Biotreatment Soil and Tree Roundtable Summary

Improvements for the Health of Trees

Held on June 30, 2016

Prepared For:

Bay Area Stormwater Management Agencies Association (BASMAA)
Contact: Shannan Young
Shannan.young@dublin.ca.gov

WRA Contact:

Megan Stromberg
stromberg@wra-ca.com

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ENVIRONMENTAL CONSULTANTS

2169-G East Francisco Blvd., San Rafael, CA 94901 (415) 454-8868 tel (415) 454-0129 fax info@wra-ca.com www.wra-ca.com

1.0 INTRODUCTION

The Municipal Regional Stormwater NPDES Permit Order No. R2-2015- 0049 (MRP) Provision C.3 mandates that Regulated Projects meeting certain impervious surface area thresholds include low impact development (LID) stormwater treatment measures in the project design. The current MRP biotreatment soil specification (biotreatment soil) required to be used in LID stormwater treatment measures (e.g. bioretention areas, tree well filters, etc.) consists of a 60-70% sand/30-40% compost mix. This mix was specified to: 1) ensure long-term biotreatment soil permeability of 5 inches per hour; 2) sustain healthy, vigorous plant life; and 3) maximize stormwater runoff retention and pollutant removal. The complete specification may be viewed at http://basmaa.org/

On June 30, BASMAA convened a biotreatment soil and tree round table to review the current soil specifications to determine if improvements to the specification can be made to positively impact the health of trees planted in biotreatment areas. Participants at the Roundtable included numerous stakeholders: Municipal representatives, compost providers, soil suppliers, soil laboratory technicians, civil engineers, landscape architects, soil scientists, construction inspectors, and Water Board representatives.

Round Table participants broke into small discussion groups to address common questions and foster smaller discussions. The group then came together to share the results of these small discussions, highlight common themes, find areas of consensus, and identify areas that require more research or discussion. This Report provides a summary of the discussion, identifies action items from the Round Table anda summary of the survey responses.

2.0 DISCUSSION SUMMARY

Participants were broken into five smaller discussion groups with experts from as many disciplines as possible in each group. Team leaders and note takers provided the attached notes from the small group discussion (Appendix A). Team leaders then shared main talking points with the larger group. The following provides a summary of the comments organized into the ten most common points that emerged from the small and large group discussions.

1. **Provide trees with access to native soil via design changes**
    - Remove barriers to roots including tall curbs, liners, aggregate, compaction, moving trees to edge
    - Engineers/designers prefer liners and tall curbs to limit risk of water damage to adjacent road, building, utilities, etc. Education of engineers will be needed for further understanding of why these elements are included and how they can be changed to accommodate trees.
    - Explore alternative designs: “Window trees in” to basins, “Tree pockets”, Vertical and Horizontal “potholes” for roots, treatment train, silva cells, forebays and structural soil
    - 90% of tree roots are in the top 18” of soil. Provide lateral access to native soil.
    - Roots grow deeper in sandy soils when water is available. Provide a deeper soil profile in addition to lateral access to native soil, increase the overall soil volume or access to native soil.
    - Soil volume is important for tree health but research from Cornell is not accurate for California. The “maximize soil volume” guideline still applies but not the quantities given.
    - Raising the underdrain on the system might provide a longer-term reservoir of water

- Aggregate layer: may be too porous, too dry and plant roots can't access water stored in aggregate; Make longer/deeper where there are no trees, remove from under trees and replace with structural soil under trees.
- Trees not appropriate in all basins
- Some sites have poor/no/compacted soil adjacent. Improve/evaluate adjacent soil to support trees
- Structural soil may be an alternative in tight spaces adjacent to basins
- Water Board is open to design changes to "window trees in" to bioretention in lieu of or in addition to changing the soil spec

2. **Conflict between water holding capacity vs. permeability rate; irrigation vs. pathogens & drought**
   - The permeability rate of 5" is based on a sizing design constraint developed by Dan Cloak based on rainfall patterns; lowering the rate would make basins larger.
   - The current spec results in a permeability well above 5" per hour in most cases. Based on moisture sensor data, basins become very dry, very quickly.
   - Achieving a mix closer to 5" per hour that is repeatable is very challenging.
   - Irrigation may help to overcome soil volume constraint and water holding capacity
   - Over irrigation leads to increase in pathogens, especially phytopthera
   - Over irrigation is unlikely in a fast draining soil like BSM
   - Using irrigation as a solution is not sustainable due to drought
   - Trees without irrigation are not practical because of the summer dry climate
   - It is difficult to provide even coverage Irrigation in a fast draining soil
   - Plants often die due to lack of water
   - There is a misconception that basins are always wet and that trees should withstand flooding. They drain incredibly fast.

3. **Topsoil in the BSM is both beneficial for plants and challenging to specify**
   - Trees need healthy soil biota, soil structure, and better water holding capacity: all provided by soil.
   - Topsoil must be a loamy sand which is not a sustainable locally sourced product (strip mining).
   - Topsoil supplies are variable with inconsistent gradation and permeability.
   - Topsoil specifications exist for landscapes, street trees, structural soils, etc. that have gradation included.
   - Handling soil degrades the structure and leads to loss of permeability

4. **More study is needed to understand what is out there, what is working and what is not working.**
   - On-going tree study by UC Cooperative Extension open to enroll more trees. Results not yet available.
   - Need to look at long-term soil conductivity and soil/plant health. Trees only beginning to mature after 10+ years. Does BSM change over time, develop into soil? What tests do we perform on existing BSM?
   - Look at soil/natural systems to find something that will sustain plants over time.
   - Are micro-organisms, soil structure, organic matter, increasing or decreasing overtime in existing BSM?
   - Are existing BSM soils getting more or less permeable over time?

- We need more data, who has the data?
- The problem is not well defined. What are the underlying issues?
- Do we have a problem with effluent water quality?

5. **Trees can fail for many variable reasons. Successful trees all have: a) adequate soil volume, b) healthy soil, c) adequate water and drainage, d) nutrients, e) quality nursery stock.**
    - Reasons for failure: Shade, not draining, compaction, barriers to soil, shallow soil, draining too fast, wrong tree, poor nursery stock
    - Changes to the soil mix may only solve some of these issues. Need to look at design as well.

6. **The soil specification should meet performance goals but also be realistic, feasible, repeatable, available and sustainably- and locally- sourced and not too expensive.**
    - Submittals for meeting current soil standard specification almost always fail.
    - Change the compaction test per lab recommendations to reduce compaction and match field conditions better. Changing the compaction test won't fix the problem because the mixes are generally way over the lower threshold as it is now.
    - Permeability testing is very expensive. Repeat testing is a challenge.
    - Involve more compost suppliers to address compost specification issues
    - Add pH requirement for sand and maybe whole mix
    - Add chemical analysis for sand, maybe whole mix
    - Give a permeability performance spec and leave the mix up to the supplier

7. **Additives to BSM**
    - Need locally sourced sustainable options**.**
    - Topsoil: improves plant/tree health but challenging to engineer and may inhibit permeability
    - Biochar lowers permeability but adds microbial activity. In its infancy and is inconsistent. No viable data.

8. **Education for city staff, designers/engineers, and soil providers needed.**
    - Provide decision tree to give clear easy way of choosing designs, soil mix, trees, etc.

9. **Revisit the specification**

10. **Compost**
    - Revisit compost gradation with compost providers
    - Consider soil to replace some or all of compost
    - Revisit testing methods

3.0 ACTION ITEMS

The following action items were identified during the large group discussion.

