PLANT IRRIGATION AND PLANT HEALTH

WITH GREYWATER IRRIGATION

GREYWATER ACTION WEBINAR SERIES

PART TWO

REGINA HIRSCH, SIERRA WATERSHED PROGRESSIVE

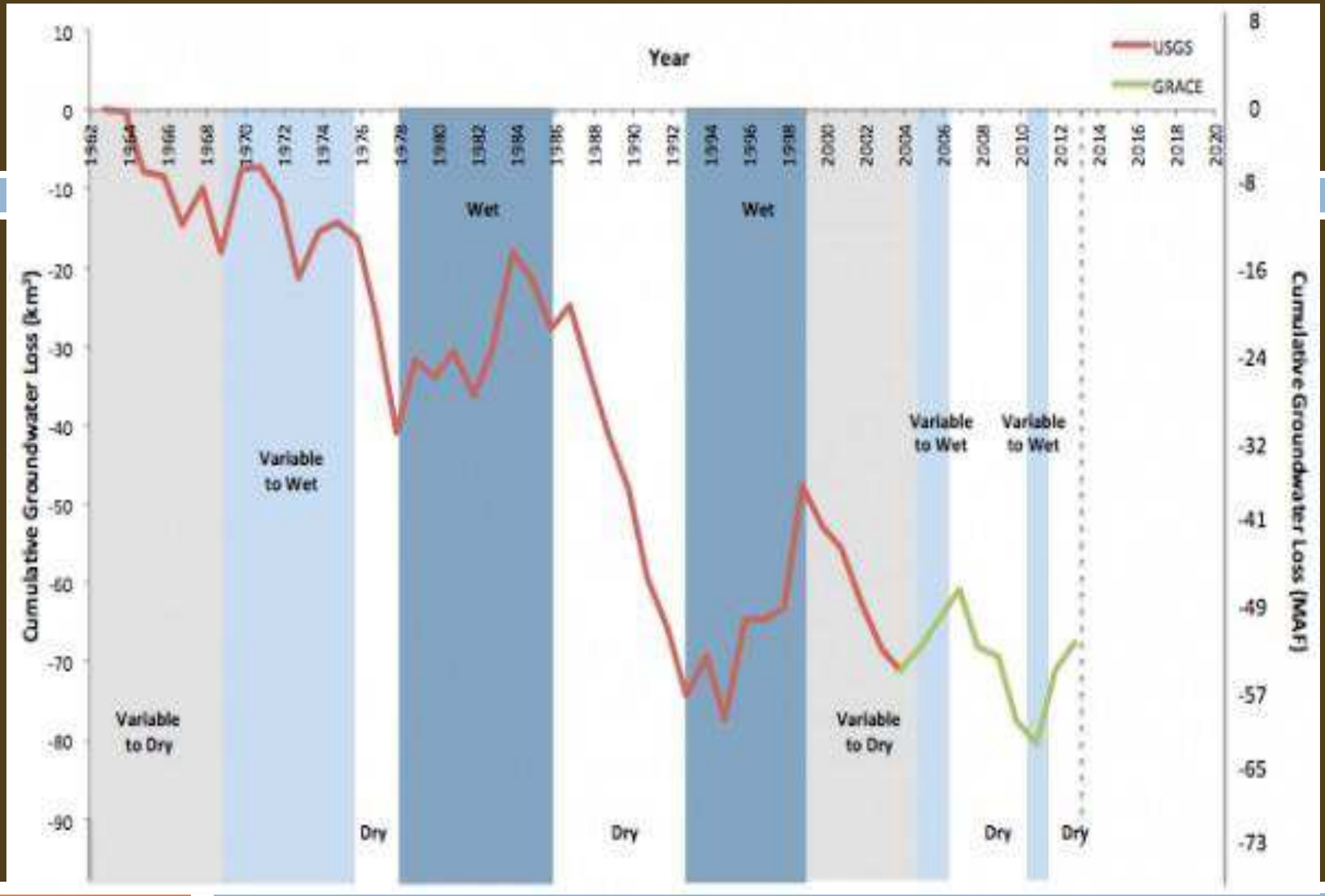
“People are always looking for the single magic bullet that will totally change everything. There is no single magic bullet.”

-TEMPLE GRANDIN

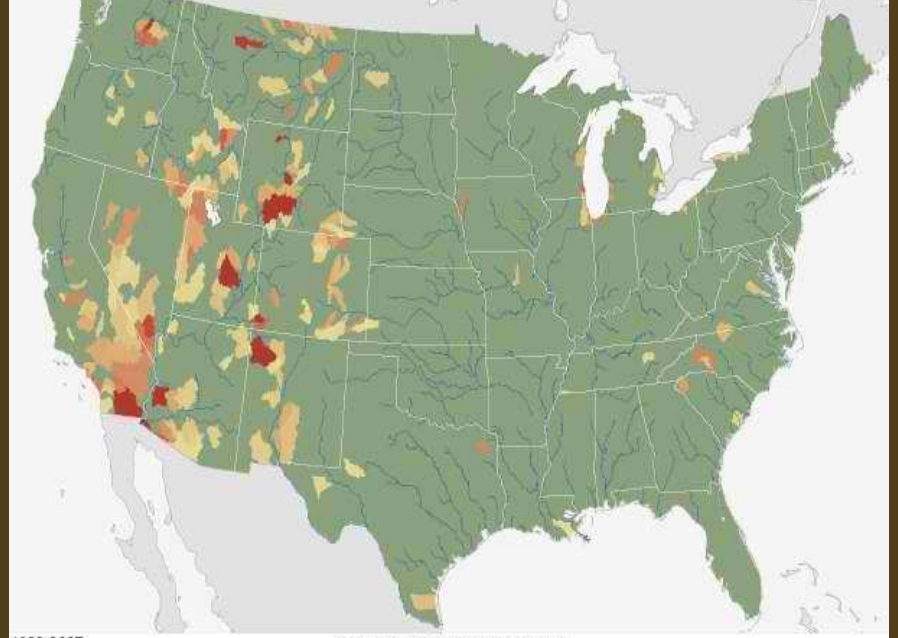
Today's agenda:

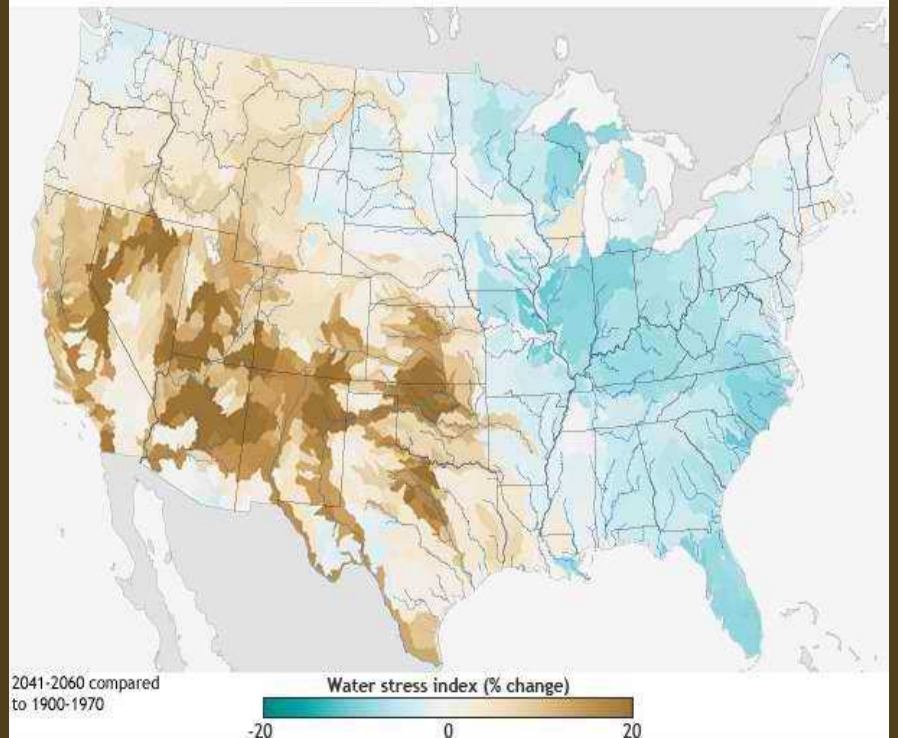
1. introduction: who we are
2. why irrigate with greywater?
3. offsetting existing irrigation v. new plantings
4. plant choices: context/basin/soils
5. greywater irrigation for various uses/surges
6. the end all: mulch basin 101
7. how to plant mulch basins
8. stormwater and mulch basins
9. plant health and drip
10. safety factors
11. case study: evergreen lodge
12. monitoring program
13. successes/lessons learned
14. questions

WHAT WE KNOW, HOW WE KNOW IT….

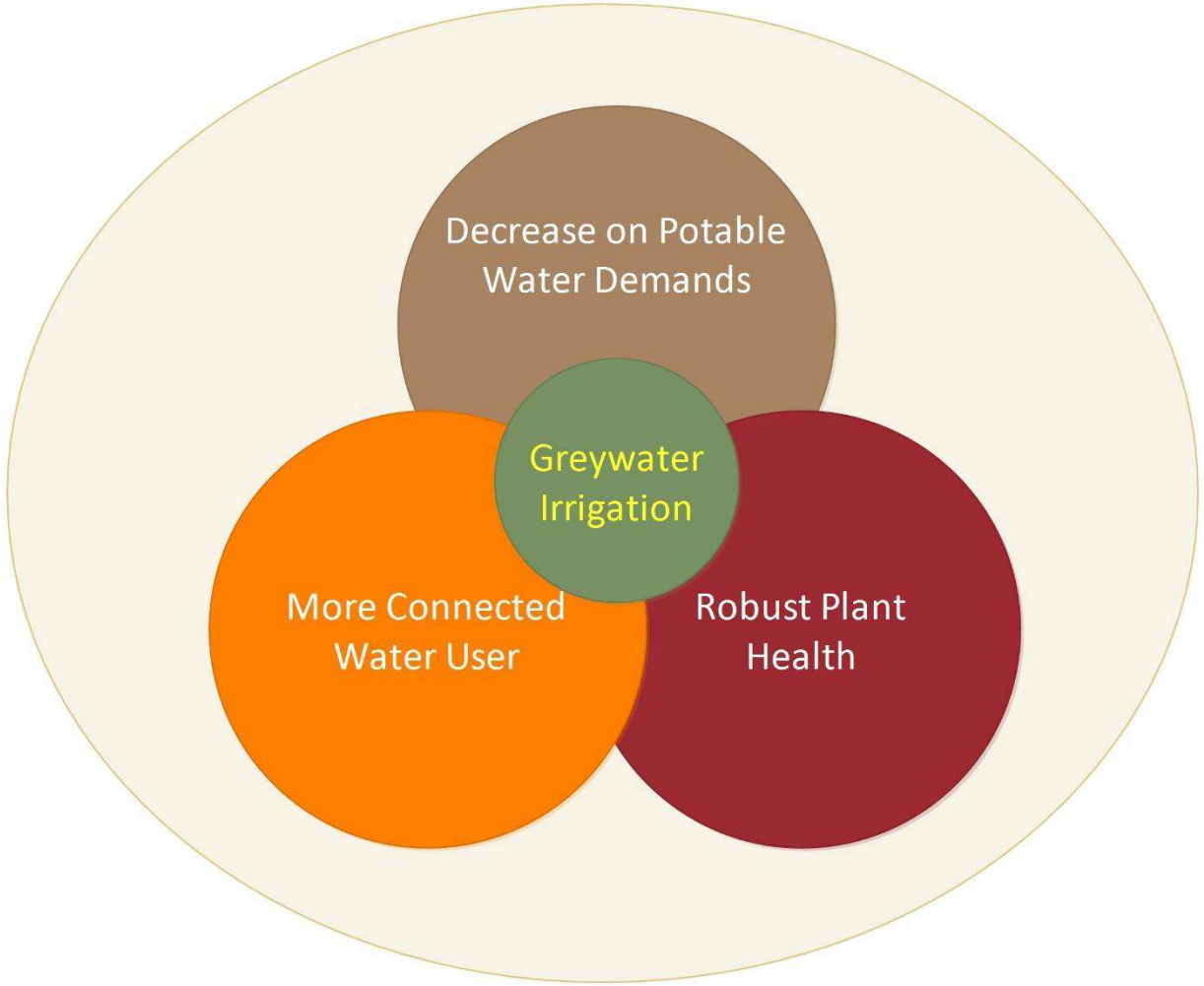


Groundwater Depletions in Central Valley, CA

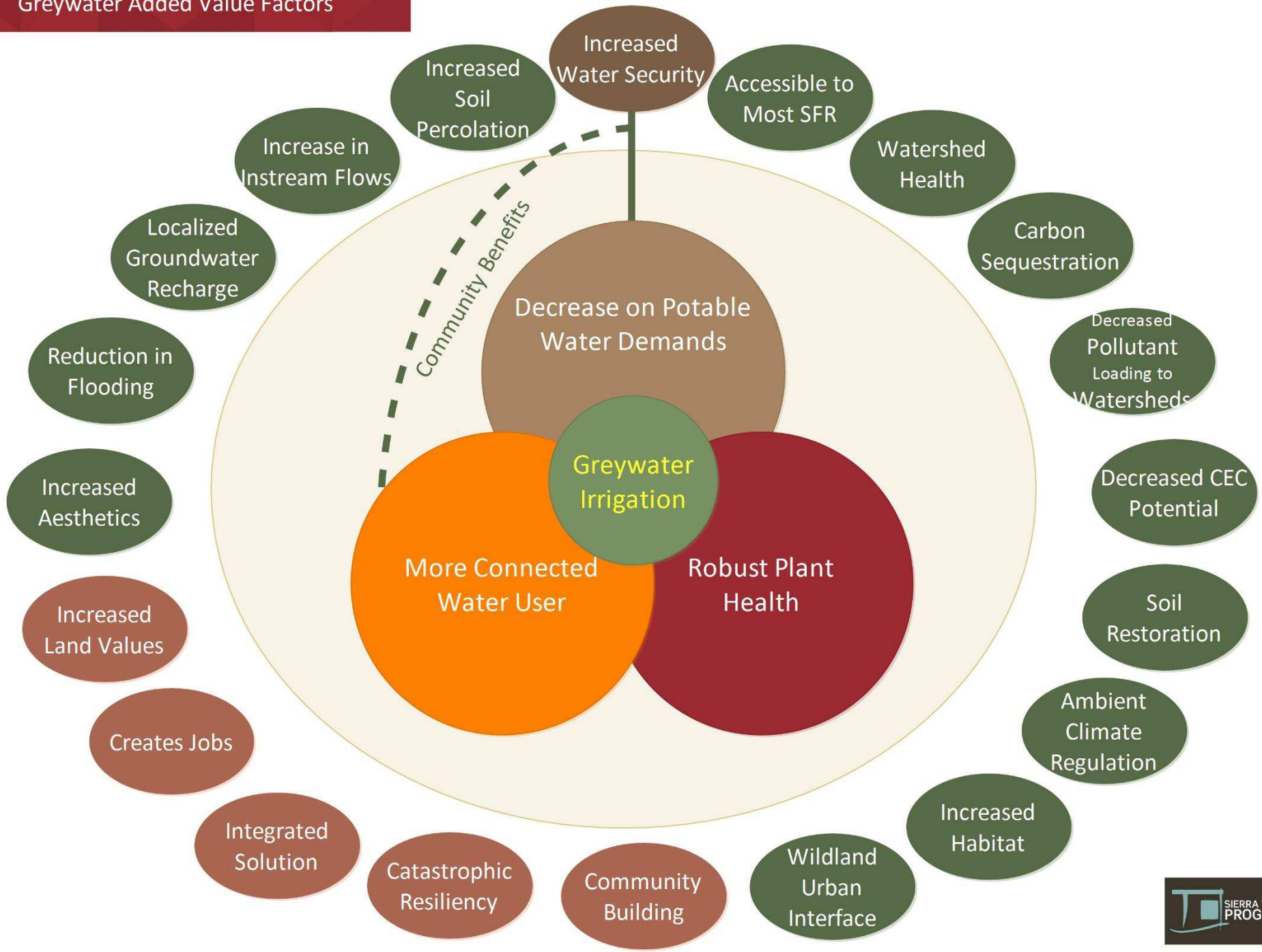

1999-2007
Water stress index (average)
<1
1
2
3
4
5
6


2041-2060 compared
to 1900-1970
Water stress index (% change)
-20
0
20

Greywater Added Value Factors



Greywater Added Value Factors



SIERRA WATERSHED PROGRESSIVE

CHOOSING WHAT TO IRRIGATE

NEW Plantings

PROS

Can develop root systems based on greywater surge patterns

May embellish current plantings with more fruit or shade

CONS

Doesn't decrease water budget with just greywater treatment

EXISTING Plantings

PROS

Water savings increases (especially if one entire zone of irrigation is turned off)

