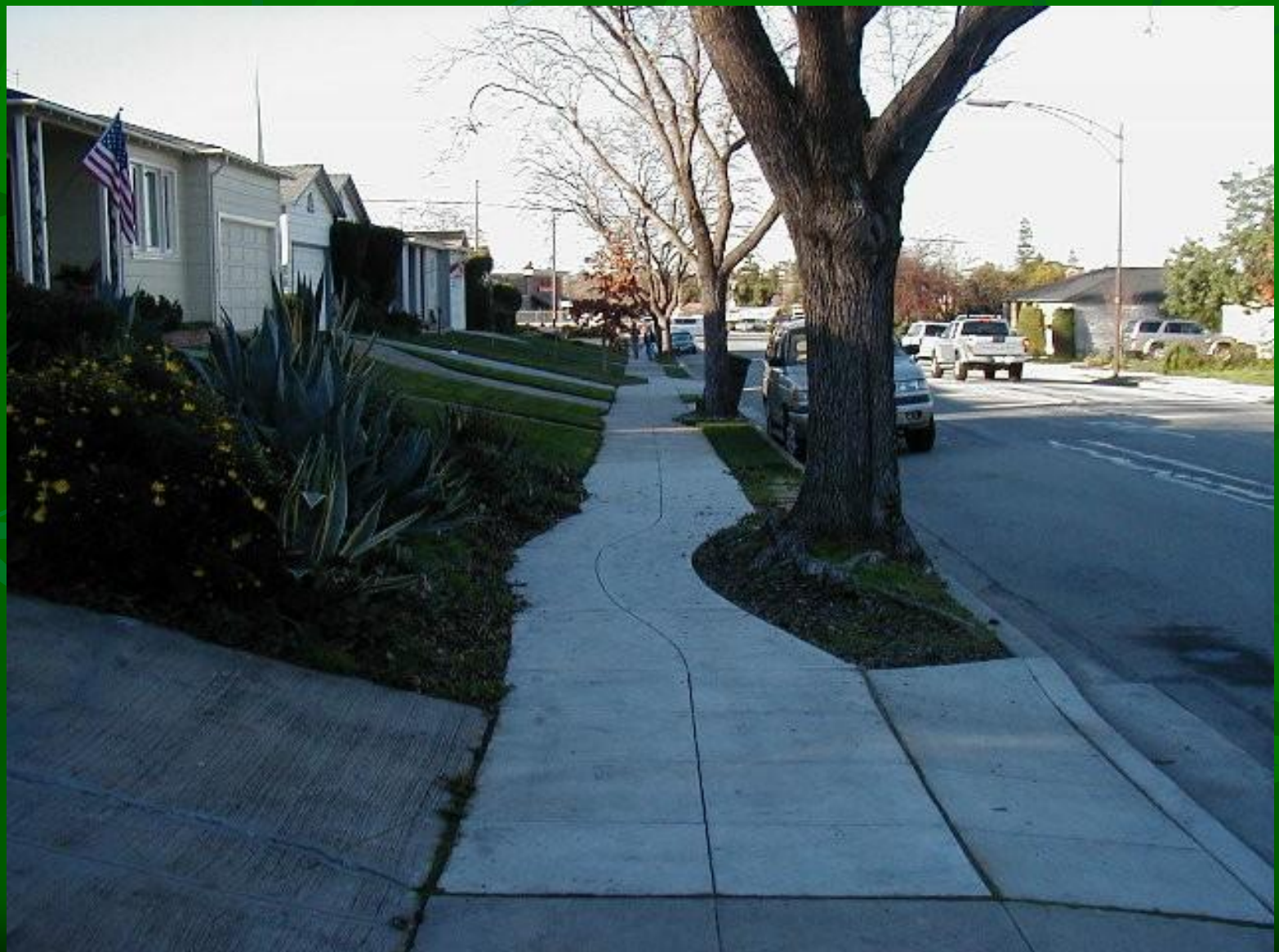
- Move sidewalk or curb over to create space
- Increase the space between concrete and trees