1. Convene a work group of compost suppliers, soil suppliers, soil labs to consider adding topsoil and/or more fines to the BSM mix. Some representatives of plants and soil health should also be present to ensure tree health needs are considered.

- Involve more compost suppliers.
- Address issues with compost and inability to meet current specification
- Address potential to include topsoil and resolve challenges in specifying and sourcing topsoil.
- Address potential to add topsoil/fines without reducing permeability below performance threshold.

2. Workgroup needed to look specifically at design of bioretention for tree health.
    - Remove barriers to roots accessing native soil.
    - "Windows" for trees, "pot holes", treatment trains, forebay, tree pockets, silva cells, structural soils
    - Increase vertical and horizontal soil volume
    - Reconfigure the aggregate layer

3. Evaluate trees in bioretention that are currently built.
    - Enroll trees in Igor Lancan (UCCE) research project
    - More clearly define the problem
    - Understand how BSM changes over time: permeability, organic matter, soil structure

4. Change the compaction test method to the Standard Proctor test (ASTM D698).
    - BASMAA to consider changing the test method in the specification. Potential to try both methods side by side for comparison prior to adoption.

4.0 SUMMARY OF SURVEY EVALUATION RESPONSES

Thirty eight participants completed the evaluation survey at the end of the Bioretention Soil and Tree Round Table. Overall 94% of participants felt the round table met their expectations and 83% were satisfied with the consensus reached. The following provides a summary of the ratings and paraphrases the comments provided.

Question	**% agree or highly agree**	**Comments**
1. The goals for the meeting and logistics were clearly expressed at the beginning of the round table	84%	• Well organized & managed • Allowed for free expression of ideas & flexibility • Goals unclear • More history would be useful
2. The literature review was sufficiently recapped	89%	• Additional topics reduced clarity • Look at more regions with similar climate • Good job/communication for time allowed • Distilled a lot of information into useful summary
3. Breakouts - the questions were helpful	58%	• Questions helpful and provided guidance, but we didn't use them • Discussion flowed freely and covered the topics without answering specific questions • Conversation lead more to design than soil • Survey and material should have focused

		on plant interplay
4. Breakouts - this exercise allowed for adequate input to develop scenarios for modified/improved soil for tree health.	89%	• Discussion was engaged, robust, productive • I learned a lot • More questions than answers • What is the goal of the Water Board relative to biotetention, trees and soil
5. The outcomes of the breakout sessions were adequately summarized.	89%	• By necessity, they were condensed • Summary raised significant areas of discussion
6. The group discussion sufficiently addressed concerns, opinions, and agreements.	89%	• Soil testing would be helpful • Subcommittees a good outcome • Would have preferred less summary or more time for group discussion • Not all issues discussed • Useful discourse but didn't resolve much
7. The facilitator managed the discussion well and provided an opportunity for all participants' voices to be heard.	97%	• Well done, effective facilitator • Great ability to synthesize and summarize
8. The right mixes of professionals were included in the round table.	91%	• Developers, contractors/installers, and more composters, more civil engineers should have been included • Fantastic/healthy mix of participants
Did this round table meet your expectations?	94%	(Limited comments)
Were you satisfied with the consensus reached?	83%	• Somewhat/no: best that could be achieved; to be expected due to complexity of the issue, varied perspectives, and difficulty to reconcile goals. •
What parts of the round table meeting were most useful to you?	Not rated	• Small group breakout session & summary • Open discussions were informative • Mix of disciplines, expertise, and different opinions
What would have made this round table meeting more useful?	Not rated	• Better management of discussion • Case studies showing successes/failures • More time needed • Send fewer papers beforehand • Give better understanding of end goal • Provide soil providers/mixers education on the spec and goals • Hard to follow the group consensus. Find consensus in small group and build from there
General comments?	Not rated	• More time needed • No real consensus • Address design outside of soil mix; design influences the success of the mix • Good work towards a difficult goal; Action items provide a path forward • Important topic to continue discussing with all disciplines

Appendix A.
Complete Round Table Notes

BASMAA Bioretention Break out group notes

6-30-2016

Blue group participants:

1. **Paul Truyts**- lyngso: goal- help make spec more realistic
   Cost is a big factor
2. **Walter Passmore**- Urban forester Palo Alto- goal: creating new standard designs for the configuration and soil volume- more relevant for tree and plant health
3. **Dan Cloak**- stormwater compliance and LID expansion- Contra Costa Clean Water Program's 2007 interest in fixing failed soil mixes (no filtration), hired Megan Stromberg to help guide creation of a spec. In 2010, Megan assisted BASMAA adopting current spec. Goal: want to see investigation and data on quality of soil for supporting plant life and infiltration after the 3 year. 5-year, 10-year mark for LID facilities.
4. **Kelly Schoonmaker**-stop waste program manager- regional public agency- rep city of Alameda. Lead compost and mulch market development education programs. Bay Friendly original trainings. Water efficient Landscape Ordinance enforcement, and lawn conversion. Goal: don't fix spec at cost of sustainably sourced material and entire materials management cycle.
5. **Sarah Sutton**- Placeworks landscape architect- Also on BoD of Rescape California. Goal: wholistic approach, 7 principles, protect water quality, conserve water, conserve energy, landscape locally, habitat creation. Need rooting volume, healthy soils, sequester carbon, microbe populations. Project example: multi benefit rain garden Ohlone green way Bart station. Treats road runoff.
6. **Sue Ma**- waterboard, engineering background. Goal: to learn about bioretention. Seen both good and poor examples. Need to focus on trees.
7. **Alan Laca**- sacramento- private consulting firm (development and transport)- meeting post construction requirements. Example Caltrans job in Colusa- designed planters for trees and treatment but species did not do well in planters.
8. **Nabiul Afrooz**- Stanford university. Design new soil media to treat stormwater and improve water quality. Recently concluded some studies with foci on pathogens, nutrients, etc. using BIOCHAR. Looking for testing locations!
9. **Brian Currier**- sac state office of water programs. Bench scale and some field scale testing. Proprietary side of mixes in recent past, but looking to share info. Goal: Identify research gaps, keep implementation moving forward.
10. **Amber Schat**- City of San Jose- stormwater management. Tree and plant health and ability to sequester/remove pollutants. Long term health of systems, maintenance requirements. Edu and training of engineers, contractors and landscaping companies

Team Leader- Dan Cloak

1. Soil Spec
    - Challenges
        - Blender perspective: spec is relatively new (2002), different spec introduced and refined and they kept changing, blenders can't control how it is used off site by contractors. What is the life span of product? Want to see someone checking it to make sure there is not experiencing over-compaction issues. Maintenance is needed to make sure weeds and imported fines are not affecting the system in the long term.
        - Reasons to keep bioretention facilities open with living soil that is renewing, as opposed to a non organic filter or drain
        - Long term soil conductivity and health viable over longer periods? Might still be draining even after 10 years, but supporting plant life? Mixed results.
        - Useful to highlight failures and find opportunities for developing criteria
        - Like creating a recipe without knowing how the cake turned out
        - Find research students and look at long term trends
        - View recent landscape installations (even non stormwater) and see what similar issues are happening (irrigation, not enough soil volume). Separate stormwater from general (general landscaping issues vs. bioretention-specific issues).
        - Lack of tree and root structure (spokes on a wheel) is not encouraging plant vigor
        - Introduce bacteria to create biofilm, increase conductivity. With biochar, lots of microbe activity but reduces conductivity.
        - Tree health issues- 10 years investigations are not long enough to really determine tree health, but after 10 is really when you start to see how that tree will perform in the long term. Conflict between infiltration and water holding capacity. Trees are survivors, but almost no trees perform well in such extremes (inundation vs drought).
        - Augment with irrigation? Tree stand chance of getting to native soil and improving beyond the bioretention, water storage potential is limited in tree, vs. if it can access below the retention line.
        - Tradeoffs in design to focus on water quality benefits vs. plant health and increases conductivity and can penetrate biofilm
        - Sand performs ok with pollutant removal, but can get clogged at surface..
        - Bioretention with healthy plants can process fines and pollutants because of soil organisms and health. What happens to soils after 5-10 years? Dead or alive?
        - Reason for 5 inch/hr is a sizing design constraint to the goal of managing big storms in small urban environments. 4% sizing factor.