Usually increases plant productivity rates

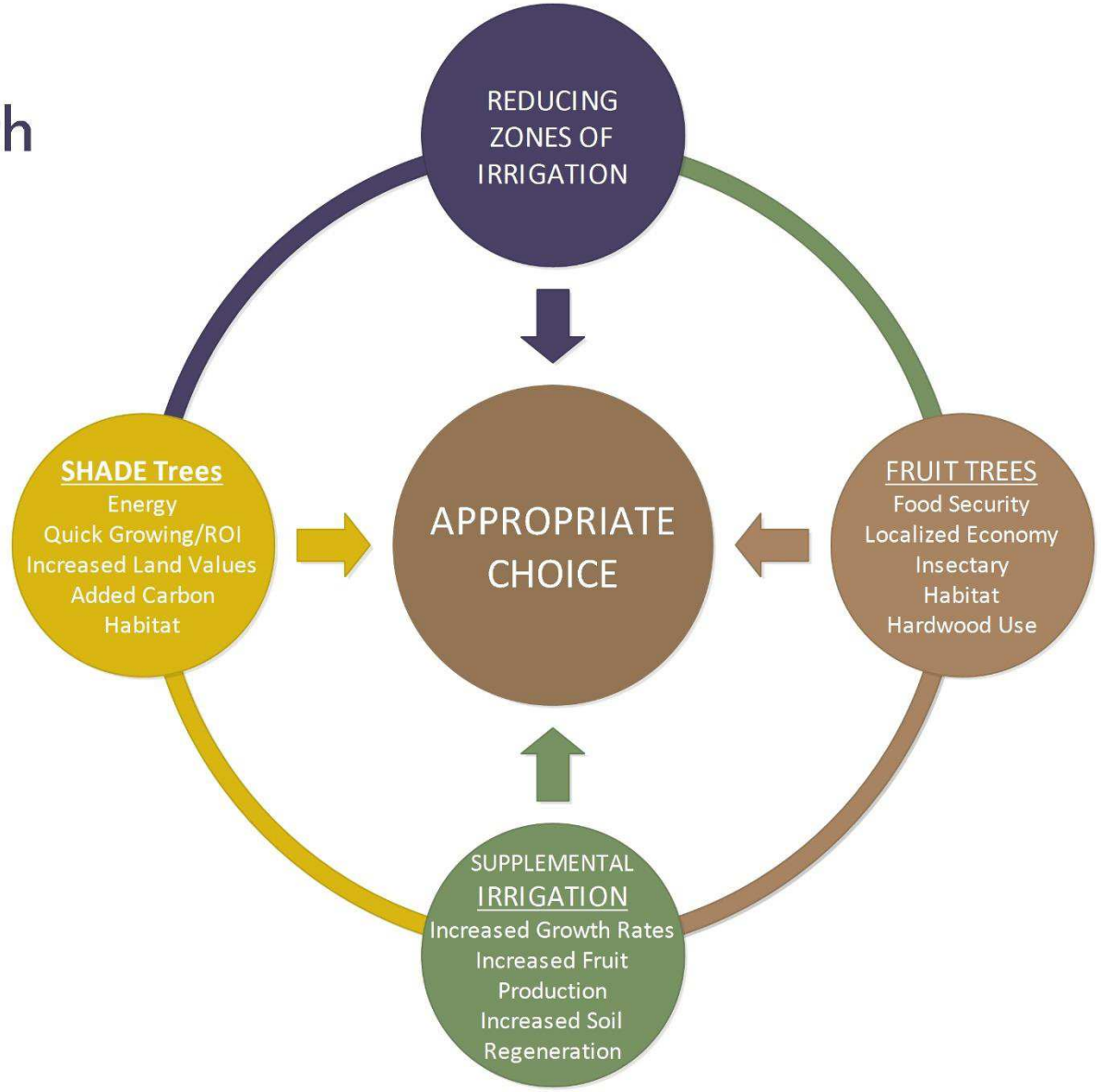
CONS

May 'prune' sensitive existing roots with surge patterns

May change take longer for existing trees to readjust

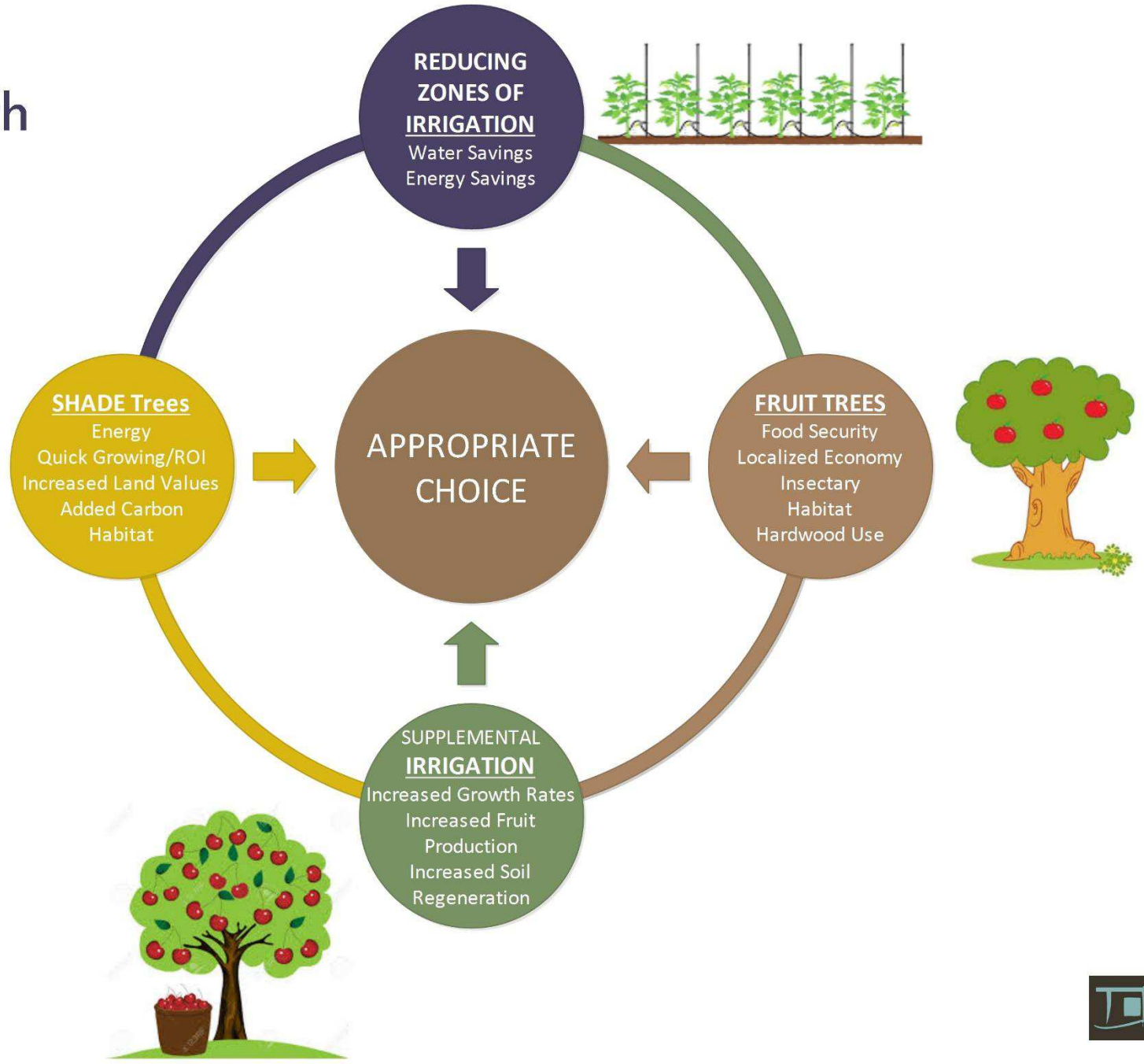
SIERRA WATERSHED PROGRESSIVE

decision factors with EXISTING Plantings



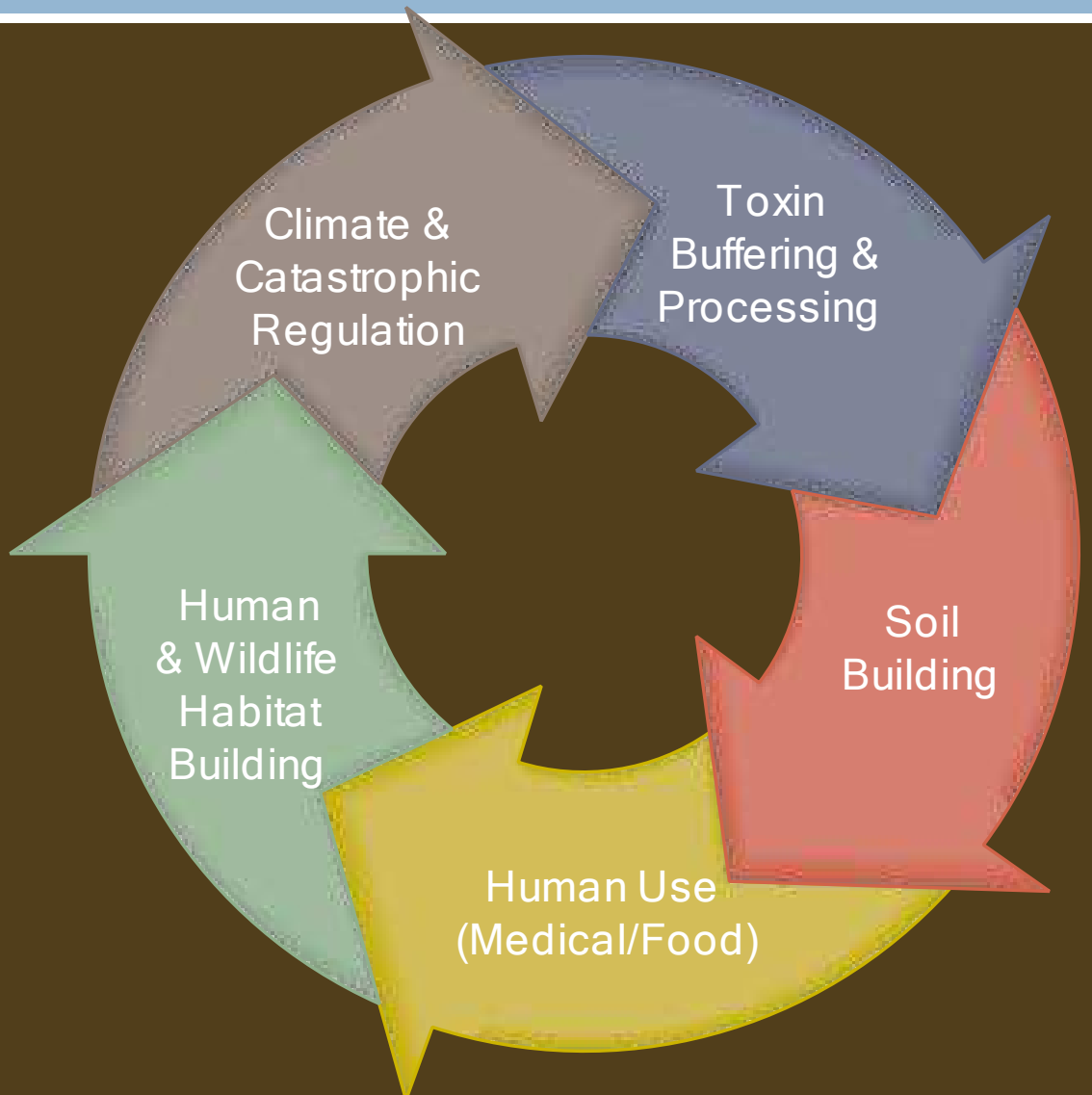
SIERRA WATERSHED PROGRESSIVE

decision factors with EXISTING Plantings



SIERRA WATERSHED PROGRESSIVE

Plant Choices by Functions



WILD URBAN INTERFACE:

A **wildland–urban interface** refers to the zone of transition between unoccupied land and human development. Communities that are within 0.5 miles (0.80 km) of the zone may also be included. These lands and communities adjacent to and surrounded by wildlands are at risk of wildfires.

Greywater Plant Favorites: Wildland Urban Interface

Common		Conditions	Water	Notables	Uses
Western Ninebark	*Physocarpus capetatus*	Variable sun and water	Low to medium	Understory fill, fall color	Dense screen, habitat, insectary, songbird habitat and food source, companion to Acer sp., Alnus.
Wild Ginger	*Asarum caudatum*	Dry to moist shade	Low to medium	Ground-cover	Evergreen groundcover, slope stabilizing, habitat, insectary
Quaking Aspen*	*Populus tremuloides*	Variable pH	Medium to high	Plumbing friend roots	Colony forming, fire retardant, tonal element, habitat, slope stabilizing, insectary, songbird nesting
Big Leaf Maple	*Acer macrophyllum*	Sun to shade	Medium to high	Fast grower, fall color	Year round photosynthesis, fire retardant, habit, cover, adds carbon, protects soils
Vine Maple	*Acer circinatum*	Sun to shade	Low to high	Vine like, fall color	Variable habit, hard Woodstock, adds carbon to soils
Thimbleberry	*Rubus parviflorus*	Dry to wet shade	Low to high	Runner	Edible, habitat, cover, adds carbon to soil, stabilizes soils
Spice Bush	*Calycanthus occidentalis*	Variable sun, water, pH	Low to high	Fast grower	Habitat, cover, incredible flower

* not long lived in USDA Climatic zones hotter than 7.

SIERRA WATERSHED PROGRESSIVE

Plant Choices: Variable Saturated Soils

"Sedges have edges,
Rushes are round,
Grasses have joints all the way to the ground."

SATURATED SOILS:

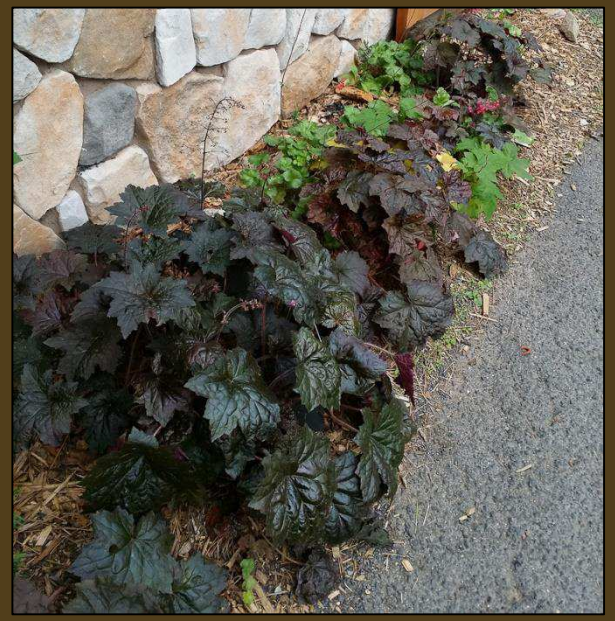
BATHTUBS SURGES
HURRICANE EVENTS
CLAY BASED
SMALL BASIN FOOTPRINT
STORMWATER RUN-ON
'Fog' BASED INPUTS

Greywater Plant Favorites: Saturated Soils

Common		Conditions	Water	Notables	Uses
Red Osier, Creek Dogwood	*Cornus sericea*	Variable sun and water	Medium to high	Understory year round interest	Dense screen, habitat, insectary, songbird and butterfly habitat, food source, companion to Acer sp., Corylus sp., Alnus sp., Rubus sp..
Sedge (native)	*Carex sp.*	Variable water,	Low to medium	Vernal adaptable if needed	Colony forming, slope stabilizing, songbird food/habitat, insectary, toxin and nutrient remediation.
Rushes *(not Equisteum sp.)*	*Juncus sp.*	Variable pH, soil structure.	Medium to high	Structural interest in landscape	Colony forming, fire retardant, tonal element, habitat, toxin and nutrient remediation, songbird food source.
Big Leaf Maple	*Acer macrophyllum*	Sun to shade	Medium to high	Fast grower, fall color	Year round photosynthesis, fire retardant, habit, cover, adds carbon, protects soils
Seep Monkeyflower	*Mimulus guttatus*	Sun to light shade	Low to high	Mat forming, vernal	Variable habitat, highly effective root-mat filtration, nectary, striking mass bloom
Pacific Crabapple	*Malus frusca*	Variable pH, full sun	Low to high	Slow grower to 40ft	Edible, habitat, cover, adds carbon to soil, stabilizes soils, hardy to freezes.
Red, White Alder	*Alnus rubra, rhombifolia*	Variable water, pH	Low to high	Fast grower to 120'	Habitat, coppice friendly, flood/drought tolerant, nitrogen fixer, short lived (50-80 years)

SIERRA WATERSHED PROGRESSIVE

Ground protectors (groundcovers):



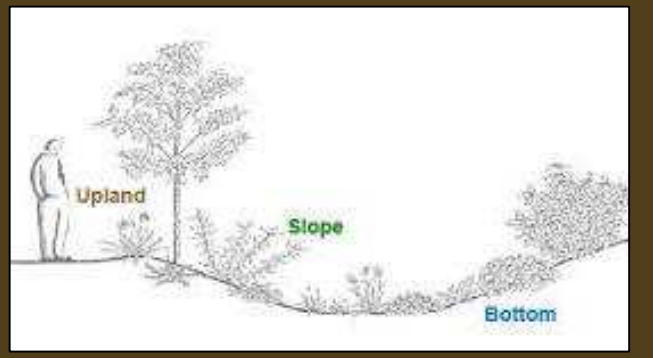
SOIL PROTECTIONS
SLOPE STABILIZING
ANIMAL HABITAT
COMPANION COOLING
NICHE PLANTINGS
RUNNING CONTROLLED BY DISPERSAL

Greywater Plant Favorites: ground covers

Common		Conditions	Water	Notables	Uses
Creeping Snowberry	*Sympho-carpus albus*	Variable sun and water	Low	Year round interest, white fruits	Interchangeable, habitat, insectary, songbird and butterfly habitat, fall color, can extend 6” from greywater input source
Sedge (native)	*Carex sp.*	Variable water,	Low to medium	Vernal adaptable if needed	Colony forming, slope stabilizing, songbird food/habitat, insectary, toxin and nutrient remediation.
California fescue	*Festuca californi-ca.*	Variable pH, soil structure.	Low to me-dium	Structural interest in landscape	Colony forming, tonal element, habitat, tox-in and nutrient remediation, multiple animal food source, drought tolerant.
Wild Ginger	*Asarum caudatum*	Dry to moist shade	Low to me-dium	Ground-cover	Evergreen groundcover, slope stabilizing, habitat, insectary
Seep Monkeyflower	*Mimulus guttatus*	Sun to light shade	Low to high	Mat form-ing, vernal	Variable habitat, highly effective root-mat filtration, nectary, striking mass bloom
Alumroot	*Huechra micrantha*	Variable pH, full sun	Low to high	Slow grow-er to 40ft	Edible, habitat, cover, adds carbon to soil, stabilizes soils, hardy to freezes.
Swamp Onion	*Allium validum.*	Variable water, pH	Low to high	Weed block	Insectary, flood/drought tolerant, nitrogen fixer, food source, butterfly habitat

SIERRA WATERSHED PROGRESSIVE

UPLAND/TOP TERRACE:



INSECTARIES
GUILD BUILDING
ANIMAL HABITAT
COMPANION COOLING
NICHE PLANTINGS
SIGNAL PLANTS
MEDICINAL PLANTS

Greywater Plant Favorites: upland shelf (fill ins)

Common		Conditions	Water	Notables	Uses
Golden current (and Ribes sp.)	*Ribes aureum*	Variable sun, soil, water	Low to medium	Edible fruits	Interchangeable, habitat, songbird and butterfly habitat, fall color, edible, medicinal, try w/ Spirea sp., Calycanthus, Mahonia sp.
Sages	*Salvia sp..*	Variable water, like to dry out	Low to medium	In clay soils plant 12" from inlet	Colony forming, slope stabilizing, songbird food/habitat, insectary, butterfly habitat, medicinal, cultural uses.
Tundra Rose	*Diasiphora fruiticans floribunda*	Variable pH, soil structure	Low to medium	Breaks up clay soils	Butterfly favorite, long bloom, habitat, frost hardy, low maintenance, drought tolerant to regular irrigation friendly.
Lambs Ears	*Stachys byzantina*	Dry to moist sun	Low to medium	Moon plant	Slope stabilizing, habitat, insectary, medicinal, moon garden, sensory texture plant
California Fuschia	*Epilobium cannum*	Sun to light shade	Low	Mat forming	Variable habitat, hummingbird favorite nectary, striking mass bloom in fall, poor soils
Penstamen sp.	*Penstamen sp.*	Variable pH, full sun	Low	Hummingbird attact	Hummingbird favorite, long bloomer, guilds to California buckwheats/fuschia
California buckwheat	*Eriogonium fasiculatum.*	Variable soil type	Low to high	Mass blooms	Insectary, drought tolerant, strong slope stabilizer, nitrogen fixer, abundant food source, butterfly and songbird habita

SIERRA WATERSHED PROGRESSIVE

Designing Greywater Irrigation

SIERRA WATERSHED PROGRESSIVE

Calculating Real Water

DORM	Student	Expected** Wastewater (g/w)	Weeks In Use	Expected** Wastewater (g/y)
Dorm A	30	1,620	45	72,900
Dorm B	32	1,728	45	77,760
Dorm C	34	1,836	45	82,620
Dorm D	35	1,890	45	85,050
Dorm E	47	2,538	45	114,210
Dorm F	20	1,080	45	48,600
Dorm G	35	1,890	45	85,050
TOTALS	**233**	**12,582**		**566,190**