Move the sidewalk either way

Move sidewalk and curb away

Relocate Sidewalk Towards House

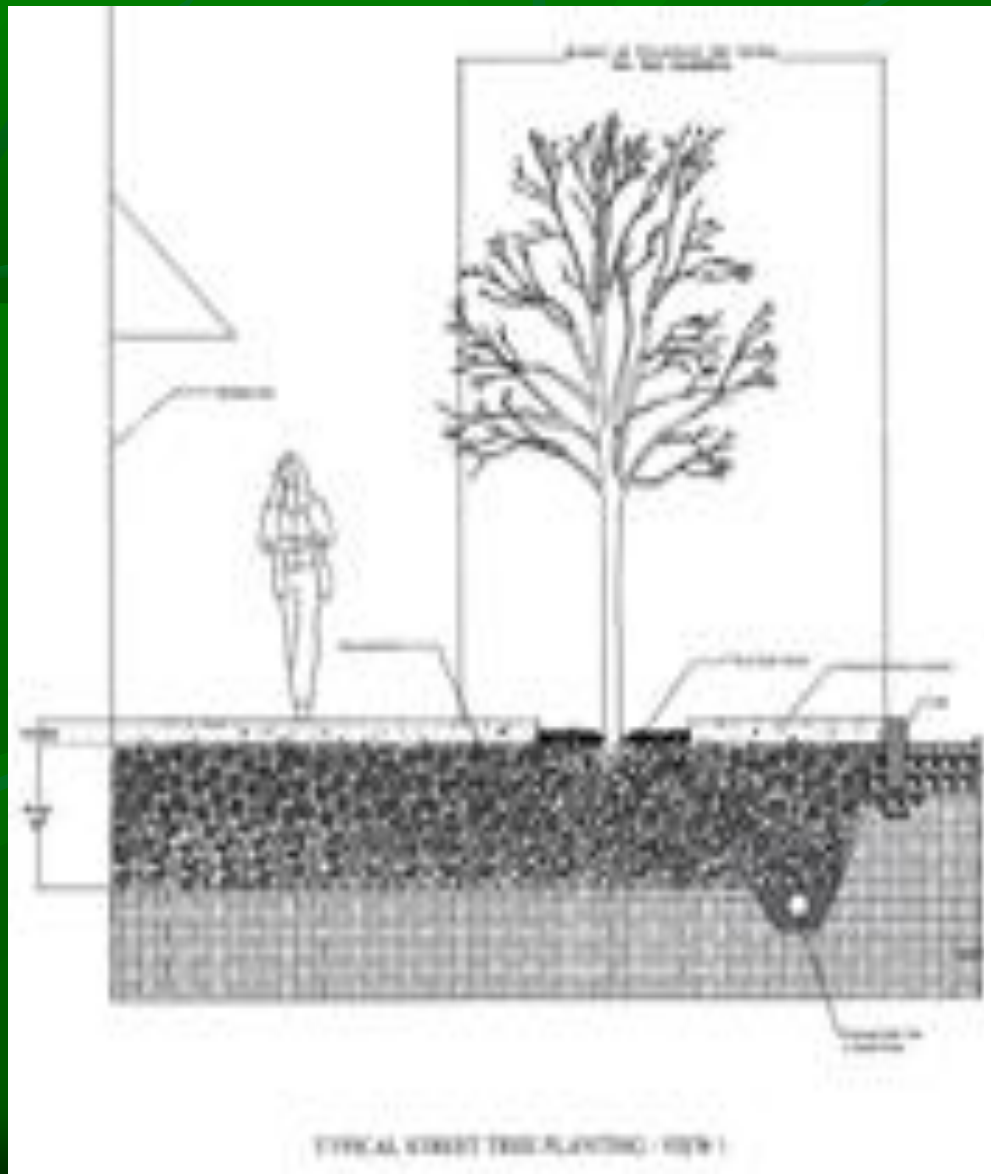