- Trying to hit a lower specified infiltration rate is more difficult than appears, so 5 inches/hour is not really the issue
- Configuration: Raising underdrains on systems
    - Porous spec is leaving plants dry too often and have trouble penetrating to area below bioretention areas (true for plants and trees?)
    - Modern config any better? Dead water stored for plants, available?
    - Tree roots cant access the water if the surface tension is not present

2. Structural/Design Configuration
    - Challenges

        - Tree Pocket solution? Placement on sides instead of over drain?
        - Structural Soils? Allows trees to penetrate and has good water holding capacity that you can develop fine roots in medium.
        - Engineered soils too complex for most buyers-
        - 90% of adsorbing tree roots are in top 18" of soil
        - The transitions from soil mix to gravel and gravel to native soils may create barriers to root penetration
        - Horizontal component more important than vertical- the width of tree wells is much more important. Create paths of least resistance.
        - Structural soils are used in parking lots, streets, tree cells, etc…
        - Urban constraints really dictate the ability to include trees
        - Determine where trees are appropriate
        - Success and failure observed in many scenarios, sometimes issues are obvious.
        - Need to include bioretention in foundation plans- train city staff and engineers to include tree space- have to work with old thinking to show geo tech engineers that it can work.
        - Tree health guidance is related to wind, light, exposure, water, and appropriate tree species selection given the specific location constraints.
        - Select subspecies/cultivars from climates with no summer rain.

    - Supplemental Irrigation:

        - Issues with plants trying to access adjacent water sources during no irrigation, or outside episodic events?
        - Temporary? For how long?
        - Establishment periods for tree is minimum of 3 years, and then remove it and trees will have to seek out their own long term sources.
        - Can configuration changes account for this need?
        - Trees find its way to get to where it needs to get water and soil, but need to design so that trees can access these areas (path of least resistance)

- Vic Cluasen- UC davis- insert tubes down to 1 meter for plants to get established quicker, and get away from temp irrigation reqs
- Roots will move where the available soil, water, nutrients are, but still have majority of fine roots in top 18"
- Training trees inappropriately to live within confines of bioretention and creating major failures? BSM to sand or clay outside retention area?
    - **Natural barriers to root growth** (gravel layers in bottom of profile)
- Alleviating compaction created during construction? In the spec already (rip bottom)
- Vertical and Horizontal potholes included in design to allow root movement (pockets within the BSM mix that have ability to support trees).

3. Soil Additive:

o Challenges

- Gel polymer (Cornell university) that is supposed to have better water holding capacity is added to structural soils, but tree roots just move through to native soils (only acts as a conduit) so water holding capacity of the structural soil not as important in long run.
- Biochar does hold water well, but creates low permeability (6 " with 15% biochar and sand)
- Using biochar and compost does not remove much pollutants
- Compost tea instead of compost- requires repeated applications. But helps inoculate soil. Most results with trees are favorable, but not a silver bullet
- Inoculating with Michorizal fungi? Variability with injection studies
- Inoculation process/method makes a difference and use broadsprectum because of uncertainty in which will take hold.
- Reserve small quantity of "native" or topsoil that has some resident microbes still present.
- Treatment train to deal with nutrient export issues with compost? Secondary containment? Complex and more expensive? Another area for failure.
- No current reqs on nutrient export. How does it perform after 3+ years?
- Some sensitive areas require special approaches: e.g. Tahoe needed to work with supplier to get extra rinse of additives in retention areas (primary issues are with Phosphorus and nitrogen).
- Compost suppliers (finished and unfinished)- making and selling it like crazy.
- Sheer volume of material that is used and moved every day. Reality is tough to please all players with test results, price point, and availability. Commercial scale needs are different than designers, engineers, planners, etc…
- **Tree pathogens**: phytophera- more irrigation, the more vigorous the pathogen is

- Many nurseries have issue with this pathogen and spreading it to projects
- Plans to test coconut fiber/pith and biochar-Nabuil Afrooz- issues with it coming compacted and hard to break apart
- Wood fiber is perhaps easier to obtain, locally sourced, byproduct of sustainable forest practices?
- Activated alumina- does not look plant friendly, any research on how plants respond to it?

BMP Database- contains info on effluent quality (import vs export of pollutants and pathogens)

Enforceability of compost spec? suppliers provide test every few month of material not older than 120 days. Almost always immature. Space is expensive. Testing on site not feasible. Ask for the last six sheets to determine if there is a trend in product quality.

Cal Recycle allows 0.5% by weight for inert materials (glass and plastic)- because of feedstock (foodwaste, green waste, safeway)

RED GROUP

Dale Bowyer (Water Board), Jill Bicknell (SCVURPP), David Haas (CalFire), Robert Schott (CalTrans), Will Bakx (Sonoma Compost), Annamarie Lucchesi (Waypoint Analytical), Shawn Freedberg (Deep Root), Peter Schultze-Allen (SMCWPPP/SCVVURPPP), Katheryne Kim (Wood Rodgers)

Dale's main goal: window trees through to the underlying soil, and there's no way to make bioretention soil suitable for growing trees

Dale Bowyer: Bay bridge Caltrans project used a little more topsoil. Infiltrometer testing found it was averaging 15 in/hour (really high permeability). Probably grew saltgrass on it, but permeability was much higher than anyone expected

Katheryn Kim, Wood Rodgers (landscape architecture dept.): Wants to stay on top of what's new in the industry. Not much in the way of input; mostly has knowledge of what trees need. Interested in learning about solutions for this problem

Peter Schultze-Allen: It's hard to find a solution based on what everyone else is doing due to soil conditions, climate differences (even within the Bay Area). Thinking a lot about this particular test to compact the mix (ASTM D1557 test). This was a conservative approach (worst case scenario), but now we're learning that we're not compacting it that much during construction so hopefully we can use less conservative testing (ASTM D698 test). Would like to hear more about what this group thinks about changing the spec to make a huge difference in the amount of finds in these tests.

Worst case scenario for failure: puddles/standing water form due to clogging/compaction

Found a green street project that wasn't infiltrating quickly enough; compaction is usually the culprit. The problem is having good records about what they installed, except without any soil mix records. We should be keeping track of this now

DB: Guessing contractors think it's cheaper to get surrounding (clay) soil or whatever is cheaper

Jill Bicknell: mostly here to listen and understand all the issue. Whatever proposal comes out, she wants to become educated.

Robert Schott, Caltrans: big fan of case studies, and the science of proving/disproving something after the fact. Interested in hearing this/similar soil blend in different applications and how well it performed in bioretention, water retention, how much washed away, etc. Doesn't think bay bridge is a good study because they pumped water up, and it's a different thing when it comes to rain gardens. (He recognized that he and Dale might be talking about two different parts of the bay bridge treatment system.)

David Haas: pretty new to all this, coming from a plant based background, increasing volume to promote tree establishment/growth. Some ideas have already been discussed in slides from earlier, esp. in regards to soil depth. You need to increase depth and not just lateral soil space. Agrees a small gravel layer would seriously deteriorate root growth in that area.