Calculating Real Water

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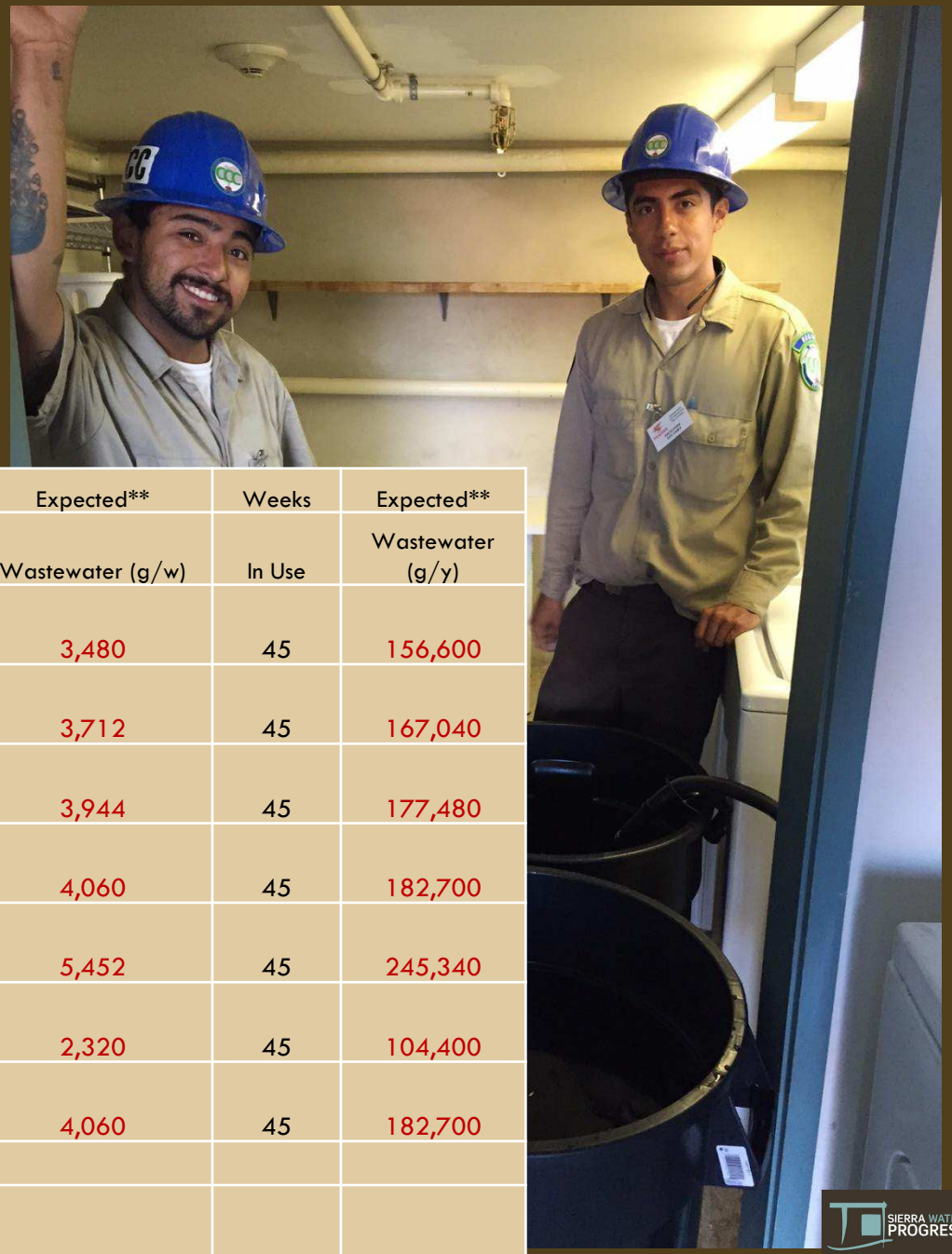
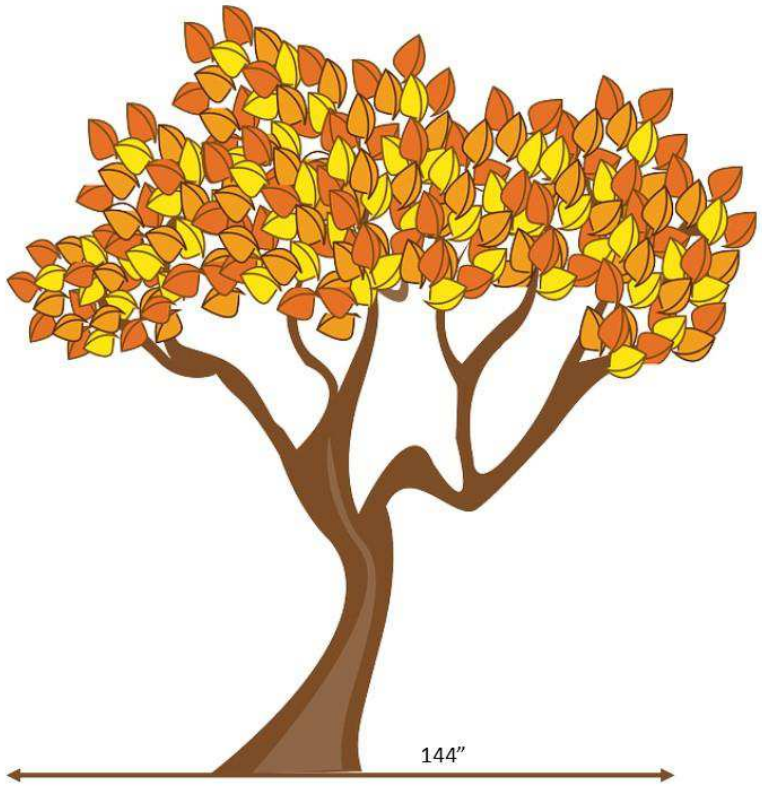
TOTALS	**233**	**12,582**		**566,190**

DORM	Student	Expected** Wastewater (g/w)	Weeks In Use	Expected** Wastewater (g/y)
Dorm A	30	3,480	45	156,600
Dorm B	32	3,712	45	167,040
Dorm C	34	3,944	45	177,480
Dorm D	35	4,060	45	182,700
Dorm E	47	5,452	45	245,340
Dorm F	20	2,320	45	104,400
Dorm G	35	4,060	45	182,700
TOTALS	**233**	**27,028**		**1,216,260**



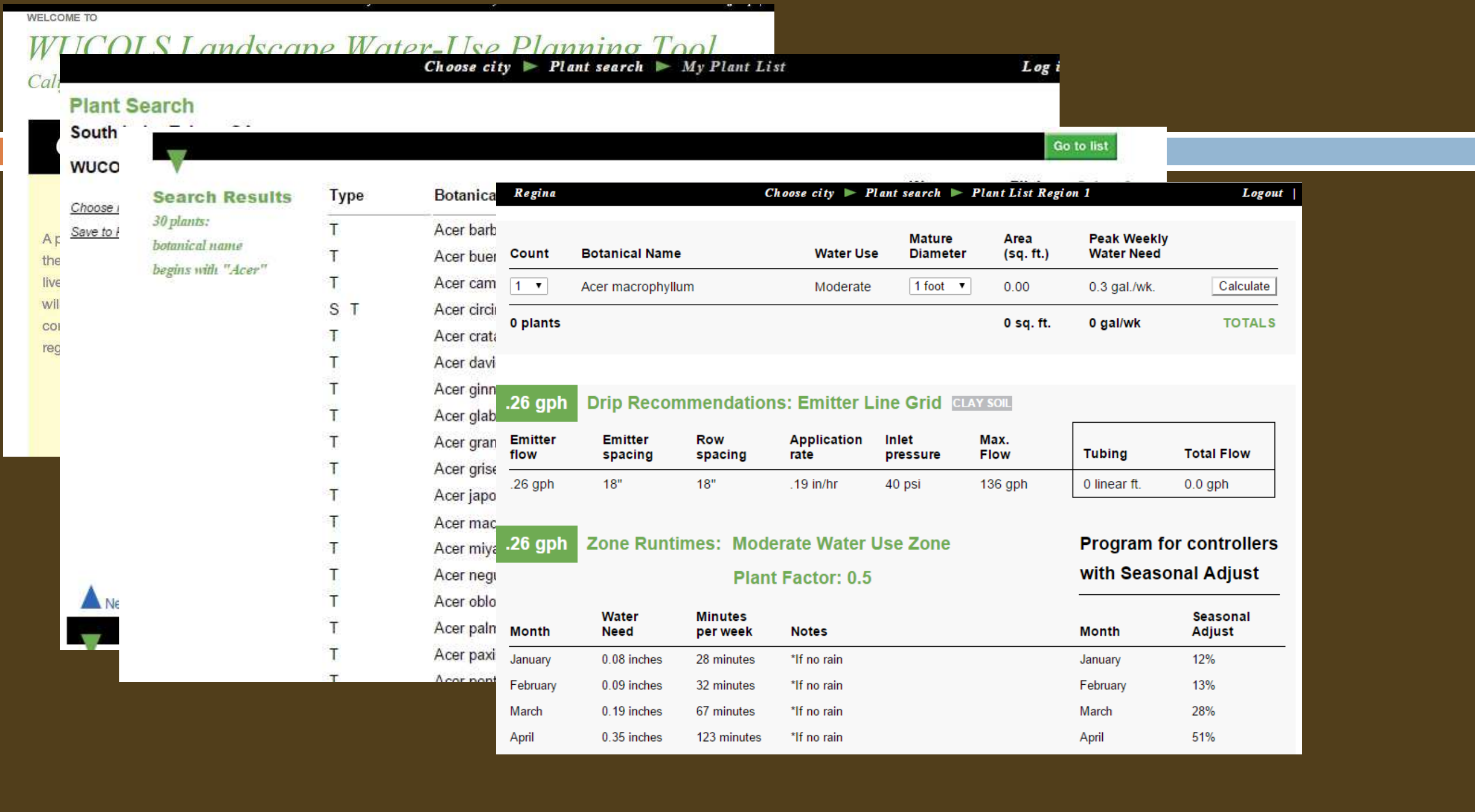
How to Calculate Water Need:



Diameter of Canopy (inches) x .623 x Inches per week plant need=

144” x .623 x 1.5”=134 g/w

SIERRA WATERSHED PROGRESSIVE


WELCOME TO
WUCOLS Landscape Water-Use Planning Tool
Choose city ► Plant search ► My Plant List
Log i
Plant Search
South
WUCO
Choose
Save to
Go to list
Search Results
30 plants:
botanical name
begins with "Acer"
Type
Botanica
T Acer barb
T Acer buer
T Acer cam
S T Acer circi
T Acer crata
T Acer davi
T Acer ginn
T Acer glab
T Acer gran
T Acer grise
T Acer japo
T Acer mac
T Acer miya
T Acer negu
T Acer oblo
T Acer paln
T Acer paxi
Regina
Choose city ► Plant search ► Plant List Region 1
Logout |
Count
Botanical Name
Water Use
Mature Diameter
Area (sq. ft.)
Peak Weekly Water Need
1
Acer macrophyllum
Moderate
1 foot
0.00
0.3 gal./wk.
Calculate
0 plants
0 sq. ft.
0 gal/wk
TOTALS
.26 gph
Drip Recommendations: Emitter Line Grid
CLAY SOIL
Emitter flow
Emitter spacing
Row spacing
Application rate
Inlet pressure
Max. Flow
Tubing
Total Flow
.26 gph
0 linear ft.
0.0 gph
.26 gph
Zone Runtimes: Moderate Water Use Zone
Plant Factor: 0.5
Program for controllers with Seasonal Adjust
Month
Water Need
Minutes per week
Notes
Month
Seasonal Adjust
January 0.08 inches 28 minutes *If no rain January 12%
February 0.09 inches 32 minutes *If no rain February 13%
March 0.19 inches 67 minutes *If no rain March 28%
April 0.35 inches 123 minutes *If no rain April 51%

Dispersal

Basics

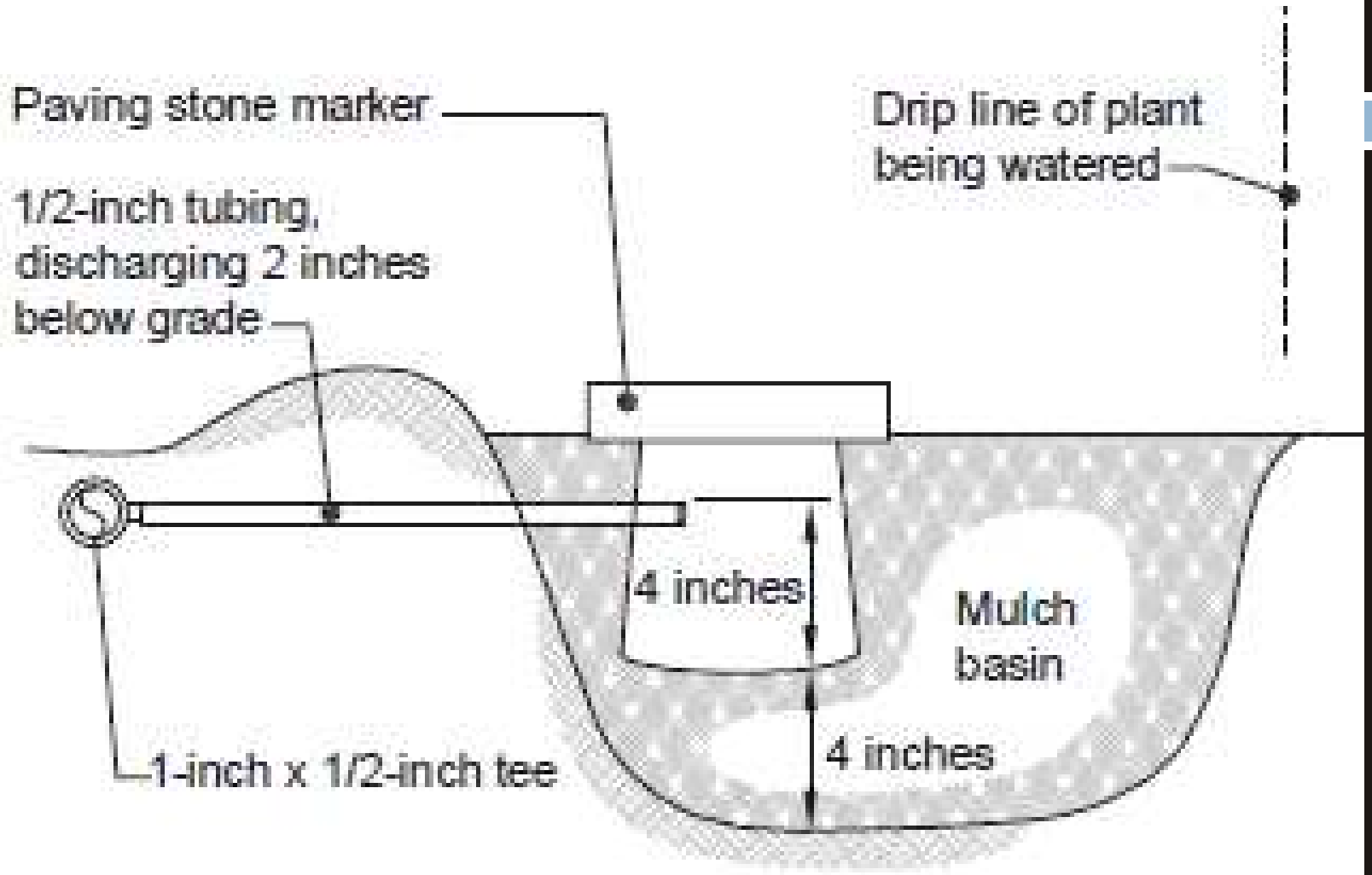


Figure 4. Mulch shield placement.

Drip Irrigation

MULCH POCKET
(greywater drip)

Mulch filter

Airgap

Increased root zone

Decreased cloggage

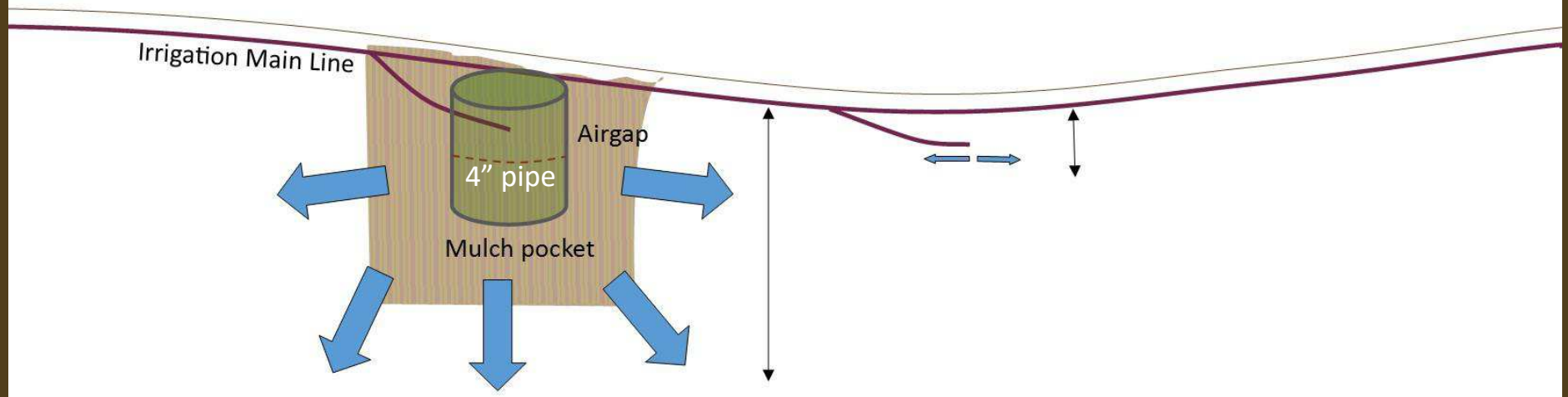
MULCH COVER ONLY
(greywater drip)