Relocate and Narrow Sidewalk

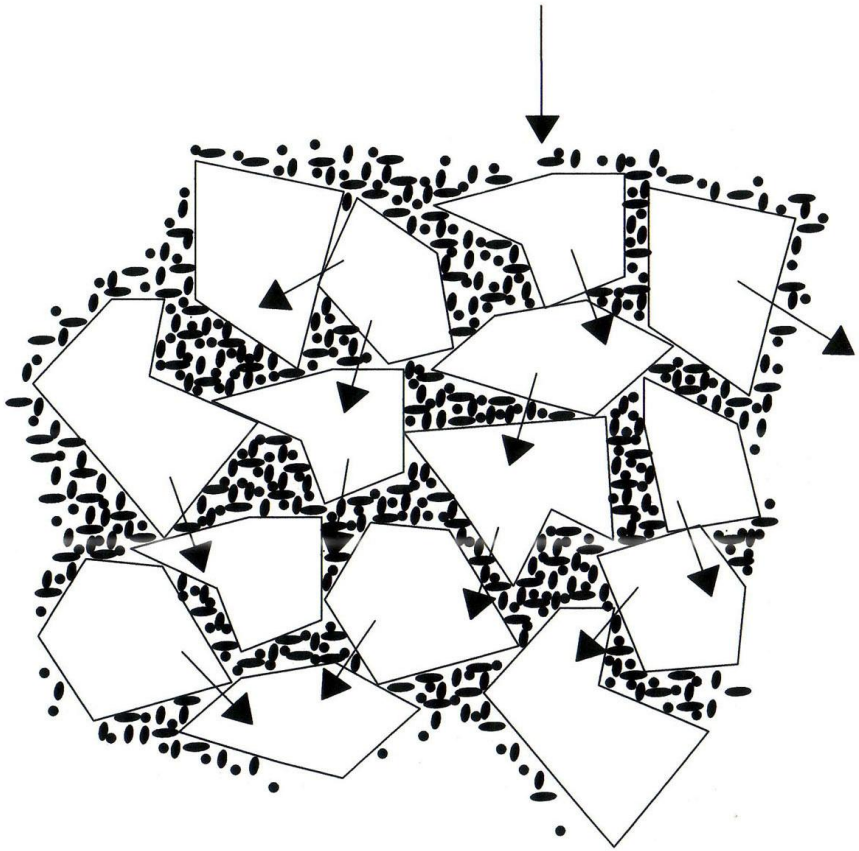


More Recent Options