KK: Soil with lots of cobble tend to result in roots sticking near the surface

DH: When that happens, that's when you have tree failure

Annemarie Lucchesi: Also results in soil pH of 9-10

RS: When it gets rinsed, the pH issue disappears. But a well-drained layer results in trees having a hard time going down to where it's dry.

DH: restricting root to size of a certain hole

AML: seen failed testing on fawning setups due to improper installations. Can we adjust the specs to have some mineral fines that won't clog the system and not have the copper and issues from defined compost? A lot of times they're dealing with a really coarse compost that's not providing an adequate nutrient source in loamy soils, in particular. Small plants tend to be a common installation.

PSA: Haven't gotten much information back from small plant installation

Shawn Freedberg: We are at the end of the line in terms of what we're dealing with. Involved in development driven projects. Since we're putting such a high volume of water into a small surface area of bioretention, the soil has been developed to accommodate that. But if we want to plant trees, then it seems that the relationship of surface area to treatment area needs to be looked at. If we were able to make that space larger, we could use more topsoil and less fabricated soil to provide SW treatment AND plant trees. The fact of the matter is they're testing a lot of products and highly specific mixes that will be very hard to find, supply, and install in the precise mixes that they're producing in the lab. We're trying to bring things back to a pre-developed condition. Bioretention needs to be bigger, and surface area needs to increase.

DB: Shawn F is up against California real estate.

JB: Retrofitting urban environment. Things need to be balanced.

SF: If you go from 4 to 6%, could we see impacts to these issues? Because of the demand and return on development, I see how willing those developments are to pay for more regulatory enforcement because the return is so great. When the city/staff pushes back on them, they just want to get it over with.

JB: AS we move forward, the cities are going to be the developers. It's not just private sector. This needs to work for a city street as well.

SF: In Palo Alto, they want a quick turnaround to get things built as quickly as possible.

PSA: Problems with street trees in very tiny holes. Start with giving trees root space. IF you want a bigger tree, give them a bigger area. Maybe what the tree needs, the permit requires can find a happy medium.

DB: Trees and bioretention systems need to both be happy and both be able to function. I think there are ways to do that. Bioretention systems around the tree – we need to figure out a standard design for this, and I think this has already been done in OR and WA.

JB: motion to generate consensus that trees and bioretention systems are compatible? Not promoting either one, but it might be interesting to think about.

SF: Not only are they compatible (debatable), but what role do trees have when we're trying to do with bioretention? WE need to find a role for trees in treating the stormwater. Some people in this room don't think they're compatible due to difference in soil necessities, but trees in open bioretention are going to do a lot better than standard street trees. From my view, bioretention is a golden opportunity for a strong tree to grow vs. the alternative surrounded by concrete and asphalt. Once you have that open space, you have a lot of potential to grow a healthy tree. Cites a U of Chicago study where trees are taking that water up. We need to find a way to make these compatible.

PSA: One of the things I've learned over the years is people think you can just plant a tree in a bioretention area. We also need to think of the design from the tree's perspective – what does the tree need. We can't do one without the other and we need to start thinking about that. Perhaps a hybrid design/treatment train with a forebay with soil w/ high flow rate, small plants and then downstream a tree with a different soil mixture. There's also trash (esp. in street environment) and leaves from other trees. How can we prevent clogging from this trash? There are several different factors that go into a street environment design. Silva cells can also be used in the design.

When it gets narrow you need to spread out the water, but otherwise it's pretty flexible.

RS: Look at how much water you have and size accordingly

PSA: Know how many square feet you need, but be flexible.

DB: Old timey swales used to require water to traverse over certain distance. Now, as long as it moves through it's fair play.

SF: Is it true that we have the soil spec we have today because we know it starts out at 15-20 in/hr with the anticipation that it'll eventually get to 5 in/hr?

DB: actually you might get more permeability over time.

SF: I've seen studies that trees/woody perennials would increase porosity over time. If we can create a soil that provides more permeability after time.

PSA: The 12 in/hr max is only in the alternative spec. The regular spec has no maximum. If you mix the specified compost and specified sand it should be about 20 in/hr.

JB: But we design it for 5 in/hr

DH: Tree care is always the first to go in financial troubles

JB: but there is a long term commitment to these bioretention areas. And it's the landowner's responsibility.

DB: unless they leave the responsibility to the homeowners.

PSA: I think it would be good if we could write down all the ways tree-based systems are from small plant-based systems. Size change over time is an obvious one. If you design a system that will allow a tree to grow to 50 years old, that would be better. How the roots grow through the soil, root size, root uptake, needs of tree later in life (increased irrigation) are all possible problems to consider. If we could use our clay soil, that would help a lot (if it's not compacted).

Will Bakx: Trees are in a claustrophobic environment. If you allow it to grow deep, that can affect irrigation growth as well. When you take that and apply it to the soil itself, you get soils that are well aggregated/structured. Sandy soils are not well structured. That over time increases permeability. Well managed soils w/ OM are very permeable. Don't just apply compost at one time. Sandy soils decompose compost very quickly. Compost is in essence the kickstarter. Mulch: fungi try to break down mulch, which breaks into soil for nutrients. Look more in the whole ecosystem of what's in the soil instead of just the plants and soil.

RS: Yes, take natural systems into account.

WB: Assist the ecosystem to get a natural aggregation going. Also, when materials are being imported, I don't like it. Look at resources that exist in my community that people perceive as waste. What can we make use out of with it? Taking these materials and making them a beneficial use (diatomaceous earth). Winery waste is expensive to dispose of. I've included it in my compost (5-10%), so now I'm going after big wineries and working with them to tell them how to divert the waste to compost operations.

DH: Why is mulch such a concern?

PSA: It's not a contained system. Water can overflow and follow the same line it always follows. IN line systems – anytime it fills up, it moves around.

KK: Water fish and landscape ordinance requires 3 in of mulch

WB: Mulch is lacking nutrients (pretty much C). Fungi (hyphae) see this as a good thing to break down, but needs to dig down into soil to actually get nutrients. Hyphae makes a very stable aggregate. This is the best way to do it.

PSA: Doesn't biochar do this as well?

WB: Yes, but biochar is in its infancy. Not all biochar performs. High absorption rate will attract heavy metals, but other biochar won't do so. Industry needs regulation in order to standardize conditions. Low temp is good, but high temp is bad. (There is no scientific literature to prove this, and the makers don't know.) Right now biochar is on a case by case basis.

PSA: JB and I know of a system with 25% biochar in Richmond that was built about 1-2 years ago. We'll see how the monitoring turns out for that one.

WB: That's a lot. Biochar is expensive – about $350/cu. yard. The price point should be $75/cu. yd., and right now its way higher. You have to think about what you are getting and what you want. The compost that's being mentioned out here is the same way too. These are most likely native plants that don't need high nutrient compost, so what you're looking for is low N compost. That's not being talked about. (low N for native plants, high N for ag). You design what you need, and bring it to the table. That nutrient budget needs to be taken into account.

PSA: The BASMAA spec has a minimum Total N content of 0.9%. Is that high or low?

WB: That sounds low, but they need to specify wet or dry.

PSA: There's no top limit.

WB: They need a top limit. You need to actually calculate the N budget needed. You need to have a mature compost but a ratio of 25/1 is robbing N out of the soil. You'll mobilize it, which goes straight to microbes and none to plants. 20/1 should be the max. Above 20/1 is robbing N from the plants. 12/1 is equilibrium. Now how can we get thrown off there? 12/1 isn't necessarily mature.