No mulch filter

No airgap

Decreased root zone

Increased cloggage



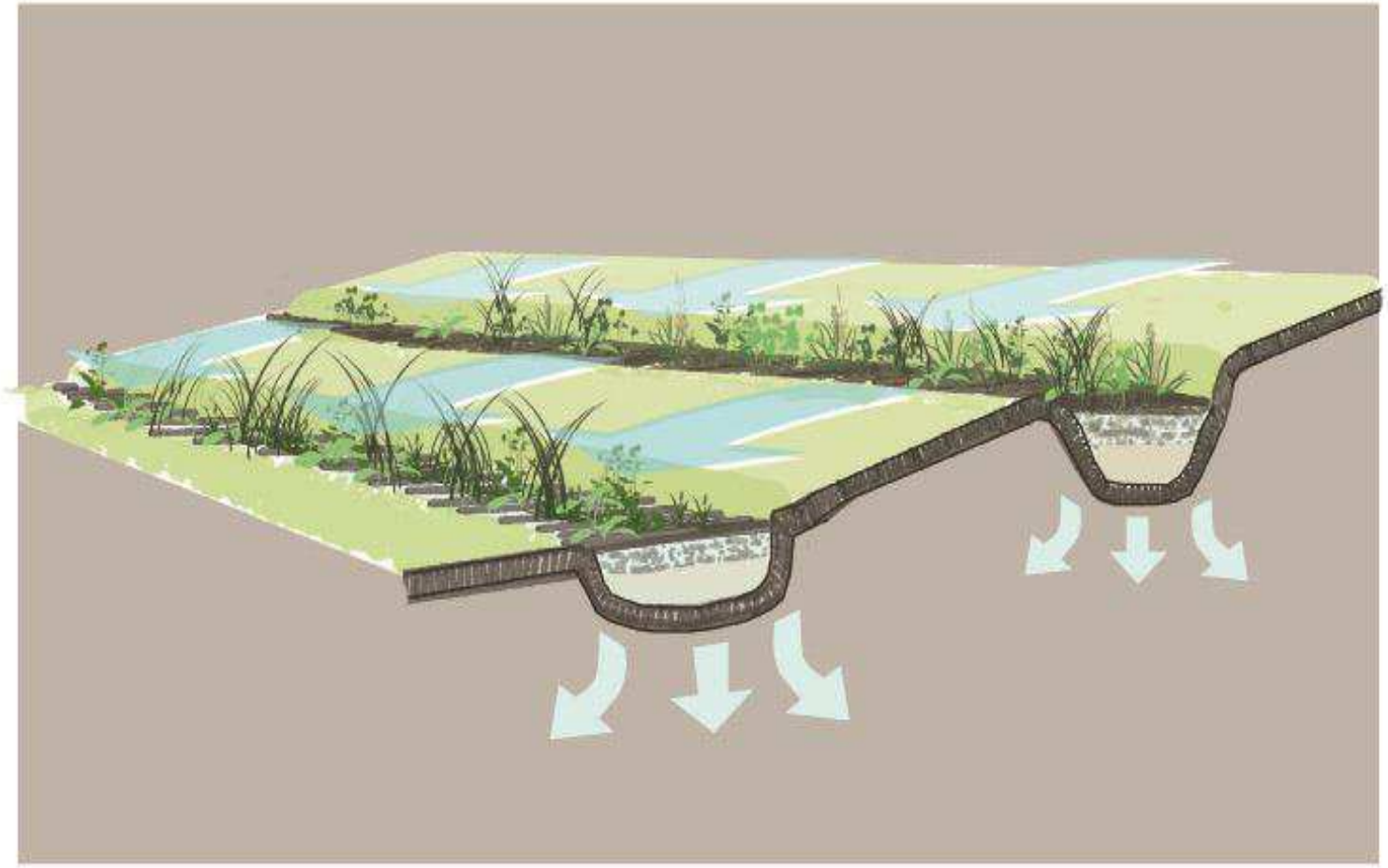
Making the best decisions for successful and resilient plant growth

SIERRA WATERSHED PROGRESSIVE

WHILE YOU ARE AT:

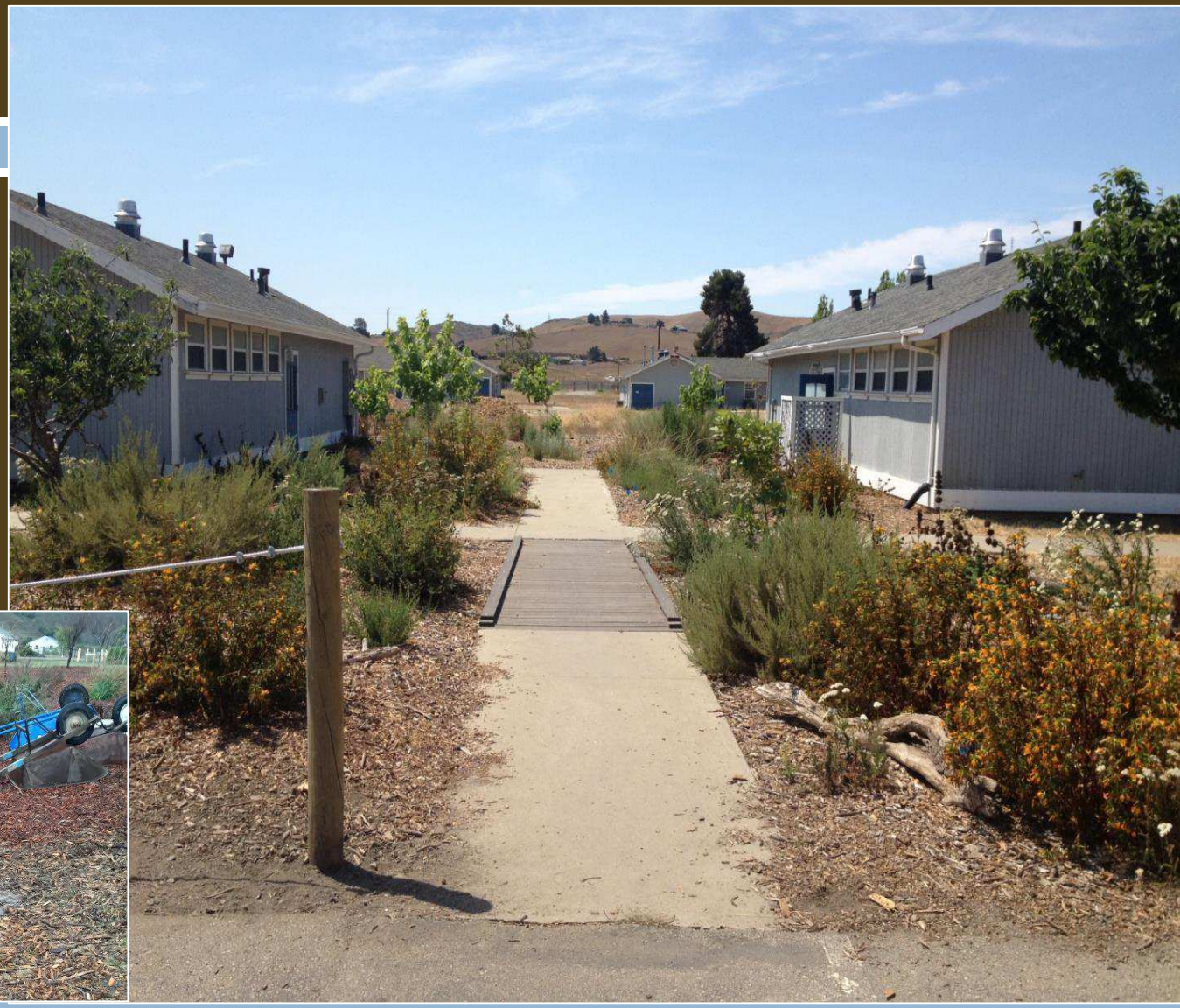
SIERRA WATERSHED PROGRESSIVE

ON-CONTOUR BIOSWALE



SIERRA WATERSHED PROGRESSIVE

8” ONE YEAR LATER



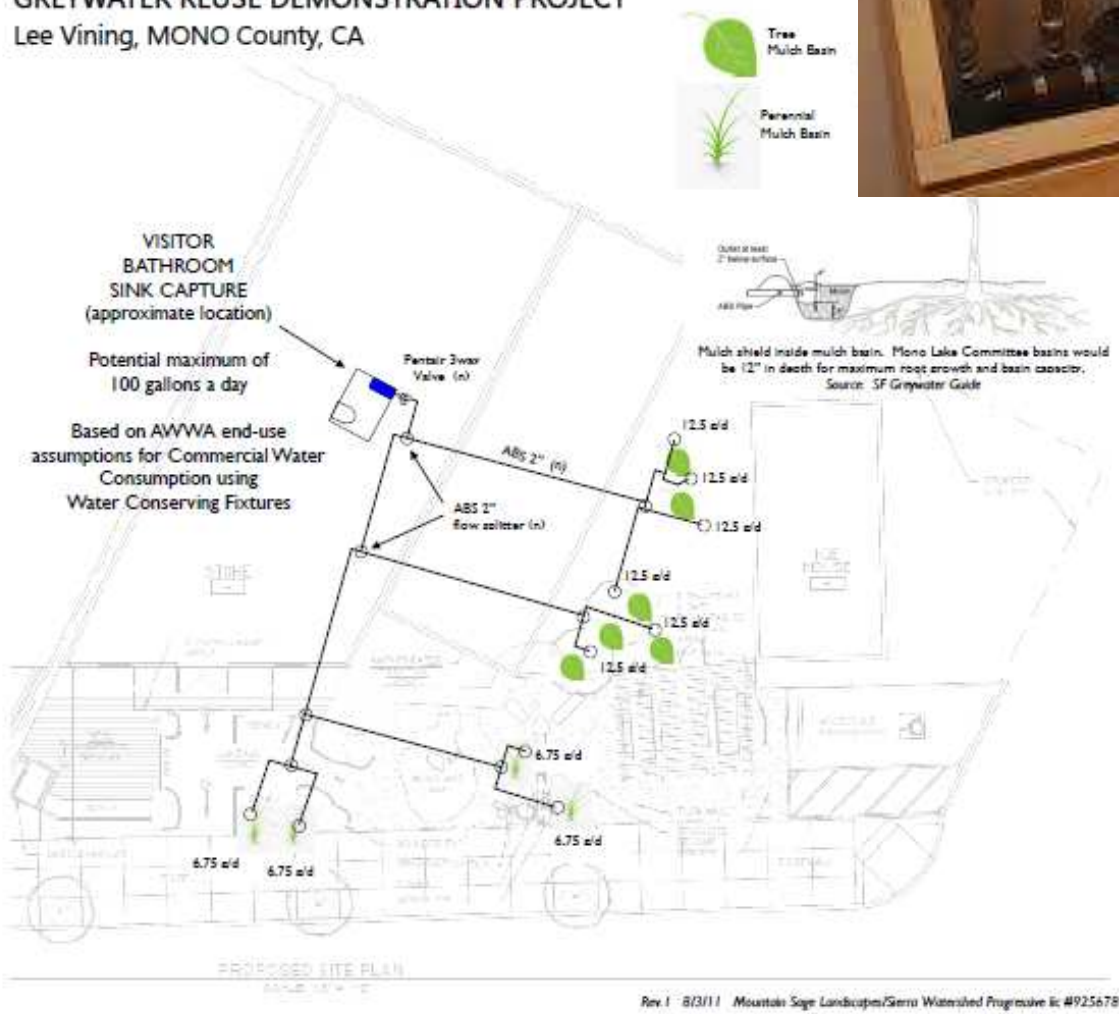
Site Case Study: National Guard, Camp SLO

SIERRA WATERSHED PROGRESSIVE

PLAN BASICS:

1. Soils
2. Percolation
3. Setbacks
4. Estimated Water g/d
5. Estimated Water g/w
6. Flow Pattern
7. Plant need (g/d and g/w)
8. Stormwater run-on and runoff
9. User patterns
10. Intended occupancy type
11. Basin sizing
12. Construction notes

MONO LAKE COMMITTEE
GREYWATER REUSE DEMONSTRATION PROJECT
Lee Vining, MONO County, CA



1. All greywater dispersal to be 2 feet from building, with 1 foot clearance to hardscape to prevent pooling.
2. ABS flow splitters to be housed in valve boxes for educational purposes.
3. Gate valves to be 'non-restricted openings', or 'full port'
4. All greywater lines prior to surge mulch pits will be vented, with overflow directed outside building
5. All plumbing will be appropriately labeled "GREYWATER, non-potable" every 4 feet
6. Trenches will be covered during end of work day, and crossing boards laid every 4 ft during work day. Trenches to be not quick, filled in and set properly
7. All above ground pipes to be protected from human/animal traffic impacts
8. All devices will be ANSI/NSF approved
9. All devices to be accompanied with reference and maintenance instructions as listed in maintenance contract
10. All plumbing to be 2.5' underground and taped for easy monitoring and identification
11. All bulkhead fittings to be insulated and properly set for expansion
12. All above ground plumbing sch 80 insulated PVC, all ABS to be subsurface with cleanouts every 10 feet
13. All ABS portholes in stubwalls to be caulked and fitted with flashing.
14. Three way valve to be available for public view and accessible, yet locked into place for healthy and safety reasons.
15. Three way valve and greywater plumbing to be sited under sink counter for education purposes, with accompanying prominent signage, and directing to further information at the MLC visitor help desk.
16. As listed in the Maintenance and Monitoring Manual, system will return to septic during times of soil saturation, such as winter or unforeseen events.

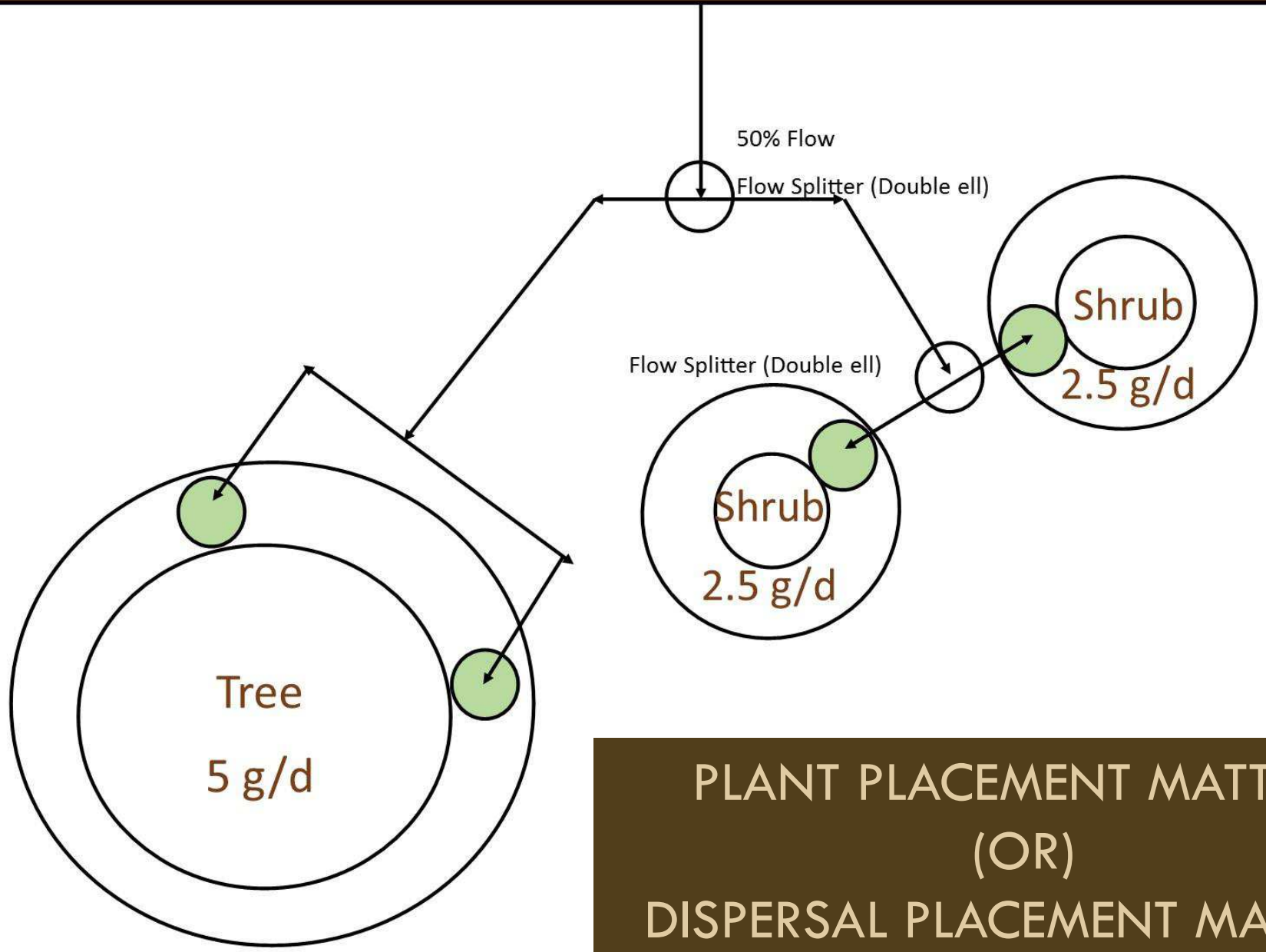
Rev 1 8/3/11 Mountain Sage Landscapes/Sierra Watershed Progressive lic #925678

This project designed and installed by:

SIERRA WATERSHED PROGRESSIVE
18653 Main Street
Groveland, CA 95321
209.732.1800
info@sierrawatershedprogressive.com
www.sierrawatershedprogressive.com
License # 925678