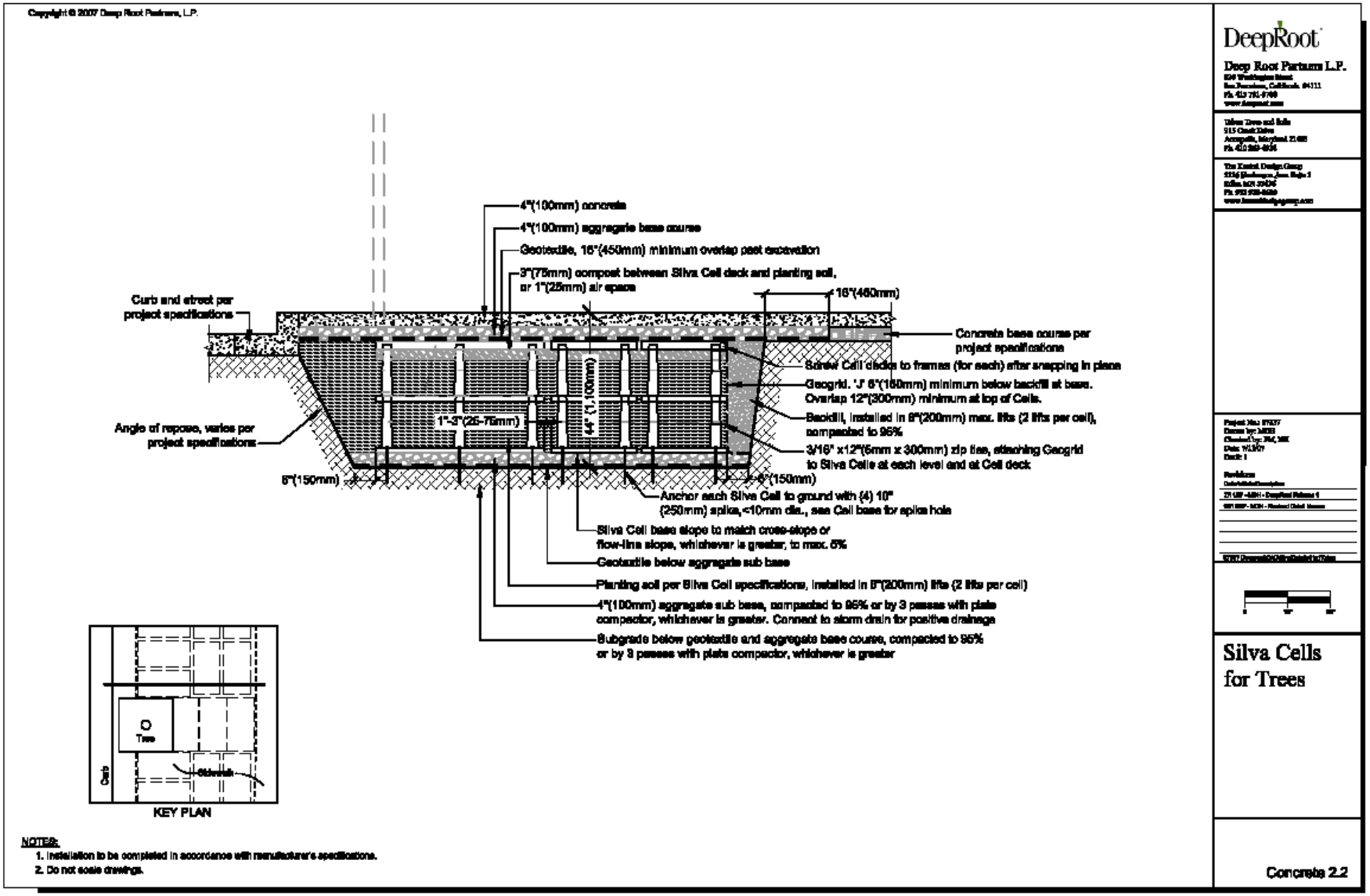
- Structural Soils
- Silva Cells
- Root channels
- Linear Planting areas