PSA: So what do you think is a good upper limit?

WB: Invite Assaf from Control Lab (Not here today), look at how much compost is being added.

RS: When it comes to compaction I'd like to see the closest conditions to the field.

WB: Assaf has some ideas about how to achieve that. I think he'd be good at getting us results.

PSA: N in this product was 1.9%, C/N ratio 17/1.

WB: The particle size distribution does not reflect the size we use

PSA: 200 sieve

AL: I think that's 0.5 mm

PSA: We require the 200 sieve in our standards. It's not typically asked for in the STA compost test. It's seen as a good at pollutant removal/cation removal. But it's better when it's dry. The #200 does seem to get finer as the compost matures too. That's another thing that could be a variable over time.

WB: They thought it deteriorates to humus but surprise! Humus doesn't really exist!

PSA: Any other questions we haven't addressed?

KK: Curiosity: it seems like there's a lot of focus on the soil, but is that the only thing that's going to be actually perfected out of this or are we also going to talk about design?

JB: We do need to keep exploring overall design but I don't think we can talk about all those components today.

WB: I think the problem is if you look at system design but you are myopic with your approach. You solve one problem and create another one. You have to look at how everything behaves in the whole system and if it answers the whole problem

JB: Our basic premise is: "What is the best bioretention soil for the tree?" but there are a lot of factors in this.

PSA: And the soil we came up with is best for small plants - not trees.

JB: Basic goal of these things is to remove pollutants. We don't even need 18 in. The nutrients are usually trapped in the first 6-12 in.

WB: Also trees are huge water pumps. That is a huge benefit.

JB: They're also intercepting rain water before it hits the ground.

SF: Seattle/VA rainy seasons are way different than the bay area too. It's something we should be thoughtful of as we move forward.

PSA: What particular trees would be the best?

RS: The soil you proposed is good for wetland species but also bad for growing trees because the soil depth is inadequate and because the soil mix of fines/aggregates is inappropriate.

JB: Depth is a design issue

RS: But it's a system

JB: What if you had a 4 foot deep system?

RS: I'd still like more native soil. It's a more natural habitat. If you're doing this in isolation and add fines then the system may fail. But getting the fines in the soil will promote the aggregation of the soil.

JB: Best way to introduce fines? Artificial or native soils from the site?

WB: If you have an adobe soil and blend it with sand, you get a dry brick. There has to be some specifications about what you have to do.

JB: Maybe its better to find a way to get the tree to go down to the native soil like what DB said

RS: also, are the native soils down there truly native soils? CalTrans is developing soils like this artificially. It's a big different problem. Brining in your soil is impractical. What depth do you need? What compaction are we looking at?

PSA: We've also been thinking about trees that are dormant in the winter. How do they absorb water in the wet winter? Deciduous vs Evergreen. We need to find an evergreen tree that works well in a street environment (not that many), but the Brisbane box (non-native) seems to do the job and is popular. What works well with environment and street environment?

WB: is Brisbane box deep rooted or surface tree?

PSA: I think it's a surface tree since it does well in the street.

AL: Would it work with our compost? Not a lot of Australian trees take up phosphorus.

PSA: Seems to be a hardy tree, not a lot of pest problems

DH: for now.

PSA: it would be better to have multiple species, but we don't have that many species.

WB: also, how does it interact with other trees around it? Also, what are other plants that grow around the trees and make a community?

PSA: This hybrid concept about forward bay w/ small plants and a tree further downstream would be something to explore.

RS: your highland/wetland analysis works well here. Wetland plants want sunshine and so do trees.

PSA: Any other questions?

PSA: Diatomaceous earth: some of our suppliers are experimenting with different things.

WB; if he's using virgin earth, lets' talk to the guy who's here.

PSA: are there any human health issues?

WB: depends if DE is wet or dry. At 25% moisture content human health shouldn't be an issue. Recycled DE comes as a wet clay.

PSA: Allowable MC is 30-55% (AL agrees)

WB: I think that's a reasonable amount. 65% is the upper limit. Below 35 creates a dust problem.

PSA: sandy usually gets dry.

PSA: Drought – trees need lots of water. That's why people went to smaller plants. What can we do to minimize irrigation requirements, esp. with street trees?

RS: I don't think it's practical to not have irrigation system due to dry summers.

DB and PSA: exit

SF: if a tree is successful in 5 years, wouldn't it be self-sustaining?

RS: however, wetland species at a certain depth need supplemental water

WB: if you have drain rock underneath it, I don't think that tree will be dependent on irrigation water.

RS; but tree won't live past 5 years

WB: true. But a shallow tree would be independent

JB: I wish Dale was here to answer questions about design of reservoir that goes through the soil but includes gravel to retain water.

WB: soil would also be more permeable at a lower level

SF: there's a difference between systems with and without an underdrain. From what I've heard, the 12 inches of gravel may need different designs depending on whether or not they have one.

JB: 90% of our systems do include an underdrain though since we don't want clay retention. Maybe the systems that are not lined…

RS: gravel systems used as a reservoir hold the water in the gravel reservoir so it can infiltrate over a longer period of time. That's a good basin design, but it's not good for trees.

SF: another thing that's challenging is looking at small bioretention spaces and variability.

PSA returns: recent change in impervious paving?

JB: I don't know if that's relevant. Everyone complains about the rock underneath

SF: all that rock needs to be brought in. It's not very sustainable.

JB: requirements vary across the state. Bay area can treat and release so that's why you see more underdrains here

PSA: Dan Cloak has talked about systems with adjustable openings in the outflow.

JB: we do have flow reduction/retention standards, but I don't think that would benefit the tree.

SF: I think the issue of the water and the tree is not that significant of a problem in general. It's not a species issue. Water flow of 5 in/hour + rain in the bay area = not gonna be a significant problem in terms of oversaturation.

PSA: when I talked about what tree to use, I was thinking of reducing irrigation.

SF: I think the experts would agree irrigation is necessary and there will never be too much water for the tree.

WB: Well it might not need irrigation after 5 years. It'll be out of the sandy soil in no time.

SF: once its past 5 years, it's finding water, oxygen and nutrients on its own and won't need outside help.

PSA: but once you get to the native soil you can't turn it off.

RS: with native soil, you need to provide all its inputs. You need to make sure the roots drain, tree gets nutrients.

PSA: we should anticipate that there might not be native soil beneath

SF: but there's middle ground in ultra-urban developments and bioretention is being implemented. Only native soils are underneath parking structures, are compacted. Irrigation and long term success of the tree are nuanced.

PSA: It's the same in Emeryville as well.

SF: Facebook didn't want bay high water coming into their system. There's goals and then there's practicality.

PSA: Does soil with more volume eventually make a difference? Water retention?

RS: I don't think they'll make significant difference and I don't think it'll be cost effective. I see green roofs that don't have this

AL: some of these have hybrid layers though.

SF: I feel like this group is going towards a movement away from additives and towards topsoil in the system. Engineers want to make sure that hydrology of the system continues to function.

RS: I think you need a different structural design for bioretention and a different for trees. I think they can be next to each other, but they're very different systems.

PSA: Forebay could be sized for 10 in/hr, and tree system for 2.5 in/hr, and you combine them to equal 5

SF: If the goal is 5, can we start out at something that starts out at 5 instead of something at 25 that will eventually clog to 5? Pull back so we can actually get some retention and account for failure.

JB: I'm not sure how much scientific footing 5 in/hr has.

RS: Caltrans has filters that do 100 in/hr and we're trying to get up to 4. We're looking at what water treatment plans are using. Soil: maybe less would be a better number.