MONO LAKE COMMITTEE

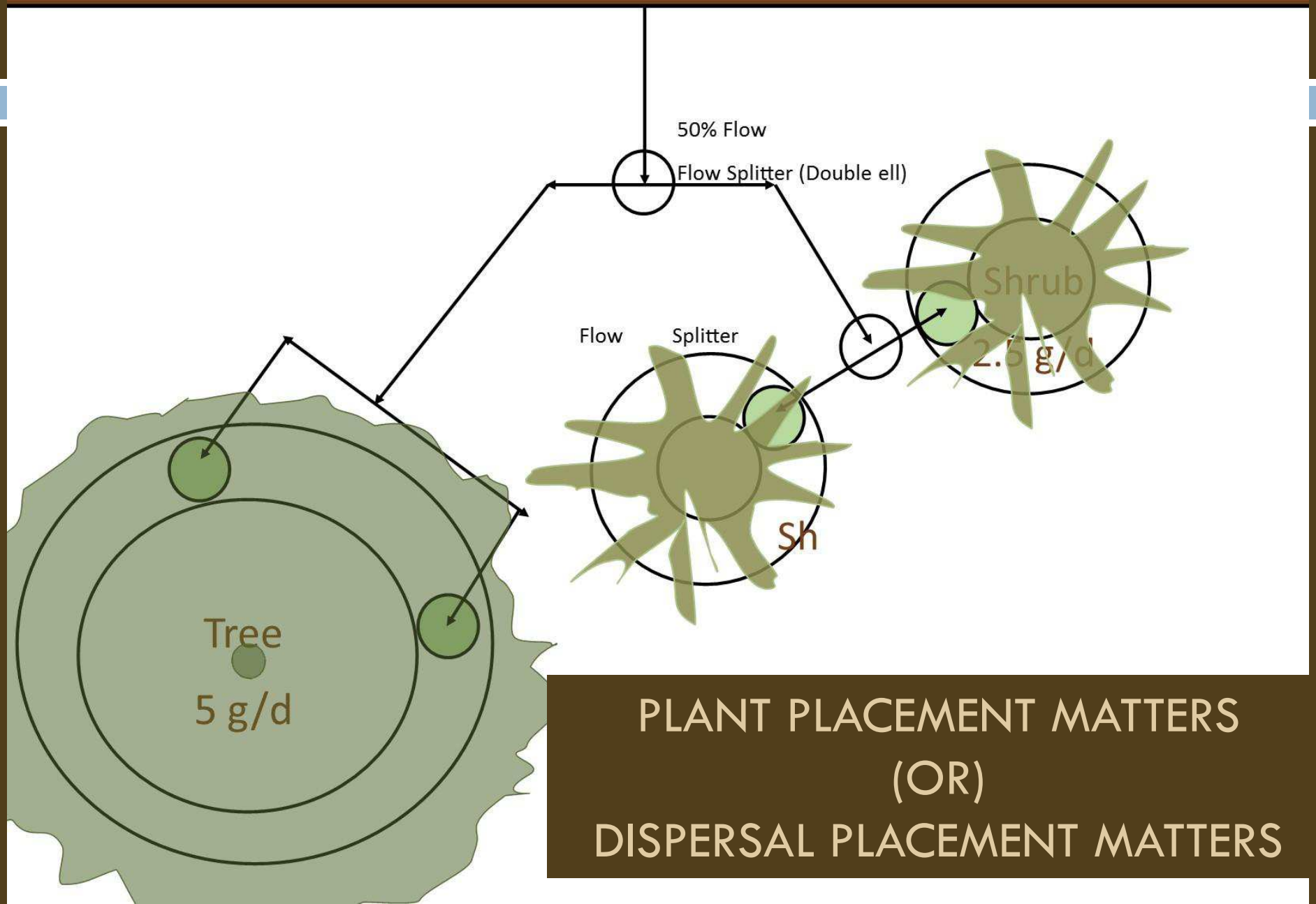
10 g/d Flow



PLANT PLACEMENT MATTERS
(OR)
DISPERSAL PLACEMENT MATTERS

SIERRA WATERSHED PROGRESSIVE

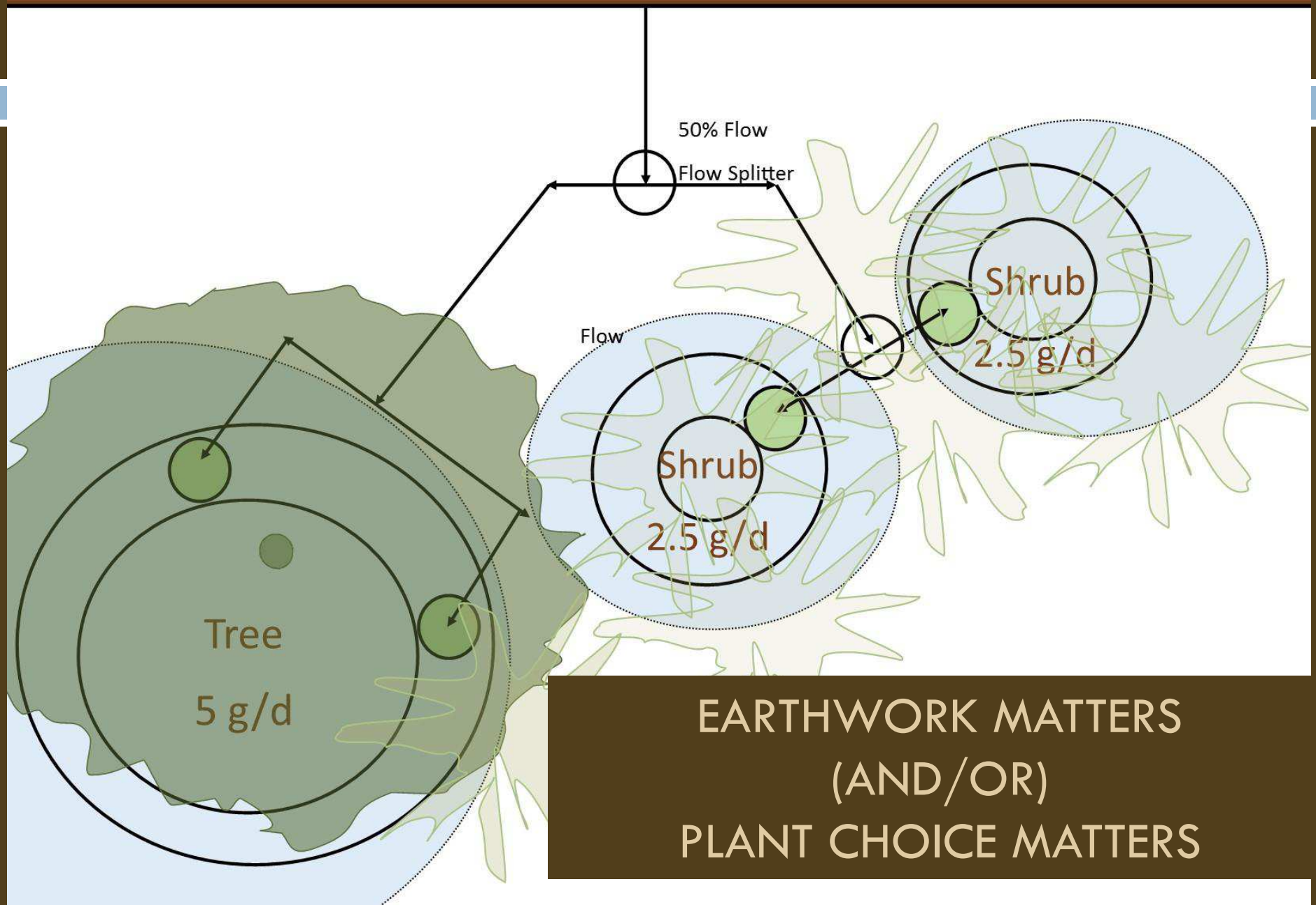
10 g/d Flow



PLANT PLACEMENT MATTERS
(OR)
DISPERSAL PLACEMENT MATTERS

SIERRA WATERSHED PROGRESSIVE

10 g/d Flow

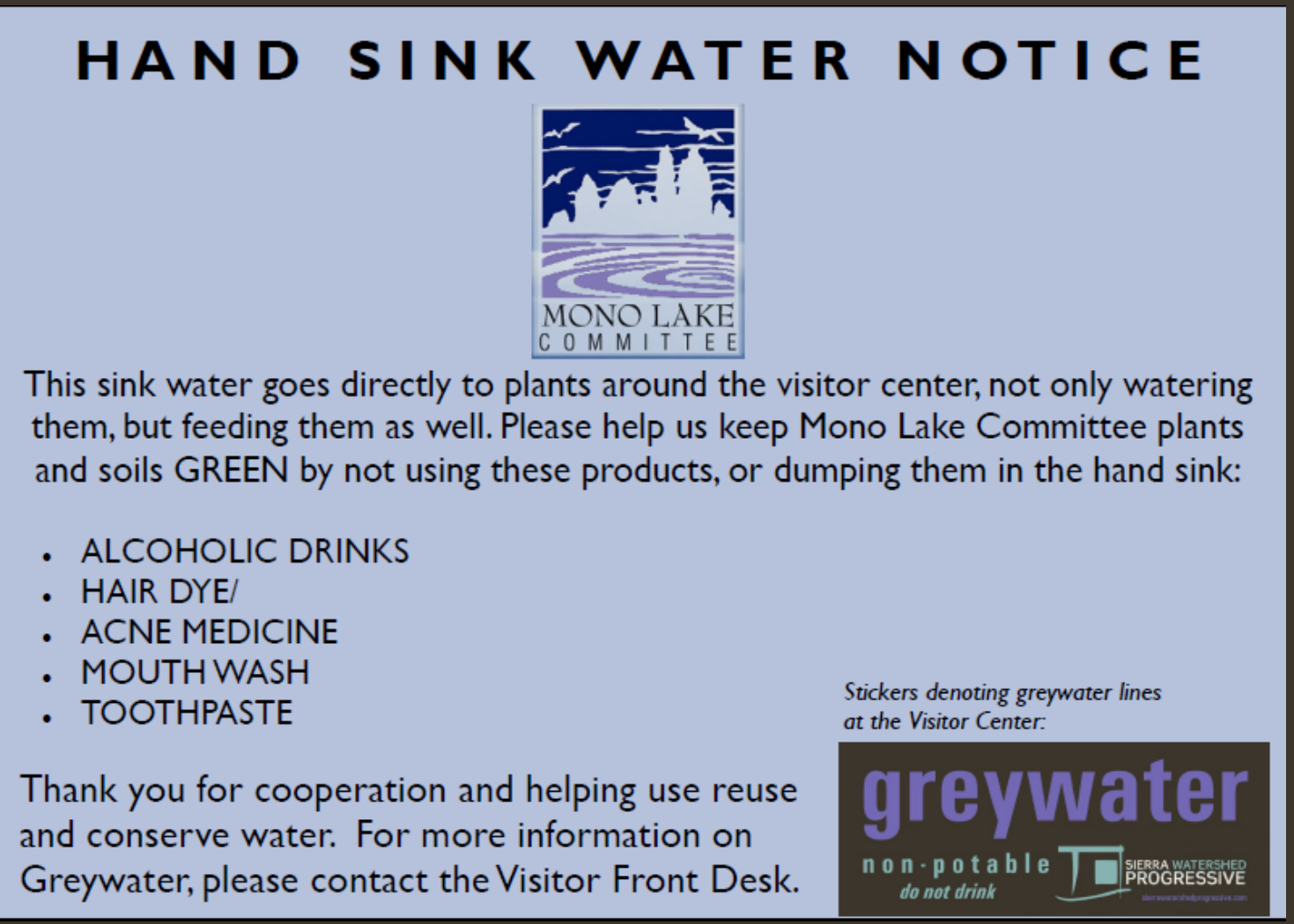


EARTHWORK MATTERS
(AND/OR)
PLANT CHOICE MATTERS

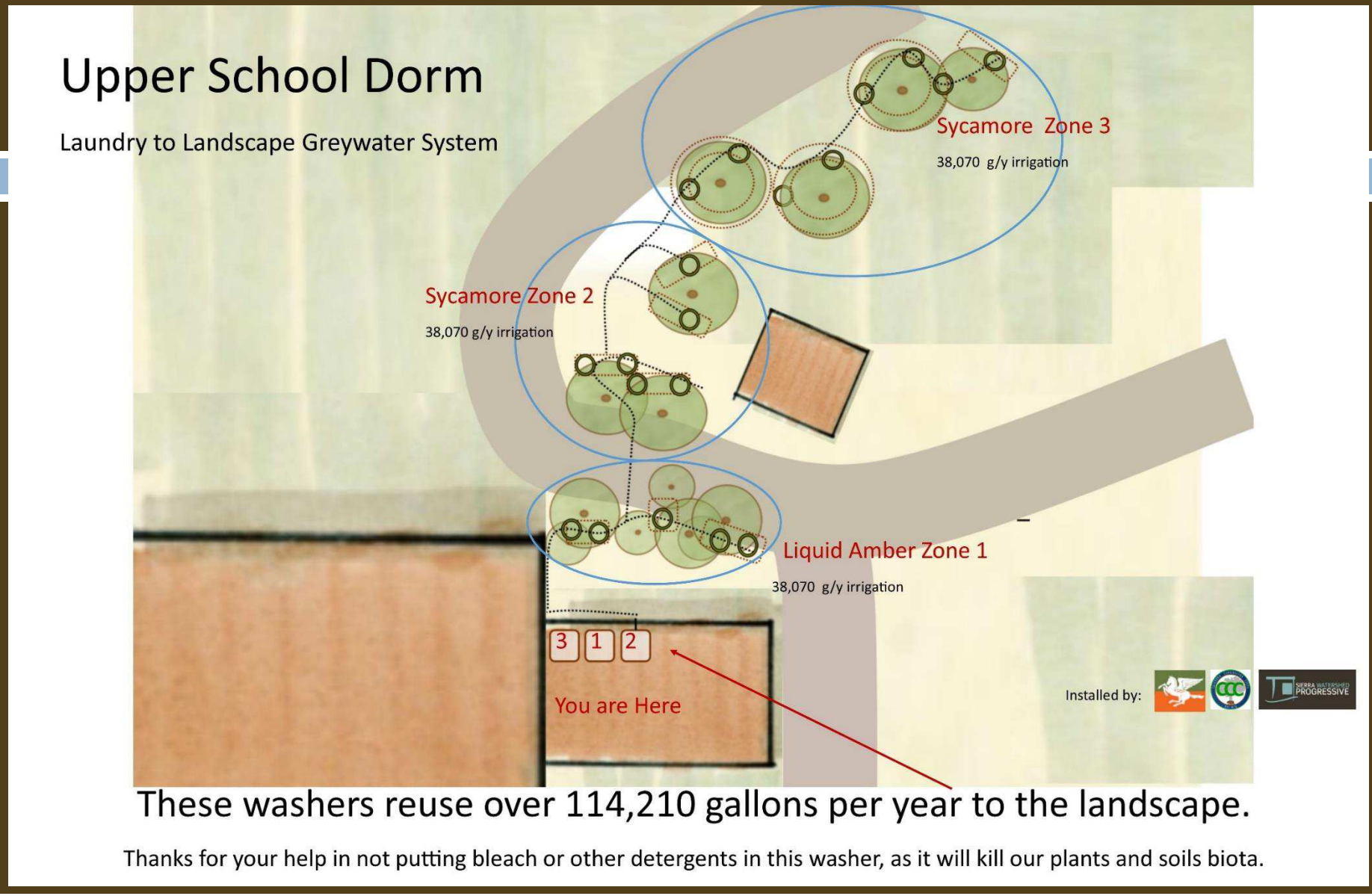
SIERRA WATERSHED PROGRESSIVE

Safety Factors

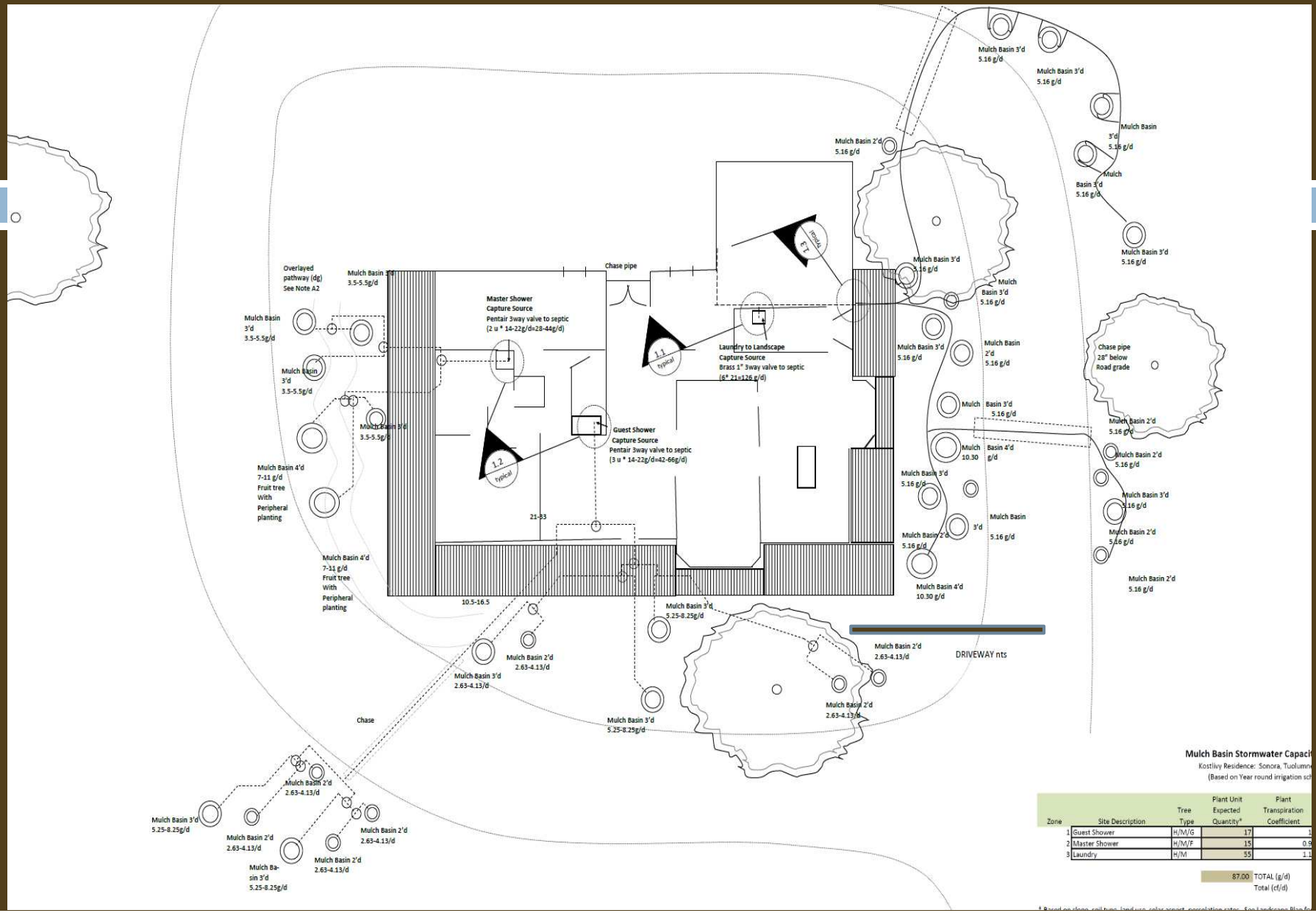
Safety Factors



- Mulch, where possible
- Setbacks
- Incidental Uptake
- Plant Choice
- Management Inputs/Control
- Maintenance/Offline Considerations
- Zones of Rest (Saltification Considerations)
- Redundancy
- KISS Trench
- Stormwater Considerations



SAFETY FACTOR: PLANT TYPE

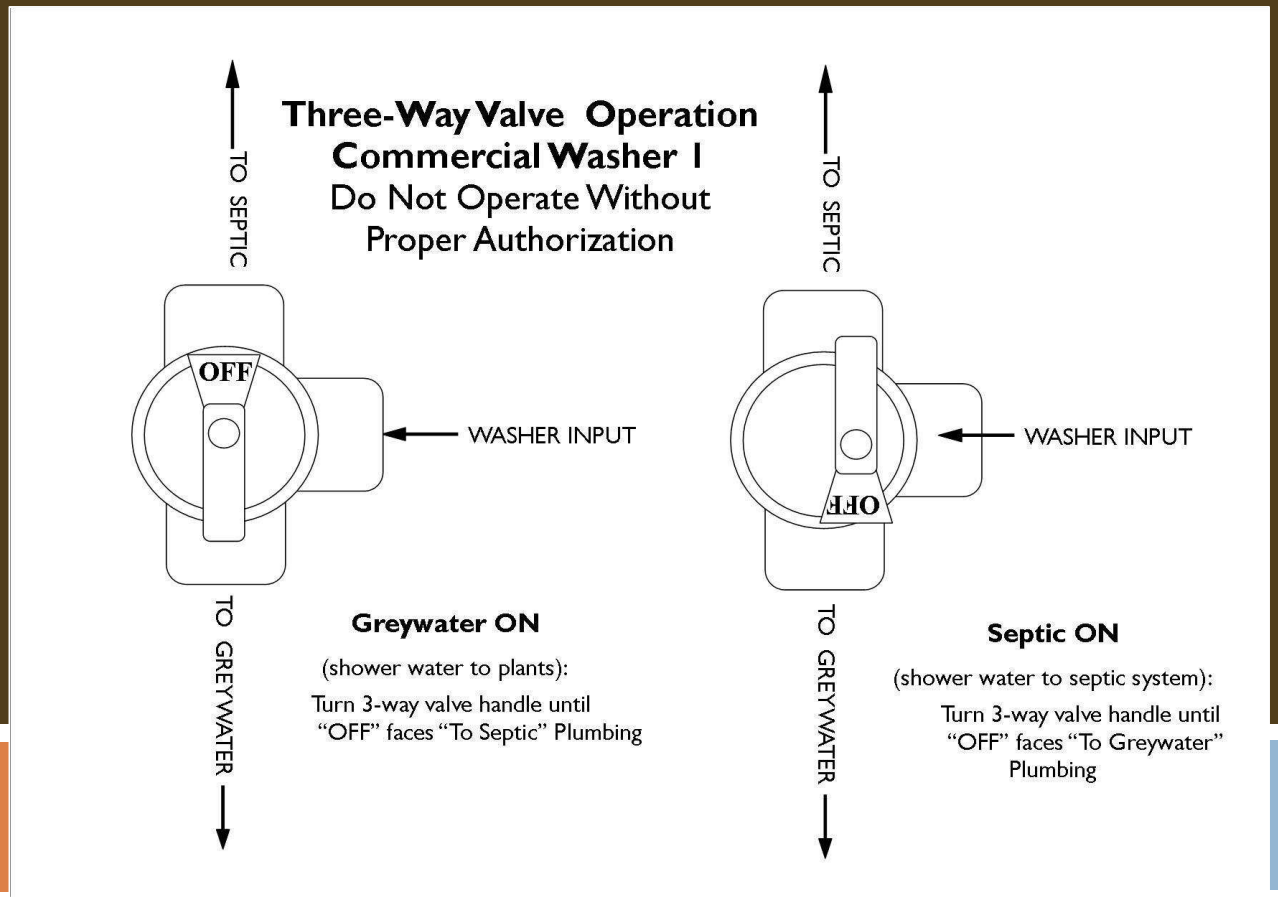


SAFETY FACTOR: SURGE TYPE/FUTURE USER

SIERRA WATERSHED PROGRESSIVE

SIGNAGE (REGULATE INPUTS)

1. At Three-way Valve Mounting
2. User Manual



Please only use these liquid detergents (NO POWDER):

VASKA
BIOPAC
ECOS
OASIS
SHAKLEY

By using sending greywater to our plants from THESE 2 washers
we are reusing approximately 68,000 gallons of water!