Structural Soils





Silva Cells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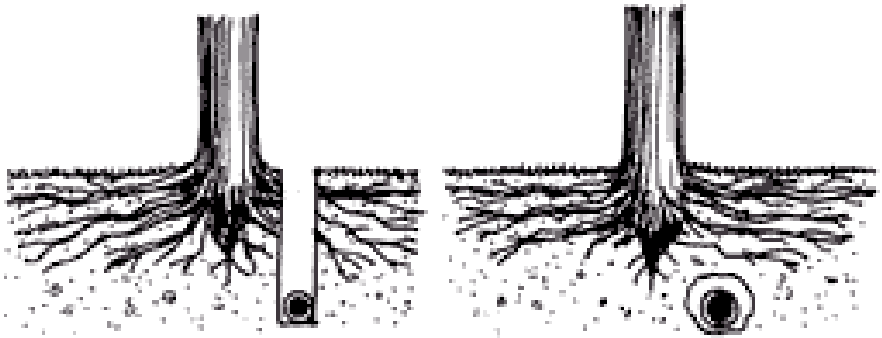
DeepRoot
Deep Root Partners L.P.
4"(100mm) concrete
4"(100mm) aggregate base course
Geotextile, 16"(450mm) minimum overlap past excavation
3"(75mm) compost between Silva Cell deck and planting soil, or 1"(25mm) air space
16"(460mm)
Curb and street per project specifications
Concrete base course per project specifications
Screw Cell decks to frames (for each) after snapping in place
Geogrid. 'J' 6"(150mm) minimum below backfill at base. Overlap 12"(300mm) minimum at top of Cells.
Backfill, installed in 8"(200mm) max. lifts (2 lifts per cell), compacted to 95%
44" (1,100mm)
1"-3"(25-75mm)
Angle of repose, varies per project specifications
3/16" x12"(5mm x 300mm) zip ties, attaching Geogrid to Silva Cells at each level and at Cell deck
6"(150mm)
6"(150mm)
Anchor each Silva Cell to ground with (4) 10" (250mm) spikes,<10mm dia., see Cell base for spike hole
Silva Cell base slope to match cross-slope or flow-line slope, whichever is greater, to max. 5%
Geotextile below aggregate sub base
Planting soil per Silva Cell specifications, installed in 8"(200mm) lifts (2 lifts per cell)
4"(100mm) aggregate sub base, compacted to 95% or by 3 passes with plate compactor, whichever is greater. Connect to storm drain for positive drainage
Subgrade below geotextile and aggregate base course, compacted to 95% or by 3 passes with plate compactor, whichever is greater
Tree
Curb
Sidewalk
KEY PLAN
NOTES:
1. Installation to be completed in accordance with manufacturer's specifications.
2. Do not scale drawings.
Silva Cells for Trees
Concrete 2.2

Other Options

- Bridging and ramped sidewalks
- Increased space
- Re-locate utilities or other improvements
- Tunneling around roots