SF: isn't 5 in/hr driving the 4%?

JB: It's the 5 in/hr and the design of rainfall intensity for a flow-based system. Designing for frequent storms. It's a very simplistic method. Soil mix as a filter drains through and you have to have a minimum of filtration to the soil. Bioretention should be a combination system. NO one wants to go above 4%.

What you're proposing is radical. But if we're talking about a 2 stage system, we can do 4% first and something else later.

SF: we see a lot of designs that are missing the intent. I'd rather have them get more credit in the development process if they can make the system bigger and allow trees.

JB: Green infrastructure is trying to get street trees etc. in the big picture.

SF: Some people can't plant these trees because the 4% will increase to 4.5%

Takeaways:

- design differently for different situations and take natural systems into account. Look at overall designs, and redefining specs for compost would be a good idea. It deserves extra attention.
- Bioretention should also find a way to incorporate without massively retrofitting the urban environment
- Look at systems approach and not just fixing the soil itself. This includes access to native soils, which go back to soil volume.
- Don't force trees down places where they can't grow.
- Think about why we integrate trees with stormwater/bioretention facilities in the first place? Why does it increase the function of the facility?
    - Improves efficiency of the bioretention facility due to water uptake (but is it necessarily true here in California?)
    - Also, are there any native plants that aren't dormant in the wet winter that can do the job?

6/30/16

Green Breakout Group

Tom Bonnell (Pleasant Trucking), Nelda Matheny (Hortscience), Greg Balzer (Caltrans), Robert Campos (Wood Rodgers), Jing Wu (SFEI), Teresa Eade (StopWaste), Nyoka Corley (LH Voss), Joshi Bhaskar (CalTrans, phone), Shannan Young (City of Dublin)

What brought participants to the Round Table:

Nelda: Soil volume for trees. Doesn't think the ratio of soil volume to trees canopy that is commonly quoted is appropriate for CA. Climate based model developed by Nina Bassuck at Cornell. Her formula was based on the soil volume required for adequate water for a 10 day supply, in sandy loam soil, in Ithaca NY. Stop using as a guideline. Instead, concentrate on growing the biggest root system possible into landscape/native soil.

Greg: Lots of different functions for bioretention areas (i.e water quality vs trees/building an ecology). Try to verify what the goal is. You aren't going to grow plants/trees in a 60-70% sand mix. Need more of a sandy-loam mix and research/testing of any new mix.

Robert: Need to pick the right tree in the correct location within the treatment area, and have appropriate irrigation.

Jing W: We will be planting trees in urban landscapes and it is beneficial to have stormwater systems with trees. Maybe have a tree specific mix. Do future research/monitoring.

Teresa E: Create sustainable landscapes, compost is the cornerstone of sustainable landscapes because of water holding and biological component. The biological component is missing in the current mix, and these are high demand systems. Additives mentioned in lit review don't have any of the biological metric. It is difficult to get bioretention areas to perform multiple functions. Maybe just have shrubs/small plants in bioretention areas.

Tom B: He's not seeing many trees in bioretention areas. He thinks it makes more sense to have only shrubs/small plants in bioretention areas. His interest is in having a specification that they can meet. They are still missing a couple of components on the compost side (i.e. Not passing the spec). Additives: everything costs, and most are not local. He thinks the top soil is good and we should go back to using that. He takes samples from different portions of the pile in order to get samples that pass the requirements.

Nyoka: Confusing regarding the quarter inch (1/4") screen. Spec indicates 40-90 % passing is required, but the compost is coming in finer than that (typically 95% passing). Alternative mix specifications indicate that only 2-5 % fines are allowed, but the sand component is already at 5% max so you can't add compost.

Greg: Are we looking at a performance spec or materials and methods?

Tom B: Cost is an issue. It's costing them $800/permeability test. Go through two different labs.

Phone (Joshi): Mostly been concerned with stormwater pollutant removal. Need a mix that shouldn't be compacted too much for stormwater pollutant removal, but that can be used in roadway conditions; it's difficult to do that. Also trying to work in narrow roadway conditions, creating environments that work for stormwater treatment and also not creating unsafe environments for vehicles and pedistrians.

Nelda: If you have 30% compost in the specification, when it degrades, you've lost 30% volume.

Teresa: Add mulch on a regular basis to help with that (compost) problem. (Not everyone wants mulch because of floating issues).

Jing: Does the biological activity of compost decrease over time as the tree uptakes/uses the compost? Nelda: plants are constantly adding organic matter (to assist with biological component). Benefit of grasses is that they add the most root mass to the soil.

Nyoka: Planted trees in Gateway Safeway in Pleasanton. They are doing well in LH Voss soil. They have been installed for three years. What is the sizing of BRAs? Some seem really small.

Shannan: Sizing is either 4% of the impervious surface drainage area, or based on the combo flow-volume sizing (as small as 2% with more surface ponding).

Teresa: Crazy idea: Hydroponic trees. Happiest trees are the ones that have broken through sewer pipes.

Nelda: It's like the Green Machine. Take the black water from the building to irrigate the landscape.

Greg: In his experience, bioretention doesn't work because it's shady, not draining, or because of compaction issues. Caltrans doesn't have a soil mix, only compost spec; no topsoil standard. They use whatever the locals want them to use. They would love a regional or state mix.

Jing: Monitored the Ceaser Chavez project in San Francisco. BRA sizing for that project: 4%. She has seen that there is no problem with standing water with 4% sizing, but with smaller BRAs, you may see problems.

Nelda: How do you irrigate in a soil that is designed to drain? Getting uniform soil moisture is difficult when you have a fast draining soil.

Nelda: What is magic about the 5-10 inches per hour? At what point are we supposed to reach the 5-10 inches per hour? At installation?

Jing: If we get failure during large storms, then we shouldn't consider it a failure because the BRAs are not designed for large storms.

Nelda: Are there maintenance standards? Are municipalities testing infiltration rates after some period of time? Haz waste issues? Teresa: we don't know yet. She thinks San Jose did a study and didn't find anything, but we still don't know. She will try to find the study.

Nyoka: Add more compost and if it's really working the way it should, then it shouldn't be hazardous waste.

Tom: The theory was that BRAs would last 7-10 years at the beginning of this. The facilities that were installed 7-10 years ago look good now. However, did it with gorilla hair to back then.

Jing: Sediment will be added over time and maintenance will be needed to maintain permeability.

Nelda: How do we encourage infiltration into native soils? Add organic matter to the native soil? Scarification?

People don't like the gravel layer. Prefer to have the gravel layer go deeper (i.e. long, narrow), or on the side? Is it really true that tree roots won't grow in the gravel?

Maintenance is huge. In order for the trees to be successful, you need to have a good maintenance program.

Nelda: We need a statement opposing lining. Edges made of concrete. Why? One landscape architect (not in the breakout group) thinks it is to keep moisture out of the adjacent landscape.

Change the soil type depending on the design of the bioretention area (more urban vs. rural) (parking lot or street trees).

Nelda: tree roots don't really go deeper than 18 inches in clay soils because they need the oxygen. In sandy soils, they can go deeper because oxygen is available. However, she thinks that we don't need to increase the depth of bioretention mix.

Big ideas:

Can't separate BRA design from materials (i.e. soil).

1) Look at the gravel layer. Will the tree roots really not penetrate into gravel layer? If they do penetrate, will they utilize the gravel layer in preference to native soil since it is less work? If so, then we would need to irrigate in warm months to keep the gravel layer wet; not a sustainable system. Think vertically instead of laterally. Jing: have to be sure that it is designed such that you are not causing more storm bypass.