COMMON IRRIGATION PITFALLS

1. User dependent, user site needs
2. Storage/filtration
3. Improper mulch basin
4. Improper soil analysis
5. Improper plant choice/placement
6. Designed for immature plants instead of mature sizes
7. Resource toolkit not used, and more energy is spent

Importance Of Mulch

A WORD ON MULCH

STOP, BE LAZY:

Leave mulch, add mulch

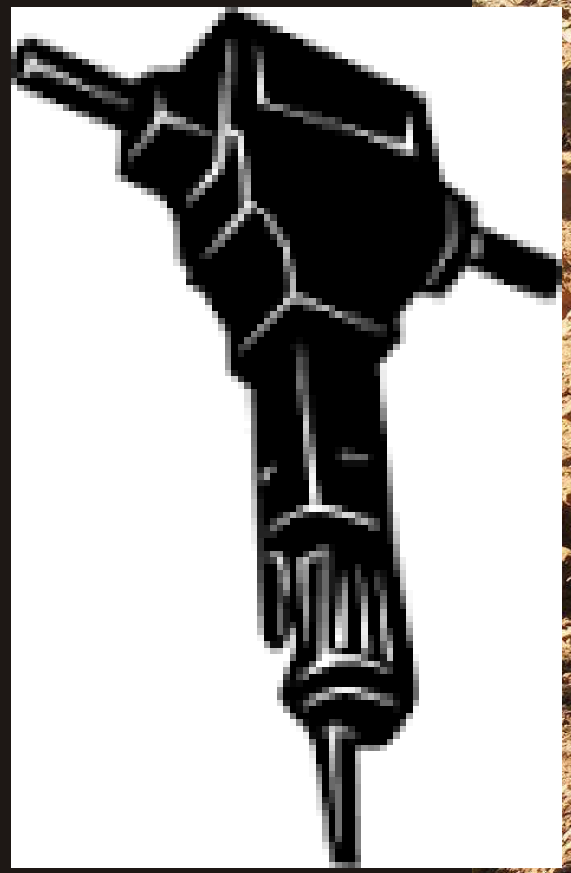
FERTILIZE WITH NON-POTABLE WATER and OTHER ONSITE ORGANICS:

Mulch holds the immunity flora and adds carbon, protecting trees from infection and drought.

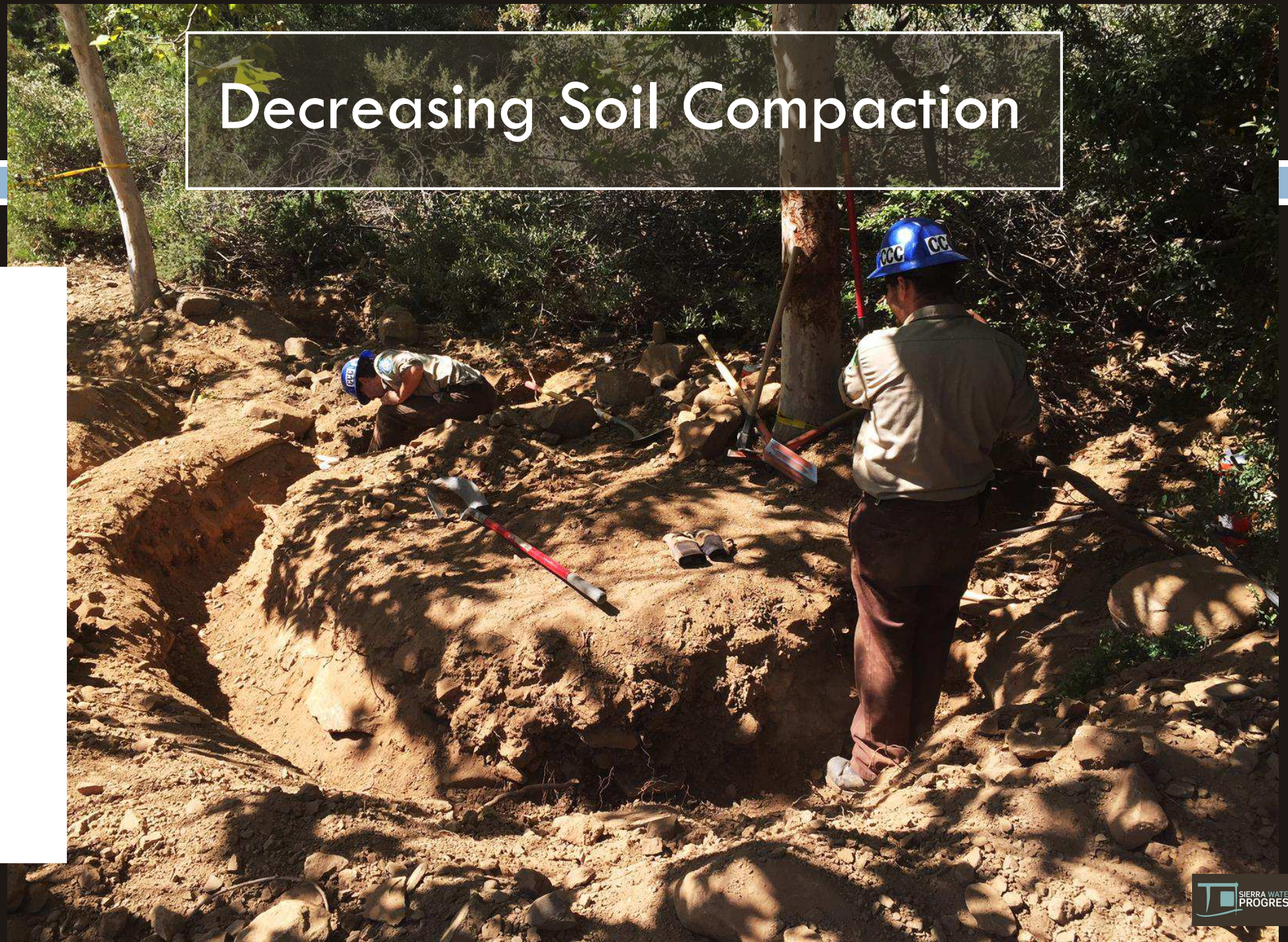
- Safety Factor
- Filter Medium
- Balances Soil Moisture
- Balances pH
- Habitat for Micro/Macrodiversity
- Improves Soil Condition
- Increase Percolation Depth
- Reduces Reliance/Maintenance on Synthetic or Gravel Filters
- Denitrifies Wastewater

Useable
Byproduct

Decreasing Soil Compaction

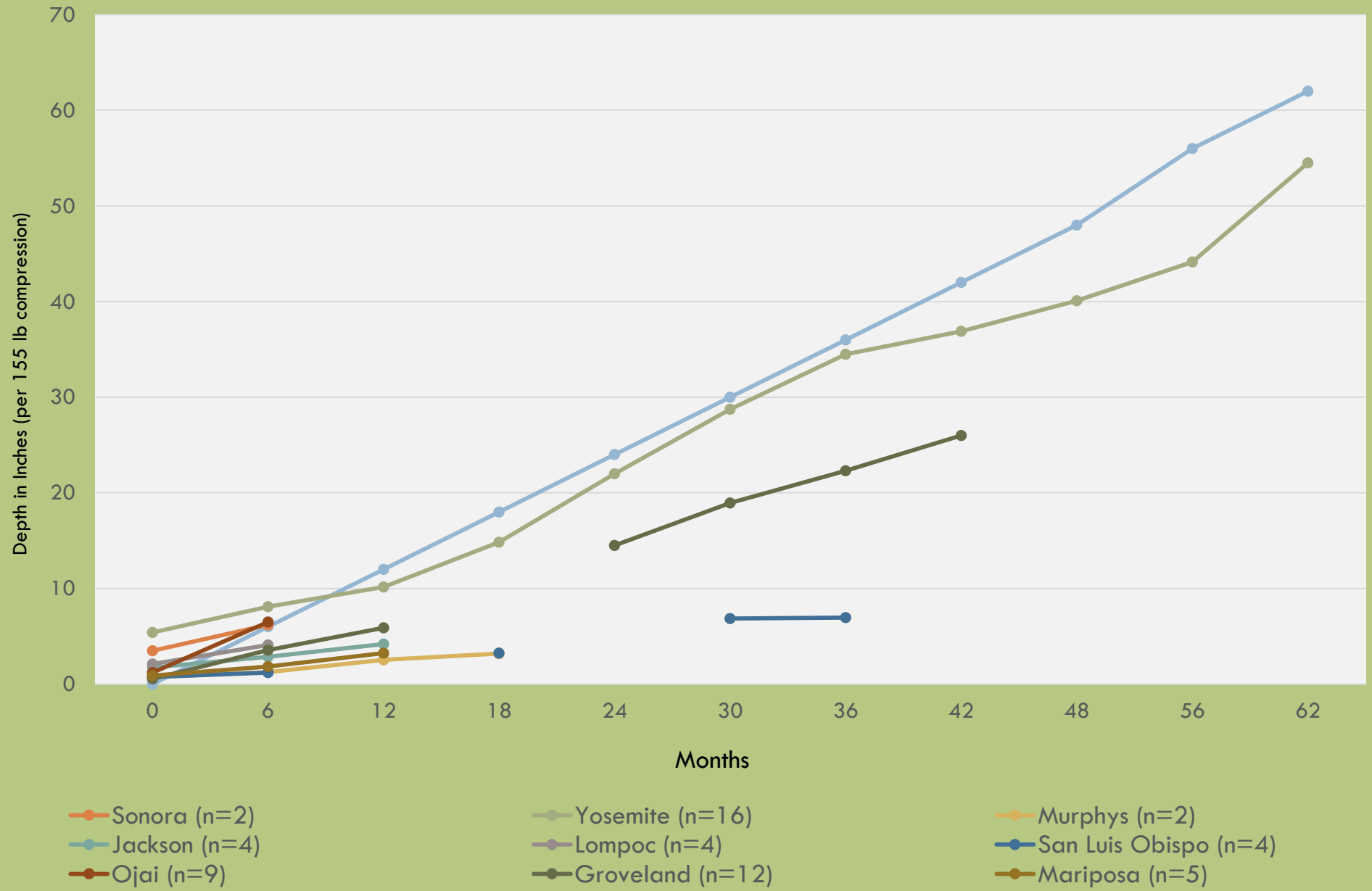


Decreasing Soil Compaction



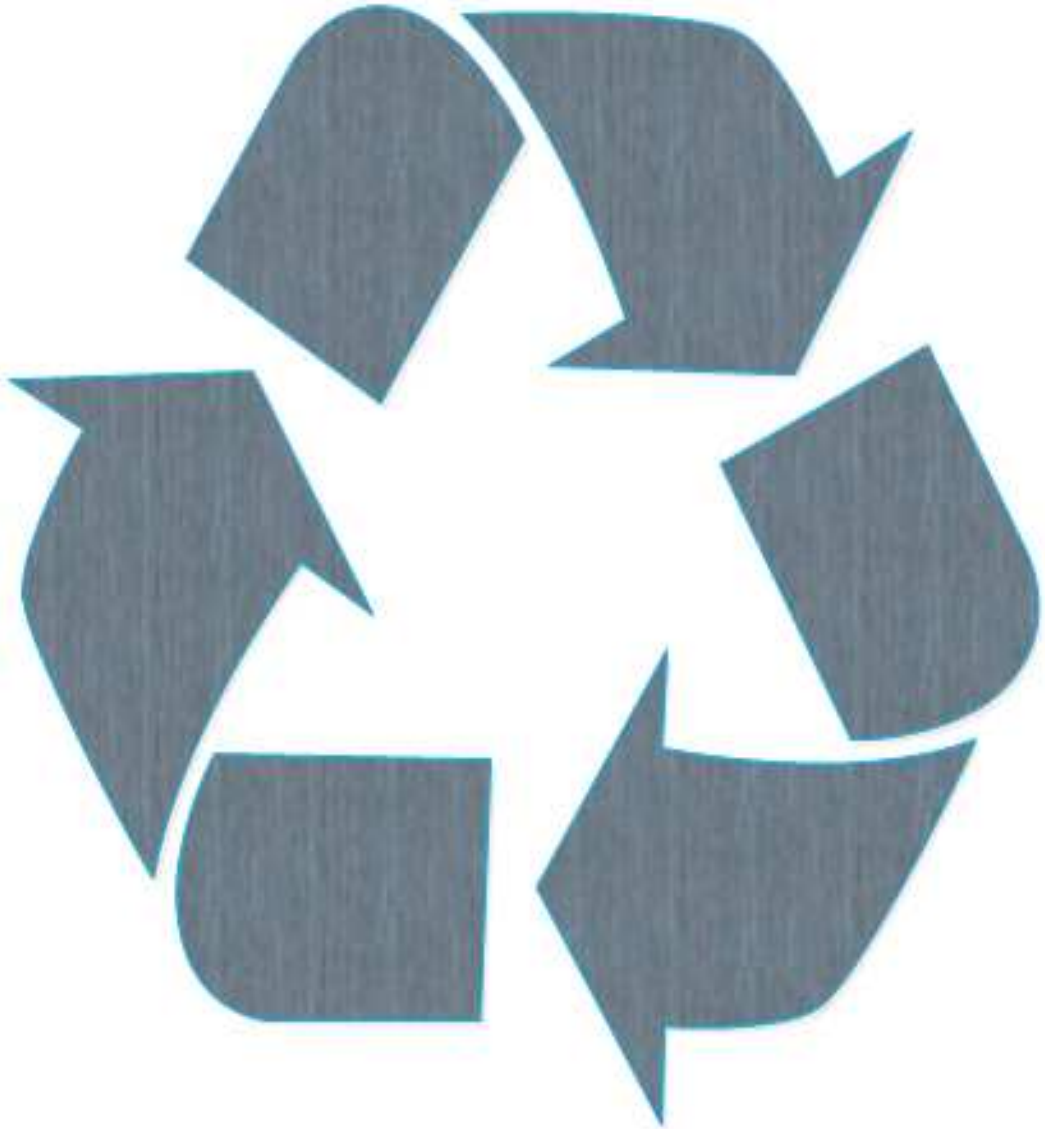
SIERRA WATERSHED PROGRESSIVE

Preliminary Compaction Testing in CLASS C Soils
Greywater Mulch Basins, Central California ~2010-2015



SIERRA WATERSHED PROGRESSIVE

Wastewater Inputs
(Greywater, Stormwater, Blackwater)



Improved Soil Structure
(Increased Stormwater Permeability and Capacity, Increased Soil Complexity, Increased Nutrient Processing Capability)

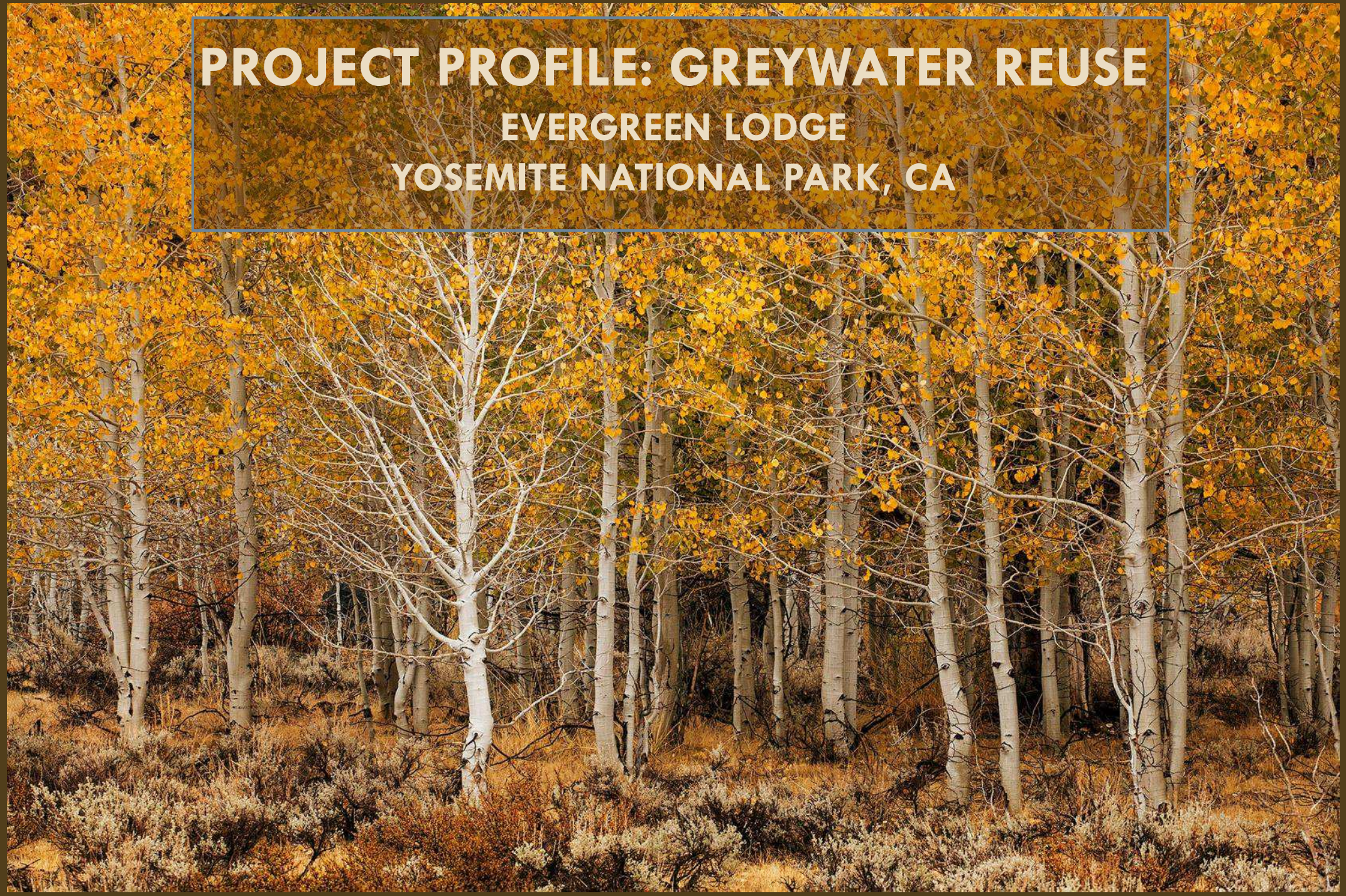
Habitat Regeneration
(Evaporative Transpiration, Increased Leaf Litter/Soil Carbonization, Increased Trace Mineral Availability, Increased Biotic Root Zone)