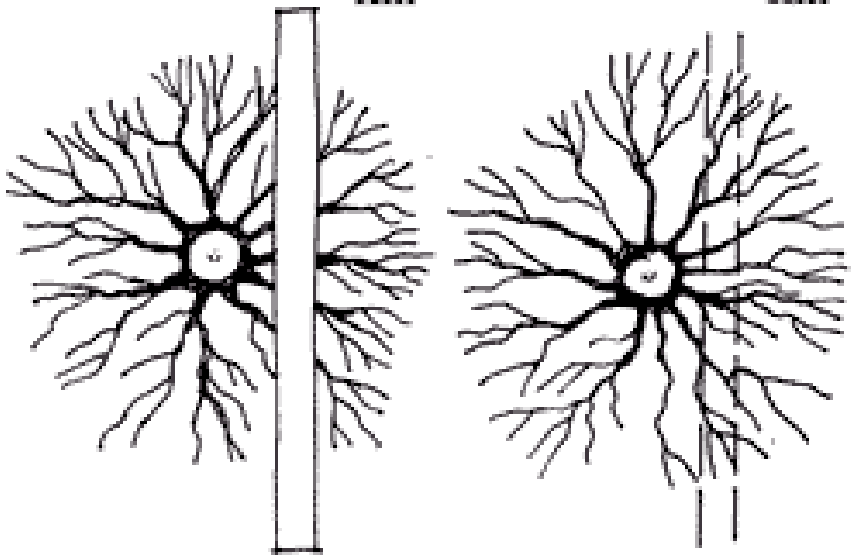


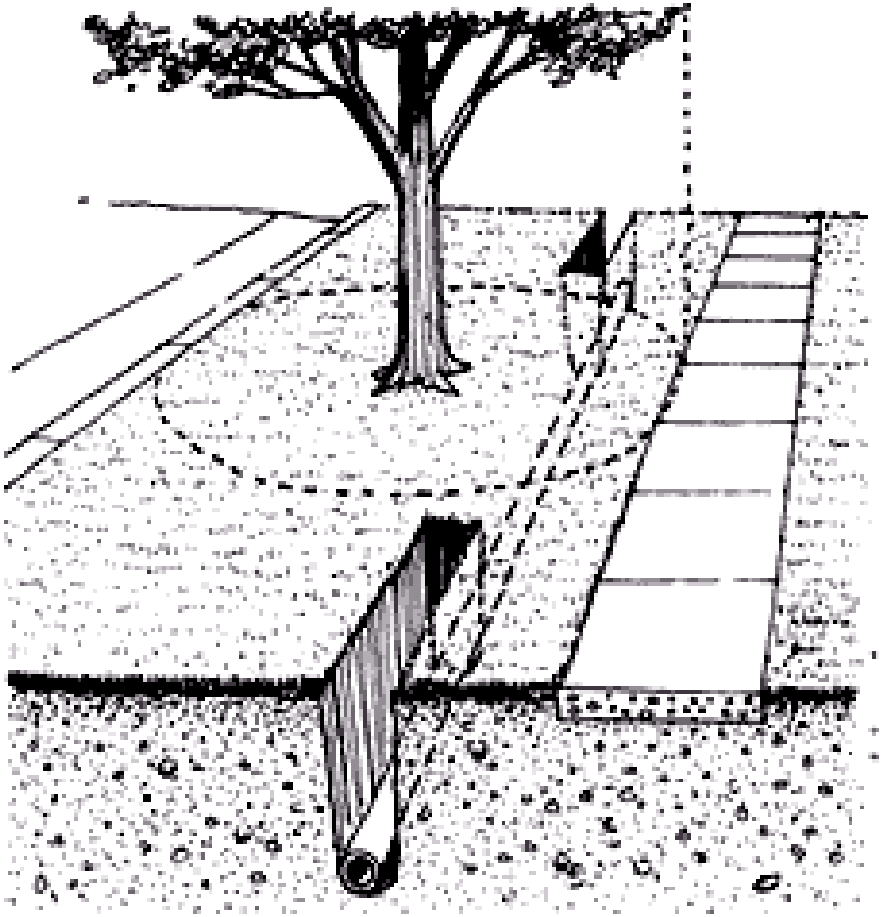
Trench

40% Root Kill

Tunnel

No Root Kill






Enlarged Planter -
removed parking spaces

Minimum distances


Trees offset from center towards sidewalk to maintain a minimum distance from curb

More possibilities

- Limit the % of trees that can be removed on a street during the sidewalk repair process
- Offset new plantings so they are farther from the curb (we have more options for sidewalks than curb retrofits)
- Relocate the hardscape farther from the trees

Increase planting strip area

Avoiding root cutting

More Ideas

- Only place sidewalks on one side of street
- No sidewalks
- Remove hardscape or increase the distance between tree and hardscape

Avoiding root cutting

Interim approaches

- Sometimes we have to take small steps to make big gains
- The costs of interim steps may be affordable
- There are things we can get pilot or trial agreement to try


Trees planted a minimum distance from curb. Grates allow the tree to grow under the sidewalk. Later the sidewalk will be moved farther from the trees


Trees planted so sidewalk can be moved towards curb. Grates allow the tree to grow under the sidewalk. Later the sidewalk will be moved next to the curb farther from the trees. There are also overhead wires next to the street

Trees offset in center of planting strip closer to sidewalk


Tree growing in planter
protected by curb


Sidewalk completely
blocked by Redwoods.
New Sidewalk will be
located in street removing
two parking spaces

Potential

- As professionals, we need to be looking / planning for the solutions that will work
- When the opportunity avails itself, we can be ready to introduce those solutions


New tree in larger tree grate creates more space between tree and grate footing

Summary

- Sidewalk design and construction is a complicated process involving interaction with many different disciplines and stakeholders

- There are options to move transitionally to avoid root damage now and develop a longer term solution as our education and partnering incubate

Conclusion

- New approaches are being tried and experimented with.
- Stay current on the topic and learn from someone who has already advanced an idea
- Cooperate with others – share as professionals
- If you live in and don’t work for the City advocate for positive change

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