Nelda, Teresa, Robert: goal is to get the tree roots into native soil as quick as possible.

2) 18 inches for the treatment soil layer seems to be working, you go deeper = dryer at the surface = more irrigation.

Materials:

3) Would having some larger woody material (composted mulch) included in the compost mix help address some of the coarseness? Tom expressed frustration that the specification has mixed goals: want it coarse at the top end for infiltration and want it fine at the bottom end for

pollutant removal. Teresa: use the same mix as in compost socks. Greg: it's difficult to get the compost socks mix because they have to compost it again. Teresa thought it is more widely available in Nor Cal than So Cal. Teresa: Why are we using such finely screened compost?

4) The group is not feeling most additives (unless you are focusing on a particular pollutant problem), except for compost and top soil (but top soil is not consistent). Focus on local sources.
5) Need to require a spec for chemical component of sand. Need threshold for salinity.
6) Maintenance standards are needed and training for landscapers.

If we are going to change the standards, we need lab testing standards.

WDOT studies on Compost amended vegetated filter systems. First flush, pollutants are exported, after that: net removal.

Group participants:
Megan Stromberg (WRA), Jeff Sinclair (City of San Jose), Alex McDonald (Caltrans), Elizabeth Lanham (Davey Resource Group), Igor Lancan (UCCE), David Swartz (City of Fremont), Meagan Hynes (Talus Soil Consulting), Connie Goldade (Community Design and Architecture).

From: Megan Stromberg
To: Shannan Young
Subject: Notes from my discussion group
Date: Sunday, July 03, 2016 11:24:31 AM

Hi Shannan,

Well done. I get that you were hoping for more concrete direction but I think it was significant forward progress.

My group had the following main points in no particular order:
-Change the compaction test to reflect the field conditions better.
-The mix needs to be slower, closer to 5"/hour. The max flow rate is too high. It needs more fines. The interim spec moved in the wrong direction.
-When mulch floats it indicates a design problem, not a problem with mulch. if basin is designed correctly, mulch won't float.
-Need to educate everyone on terminology of permeability/infiltration/hydraulic conductivity testing. Meagan Hynes to provide summary.
- pH range of sand acceptance should be up to 7.8 (7.5 at the very least). Would be good to add a pH range for the mixed BSM.
-Chemical suitability testing seems like a good idea. Especially in watersheds with TMDL
Could test for target pollutants. Do we need to test sand for metals? Look at local sands to determine if there are problems.
-Would like to have a decision tree to aid designers and reviewers. Help determine which design and/or soil mix is best to meet different goals.
-Trees need access to native soil. Tree roots grow mostly laterally not down below 18". Side barriers are most important to remove, not the aggregate layer. Engineers commonly want deepened curb and liner (concern for water moving into utility aggregate layer or building impacts.)
-We don't want to require any additives that aren't locally available. Consider the sustainability of changing mix.
-Most submittals fail to meet standard and have to get treated like the alternative mix almost always. Alternative mix spec may be too lenient.
-Look at adding Silva cells outside bioretention
-Look at work by Geofortis on diatomaceous earth

MEGAN WILSON STROMBERG | Associate Landscape Architect, CA License #5535, QSD#21167 | d: 415.524.7537 | o: 415.454.8868 x 1380 | c: 415.342.4413 | stromberg@wra-ca.com

WRA, Inc. | www.wra-ca.com | 2169-G East Francisco Blvd., San Rafael, CA 94901 | San Diego | Fort Bragg | Denver

BASMAA Meeting notes 6/30/16

Biotreatment Soil and Tree: Yellow Group

Participants: Paul Niemuth (City of Fremont), Glenn Flamik (Cal Fire), Matt Moore (TMT), Bill Sowa (HMH engineers), Dorothy Abeyta (City of San Jose), Anne –Marie Benz (BFLGC), LeighAnna Johnson (WB, note taker).

Beginning concerns/comments

What is trying to be accomplished with the soil compositions itself? Is this because of reduced space? – Glenn

Too micro of a view, wants to look at the big picture – Ann-Marie

Biotreatment cells are replacing the space in the urban environment where trees should be. How can we make biocells accommodate trees? – Dorothy

We've gotten away from our professional experience, solutions are diminishing. Wants to open the dialogue and open solutions to water quality treatment. Has concern for risk management for his clients, wants less risk at the agency level, less risk at construction level where materials are available. Find the benefit for natural reasons compared to engineering solutions, we're becoming less creative. Get away from cite and look at the regional outlook to support the Water Board. - Bill Sowa

Treatment areas need to be confined to a certain area, you can't grow plants, trees, or irrigate- isn't there a zone for alternative treatment? Engineers just want the numbers to work, not if the treatment or soil health is actually beneficial. -Paul

Can we keep a consistent amount of topsoil? Finding soil for a decent price.

The import compost material for soil may contain pollutants, or excessive nutrient content that leach in the beginning. Do we really need something to filter it if it's a short term problem?

How do we reassess something if we don't know it's broken?

Group Discussion Questions: Bioretention facility experience

What has been your experience using the current bioretention soil mix specification? What are the biggest advantages, drawbacks, most vexing difficulties?

- Inspector looks at the soil mix, they test to make sure the plant material is it alive and functioning. Results are soil sluffing; dead plants that need replacement; plants, splash blocks or cobblestone getting buried in the biotreatment soil.

Have you experienced any failures (inadequate percolation through the soil mix?) What did you discern was the cause?

- An alternative mix of soil based media (worm castings) making up 3 ft tested great in the lab, but out in the field locked up in the wood spaces and turned into clay in the rain. The cause- Bad combination of sandy loam based soil 20% fines, 10% worm casting, coco is supposed to keep soil loose but it bounded everything up even more.
- In consistent test results: Over-compaction during installation or soil design can be tested at a certain percolation rate but you can't duplicate that percolation rate during lab tests or in the field. Even with a duplicate procedure, you obtain completely different results.
- Consultant came in to tell the team how to do sheet mulching and it made it completely anaerobic, water doesn't go through it.
- Plant establishment with biotreatment is difficult, percolation ability, different areas of the cell performing in different ways.
- Failure- dead plants because we can't water them enough or failing/absent percolation. Biotreatment soil sluffing down and covering the plants.
- Loose soils

<u>Have you noted large quantities of water were needed for plant establishment in comparison to a similar typical landscape setting, and or for long term maintenance? Are you able to meet WELO water budget with this soil? If so, how did this problem relate to selection of the plant palette? To irrigation system features and design? Could Changes to either address the water issue?</u>

- Large quantities of water are needed and irrigation is needed much more frequently. To keep Juncus from looking like rags, you need to water much more heavily.
- Excess irrigation is affecting plant palette, it's really narrow depending on irrigation.
- Water holding capability of the soil needs to be addressed. It needs to be increased.
- Weeds are an issue because they do not want to use pesticides. Discerning and educating maintanance on weeds vs plants that are supposed to be there.
- Mulch is producing weeds. Recommendation-

<u>Are you familiar with any bioretention facilities that have been installed for 5 years or longer? 10 yrs? What changes if any in characteristics or performance have you noted?</u>

<u>What aspects of bioretention design and construction stand out as factors affecting long-term performance?</u>

- Do milk crates under soil affect long term?
- Must be patient with soil structure

Have you had experience with trees in bioretention facilities? What features of design and construction were innovated to support tree survival and health? Did any problems of failures occur?