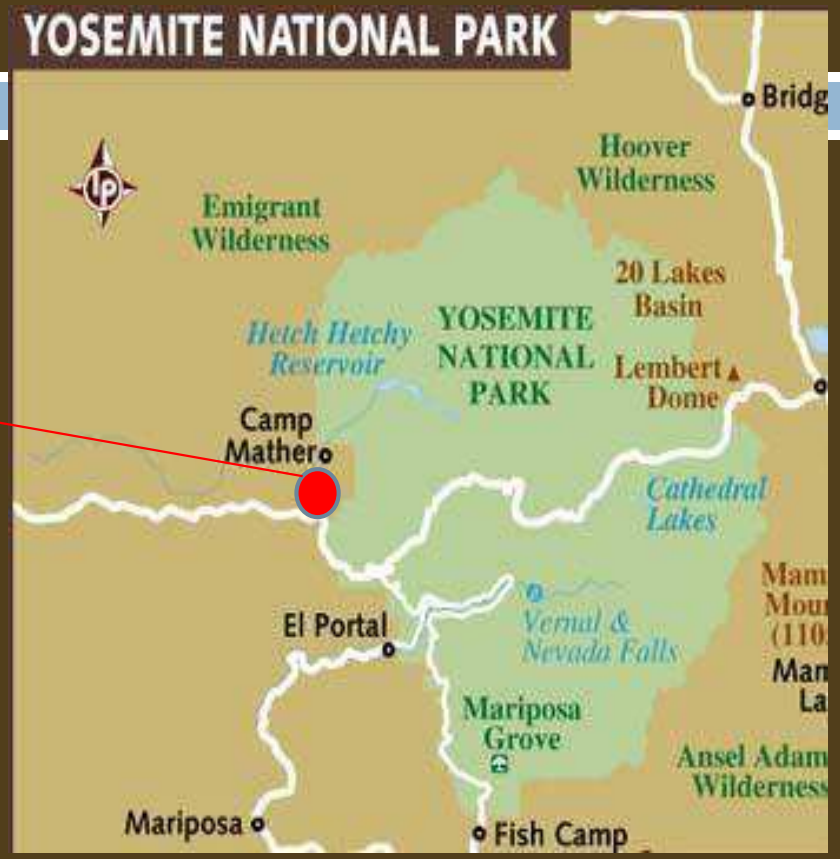
SIERRA WATERSHED PROGRESSIVE

PROJECT PROFILE: GREYWATER REUSE

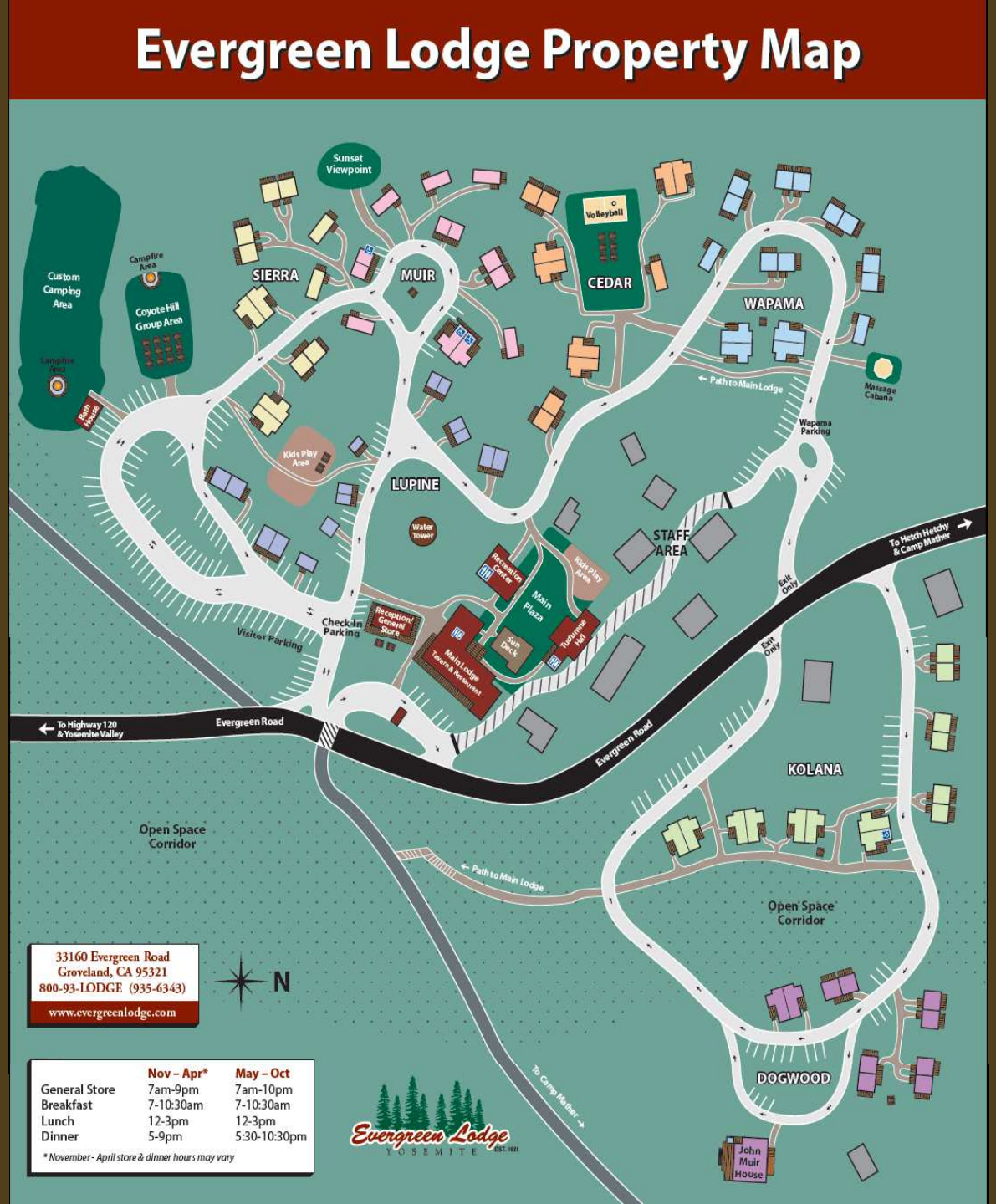
EVERGREEN LODGE

YOSEMITE NATIONAL PARK, CA





Site LOCATION



CASE STUDY: EVERGREEN LODGE

- ANNUAL GREYWATER REUSE: Minimum of 1.9 m/g/y
- PROJECT INSTALL: 2010
- TREATMENTS: Pump/filter, L2L, direct dispersal, saltwater bioswale, branched drain, pump/filter to drip
- DISPERSAL RUN TIME: Year round
- MONITORING: Quarterly, annually
- MAINTENANCE: Monthly, annually
- OBSTACLES: The need to run through winter (35” avg. precipitation), transient occupants

SIERRA WATERSHED PROGRESSIVE

Evergreen Lodge Greywater Map

Evergreen Lodge YOSEMITE EST. 1921

SIERRA WATERSHED PROGRESSIVE

Evergreen Lodge GREYWATER BASICS

- 68% of all irrigation is reused greywater
- 78% of all greywater systems irrigated existing plantings, and replaced potable water irrigation systems entirely.
- Greywater not used on plaza lawn, outdoor dining areas or children's garden
- Future plans include further all greywater reuse

STAFF DORM SHOWER & LAUNDRY

2,290 G/D

TOTAL CAPTURE: 710,472 G/Y

365 DAYS, WITH VARIABLE FLOW INPUTS

TREATMENT: PUMP/FILTER/DRIP AND LAUNDRY TO LANDSCAPE SYSTEM

SIERRA WATERSHED PROGRESSIVE

MANAGER DORM SHOWER & COMMERCIAL LAUNDRY

1880 G/D

TOTAL CAPTURE: 501,360 G/Y

365 DAYS, WITH VARIABLE FLOW INPUTS

PUMP AND FILTER SYSTEM

HARDWOOD FOREST FOR FIELDS OF REST

SIERRA WATERSHED PROGRESSIVE

52 GUEST CABINS (SHOWERS)

TOTAL 3,630 G/D

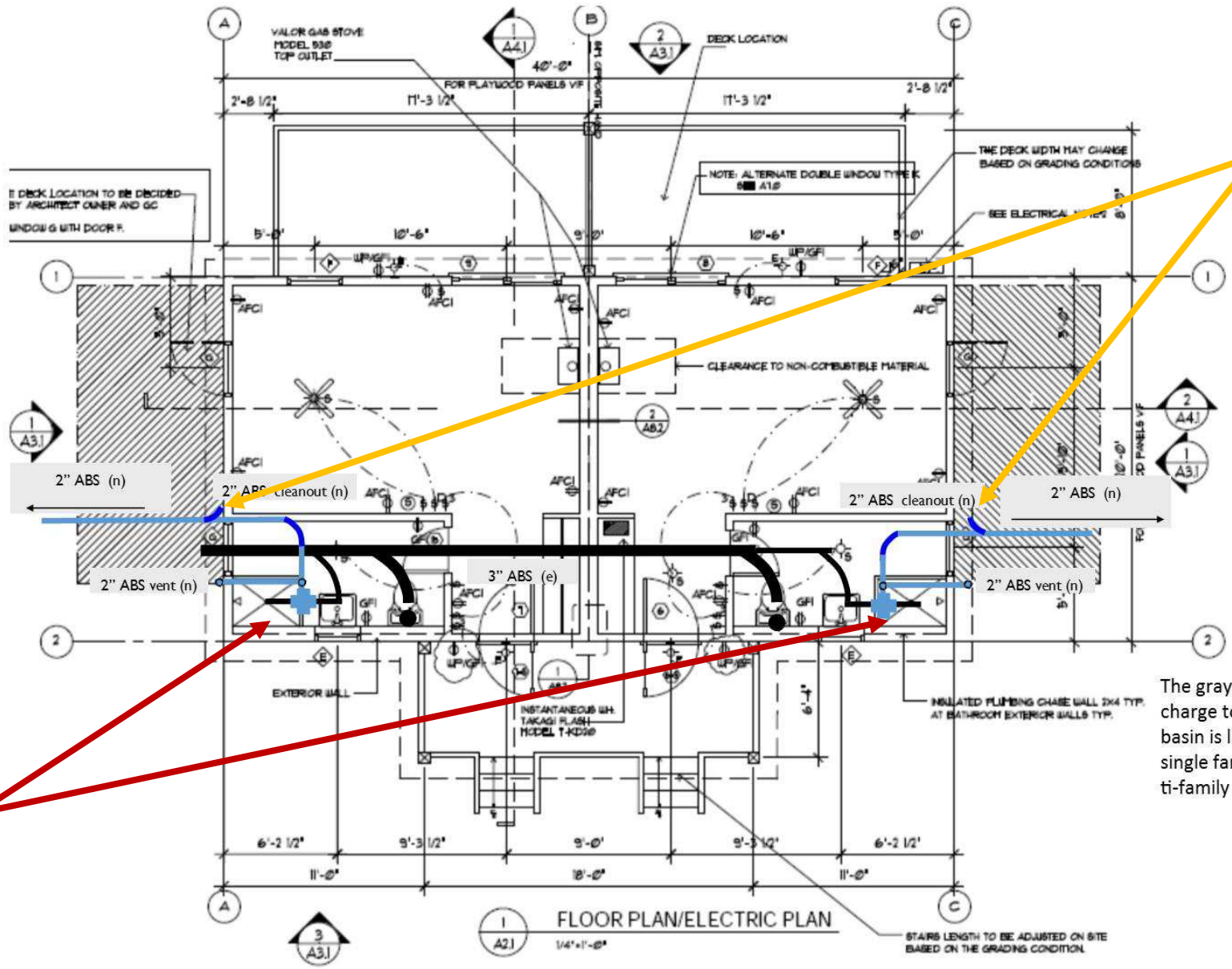
TOTAL CAPTURE: 861,218 G/Y

365 DAYS, FACTORED OCCUPANCY RATES

WITH VARIABLE FLOW INPUTS

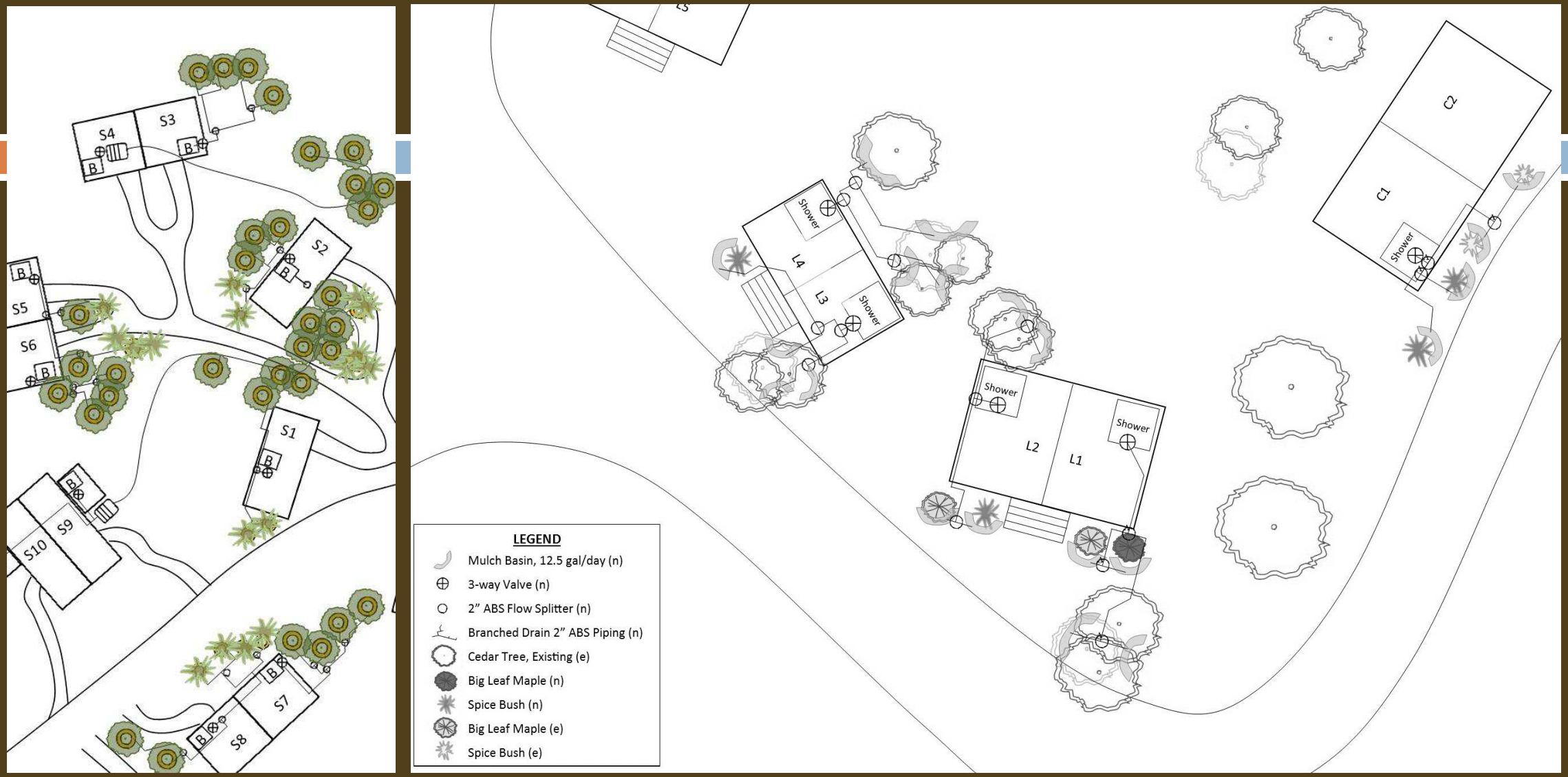
BRANCHED DRAIN DISPERSAL

Figure 4.b Evergreen Lodge Deluxe Cabin MASTER Greywater Irrigation Dispersal Schematic (Plan View)



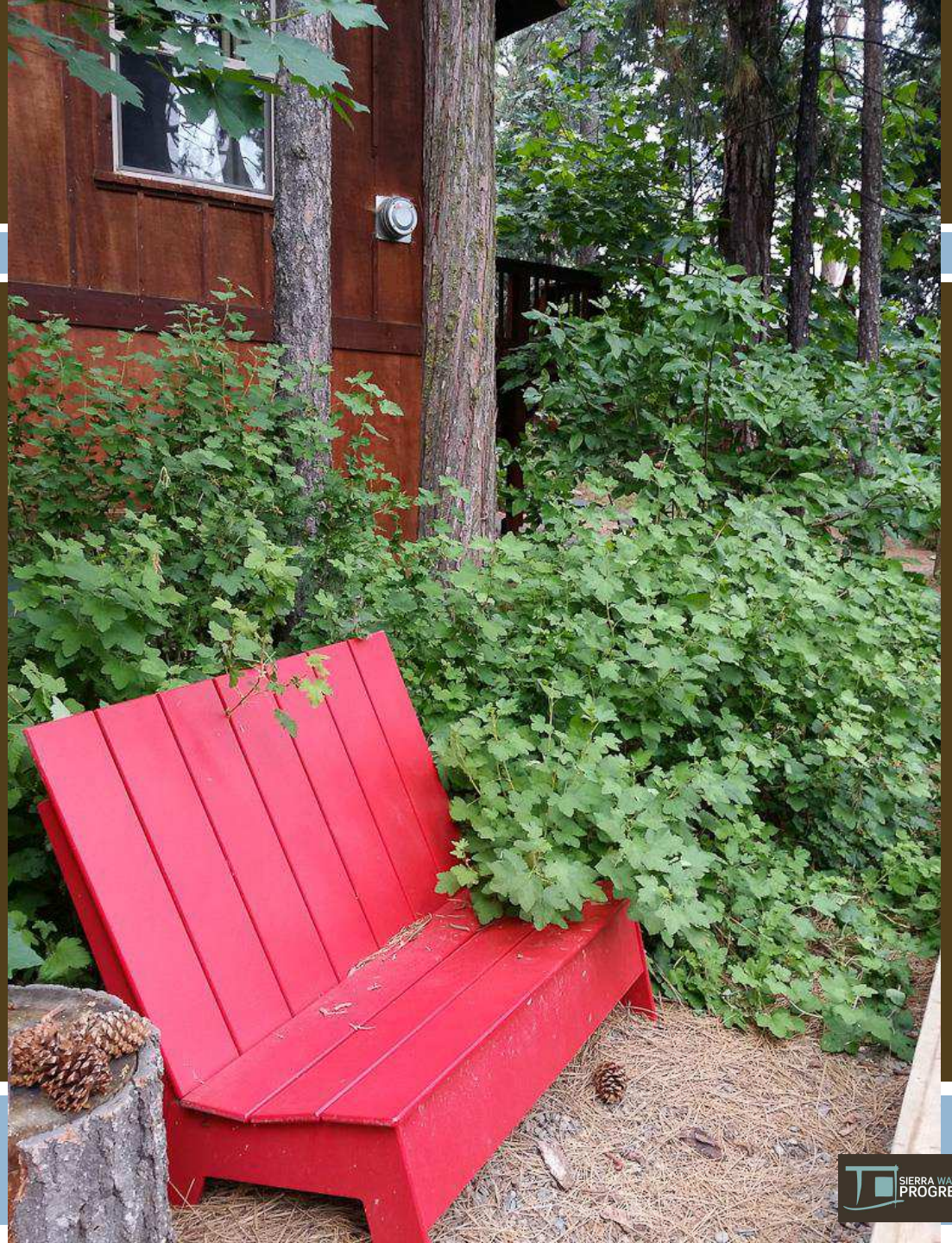
The gray water discharge to a mulch basin is limited to single family and multi-family dwellings.