- Trees were getting irrigated by a bubbler in a 3 ft deep PVC tube. It was not an effective method to deliver water to the tree roots. How do we get out of an established narrowed option solution? It took so long to create a solution. How do you beat a long term accepted plan that isn't best for planting design?

- Recommendation -Do not plant trees in concrete boxes, and get rid of Filteras.

- Plumb irrigation to where we're planting and water with truck water until the trees are established.

Do you have any ideas or recommendations for design, installation, soil characteristics, or other features for supporting trees in bioretention facilities?

- Liners are not recommended unless you cut open a hole in the liner. Use native soil to establish roots beyond the biotreatment wall.
- Recommendation -put the liners to the side from the trees. Mechanical treatment opposed to liners because they are not sustainable and chemicals leach out of liners.
- Open bottom planters is another recommendation.

Soil Testing

- It's easy to get soil approved/accepted in Fremont. - Matt
- Problem- A separate City department approves soils even though they have no experience interpreting data. – Dorothy
- There is significant inconsistency and variability with soil testing (due to environmental conditions, availability of fully compliant material, availability to aged compost)
- Batch specific is highly impractical and no one in the Bay area can do it because of needed real estate.
- Quarterly or monthly testing is much more practical.
- Lack of testing might be because of inconsistency.

Compost specification

- If compost has never met spec, what needs to change?
- It's difficult to get a sieve test on compost.
- pH is a good marker for effective composition

- You need to test the finished blended components and test for soil chemistry, not the individual components.

Question 4-

- There is no aged compost in this region, it moves faster than it should. Composted mulch works. Compost from ZBest works in sheet mulching.
- Gorilla hair or shredded wood-concerning from the fire standpoint or it matted too much yet it's effective and locks into place. It needs to be replenished because it mats down but doesn't move away.
- Subsurfaced load exceeded surface load.

Additives

- It's hard to justify the extra costs. It's better to use local resources – for environment and cost.
- Biochar has no viable data and results are hard to duplicate.
- Volcanic sand is not as costly
- Perlite and vermiculite are an environmental disaster.
- What works? engineered soil to mimic native soil. The challenge is getting consistent long term product.

Concensus and Summary:

- We need a bigger broader solution to the problem.
- We need to treat areas before they drain to sites, not once they reach every certain site.
- "More tools for the toolbox"
- High alkalinity compost or sand is a concern. Yet when you buffer sand or compost it changes the composition, stability, and effect.
- Plants are dying – wash the roots and examine and the result of the plants dying is almost every time lack of water.
- We need education on soil placement
- Educate irrigation maintenance and inspectors.
- Testing methods for the component need to be improved, need more local testing on local sites.
- Do we have enough sites and come up with funding to improve more consistent testing.
- If we can't compare what's working with the soil and water quality we need more data, but who has the data?
- Collaborate and come up with sites that are three years old and maybe apply for a grant to test and see what's working and what's not working because that is the underlying issue.

- No one is identifying the problem at hand.

Notes from Christine. Big picture comments from large group discussion are listed below.

Paul report out

- Need more data to see if we have a problem that we need to fix.

Dan (blue group)

- Knowns: locally sourced, sustained materials. WE have a process for getting the spec. Problems: age and maturity due to supply/demand. Food waste as a source, so inerts will continue to be a problem.
- Unknowns: effluent quality and if that is a concern. How does the export of ss and nutrients change over time? More research is needed.
- Configuration and volume. In the design of BRAs, need to look at the path of least resistance for tree roots. Sandwich effect of layer maybe causing problems with root expansion.
- Trees: relationship between irrigation and plant pathogens.

Megan (red group)

- Design of BRAs, in particular barriers. How do you design BRAs without barriers.
- Options. Developing a matrix/process for alternatives. Decision tree the big item.
- Add pH testing to the whole mix.

Nelda (green group)

- Tree roots into native soil. Modify the gravel layer so that it's not a flat pancake into a deeper layer.
- Improve the native soil to encourage roots to grow into it.
- 2:1 tree canopy ratio is an east coast specification
-
- BRA soil is integral to the type of design that is used
- Avoid using additives that are not locally sourced
- Chemical analysis for sand
- Consider including medium and large size compost in the specified compost mix.
- Maintenance guidelines and training for the landscape maintenance professionals.

Peter (red group)

- Integrated system design and how it evolves over time.
- How does the size of the tree over time impact the design
- How did we get to this point of today? Where did the 5" per hour come from? Dan: what is an infiltration rate that could reasonably be used in the urban landscape? Dan imported the Portland standard of 5" per hour.

- More complex, hybrid design
- Maybe there are some instances in which trees shouldn't be used.
- What do trees bring to the discussion? There are a lot of advantages to big trees (i.e. uptake of water and increase performance of BRAs)
- Access to native soil
- Maybe 18 inches of BSM isn't enough
- Workgroup of compost suppliers (maybe an action item that could come out of today)

Compost

¼ compost people can't meet it. Request is to change to 95%. Someone else thinks that is not the right approach. Need bigger particle size. ½ minus. Most trees are low nitrogen requiring plants. Look at nutrient loading of the trees and then look at the compost needs. Moving forward suggestion: compost suppliers and soil labs to develop a good spec.

Why 30% compost? Include soil instead of as much sand/compost. Include more fines to slow the infiltration rate. Fines are mostly clay, depending on your component gradations (i.e sand), then you may have plugging. But from a blenders perspective, each soil batch is different.

Define the most appropriate testing methodology. Maybe methods that are used in lab don't reflect what is happening in situ

Dan. We need to evaluate trees that have been in the ground. Igor offered to evaluate trees.

Other ideas for additives. Biochar (will slow down infiltration rate).

Soil – specification to limit variability? Suppliers say it's a natural product that is all variable, supplies variable. Horticultural people say there are specifications for landscape soils.

When we start adding sand, there is a high probability of locking up. The less you handle the soil, the better. Over time, the soil will improve.

Evaluate topsoil so we know what we are getting. Suppliers: Where are you going to get the soil (strip mining)?

What about adding about 5-10% of the compost as the compost sock variety? Available carbon is higher, then more nitrogen is immediately available.

Need to look at systems that sustain themselves over time in regard to nitrogen renewal.

Question from Dan: when the trees have been in the ground for some time, does the soil develop into a more complete soil? Is there a lab test? Maybe (ask) Can you visually look at the soil (Igor says yes, to some extent, but soils don't really form in such a short time frame (i.e. ten years).) Dorothy thinks that

soil can actually form (via the topsoil SJ specification) in a couple of years. But the BSM mix does not form soil.

Want a carbon mix that doesn't create bioavailable nitrogen so the biological breakdown doesn't starve the plants.

Focus:

Dale: treeable bioretention soil is not attainable. What we really need is a bioretention design that can accommodate trees to help them grow.

Supplier: performance spec, but don't give ingredients. Soil lab would need to be able to test performance and have it be repeatable.

How does the BSM mix function as a soil

Supplier: can't meet the ¼ inch spec. Need to change it.

Jill: two working groups: 1) to look at compost/fines, and one to look at design.

Idea of degrading infiltratin rate over time may not be accurate. Tree and plant roots will increase/maintain permeability. Design for a healthy environment and infiltration rate will follow.

What is the target initial infiltration rate? From where did the 12 inches per hour come?

Constrained right-of-way

Peter: Try out the use a different test with less compaction which supposedly mimics more in the ground conditions. Thumbs up on that from the group. Dale, we WB will allow it. Labs: maybe try out both methods side-by-side to see how it impacts infiltration.

Ron Alexander: helped CalTrans, Washington DOT spec, (include on subcommittee).

Compost suppliers are not involved. Need to involve more of them.