Rev.1 8/3/10 Mountain Sage Landscapes/Sierra Watershed Progressive lic #925678

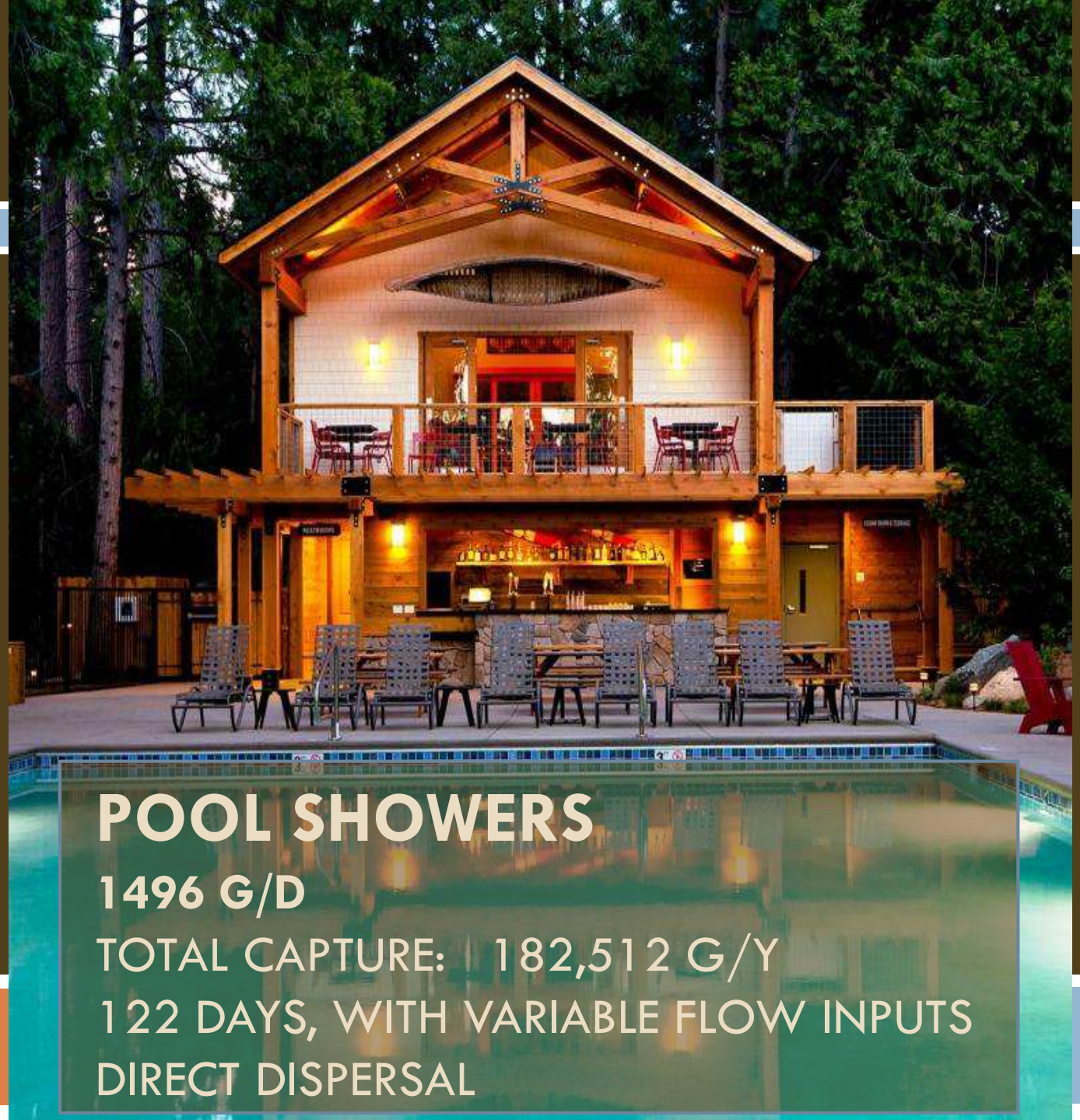


Centralized or Decentralized? Keep it Local.

SIERRA WATERSHED PROGRESSIVE



SIERRA WATERSHED PROGRESSIVE



POOL SHOWERS

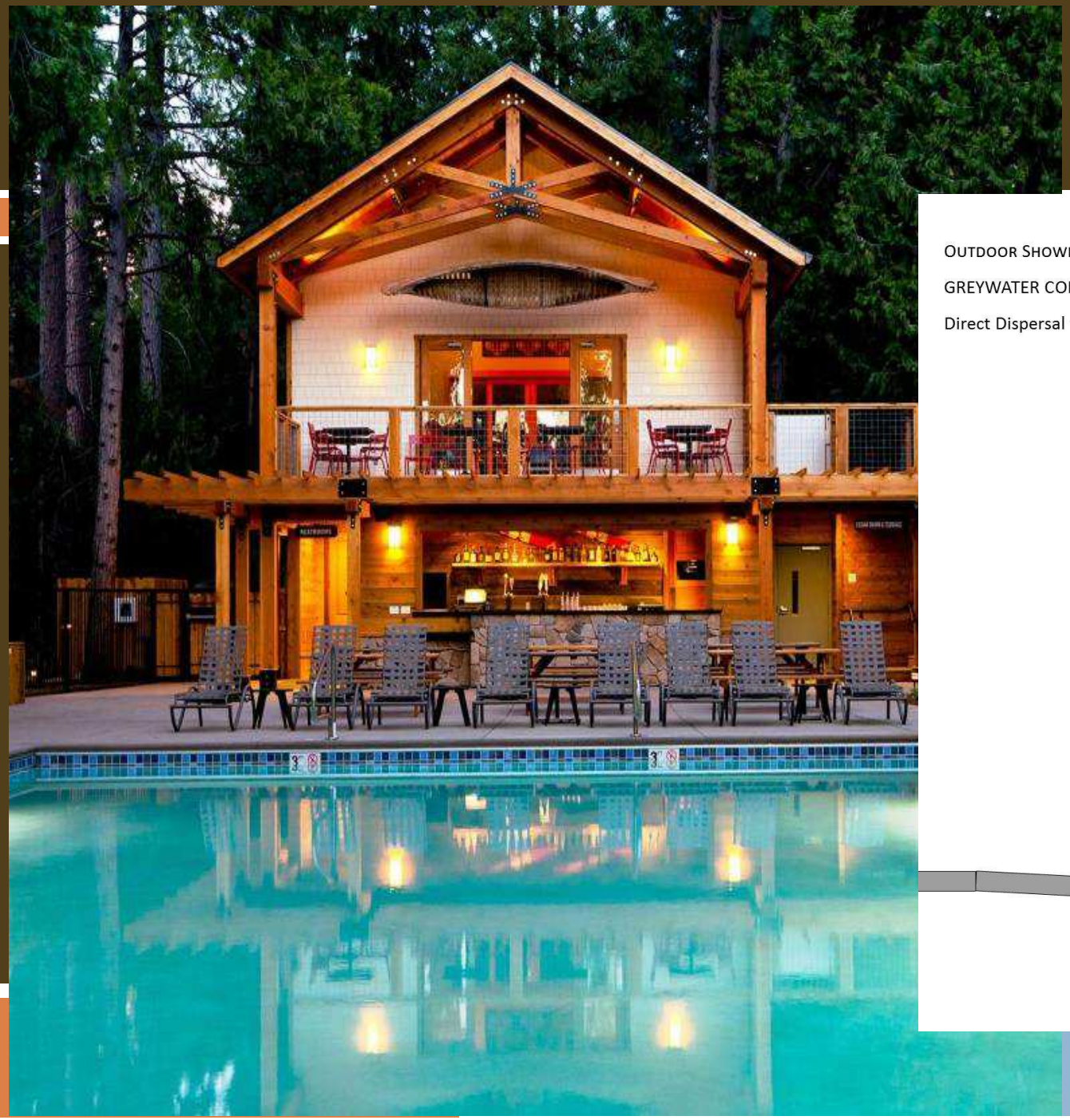
1496 G/D

TOTAL CAPTURE: 182,512 G/Y

122 DAYS, WITH VARIABLE FLOW INPUTS

DIRECT DISPERSAL

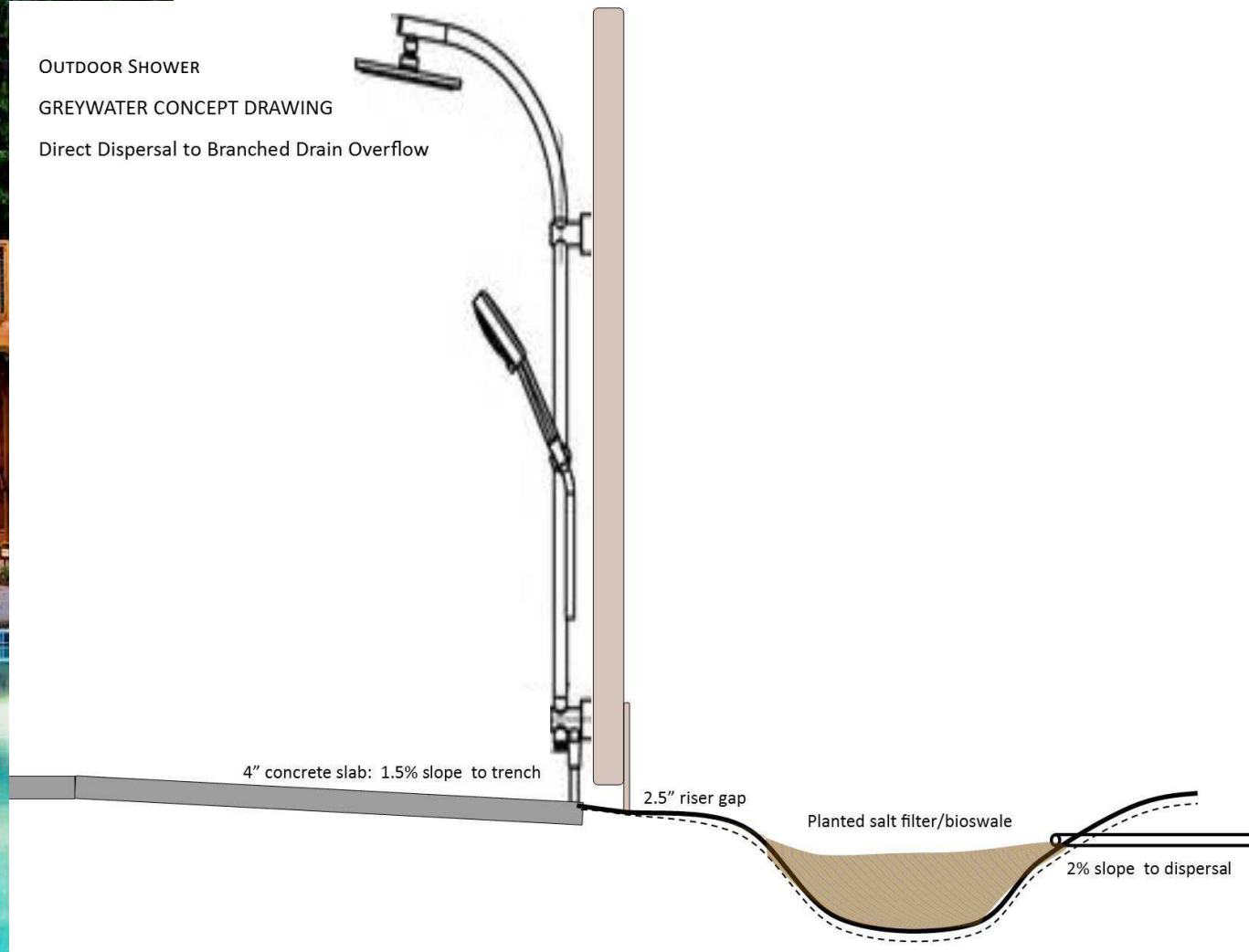
SIERRA WATERSHED PROGRESSIVE



OUTDOOR SHOWER

GREYWATER CONCEPT DRAWING

Direct Dispersal to Branched Drain Overflow



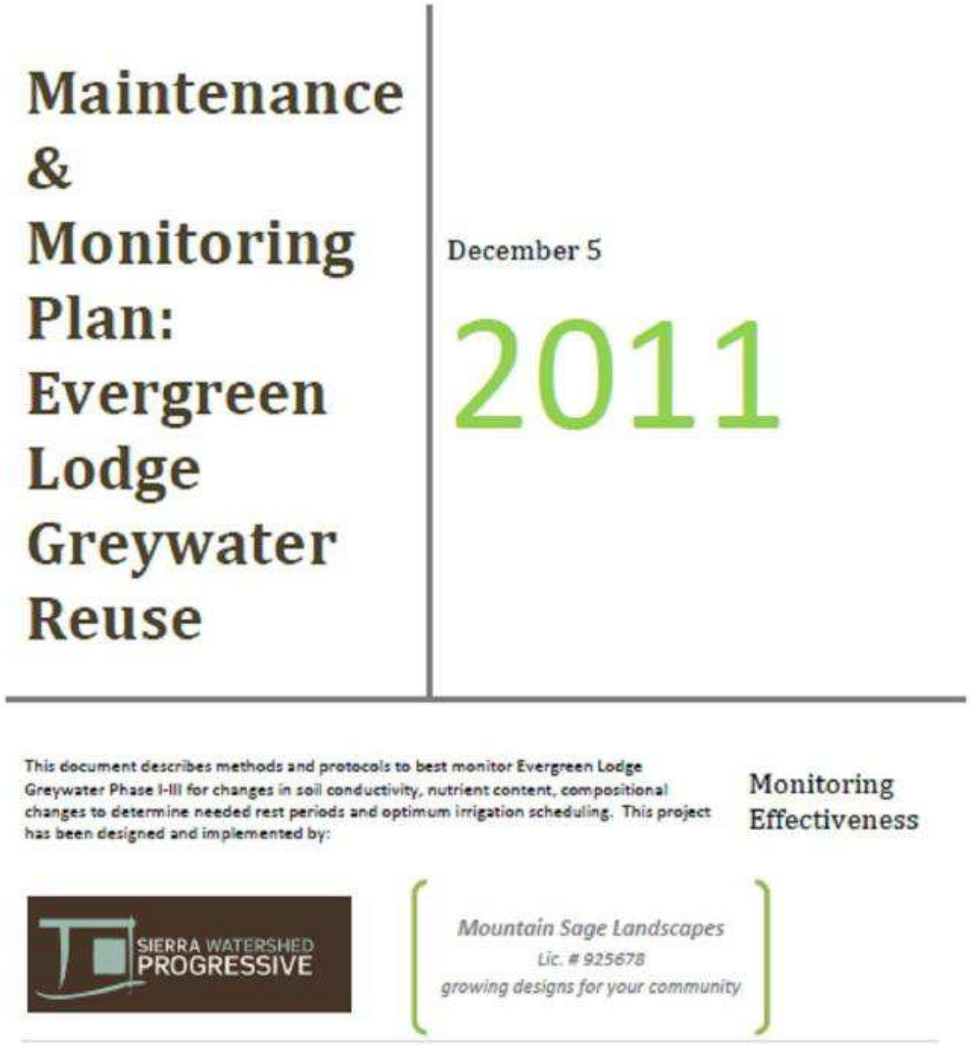
SIERRA WATERSHED PROGRESSIVE

SAFETY FACTORS:

FIELD REDUNDANCIES,
INCIDENTAL UPTAKE
MAINTENANCE
CONTRACTS
LAYERED HANDSINKS
BLENDING
NO CHILDREN AREA
DISPERSAL

LESSONS LEARNED:

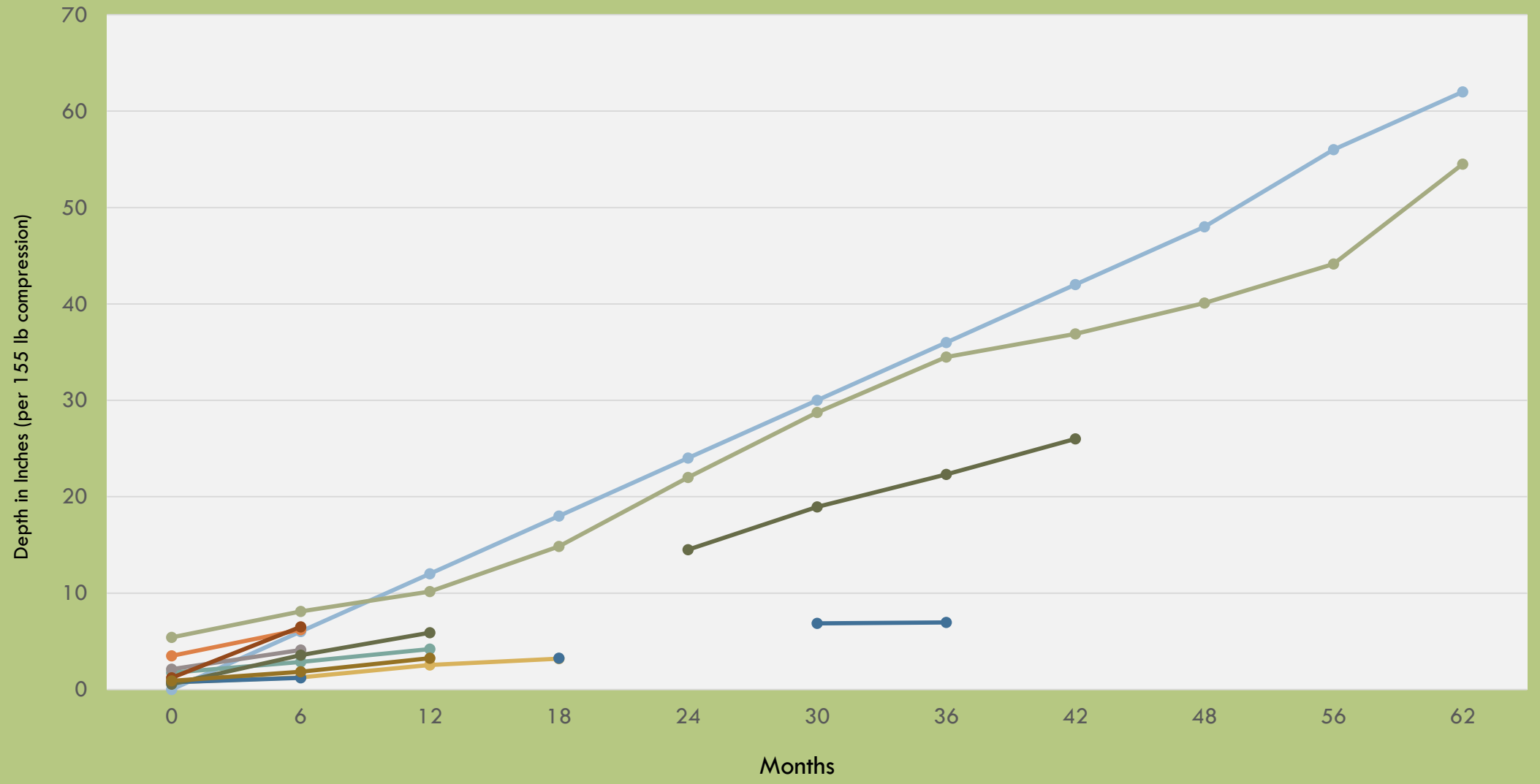
SALTWATER BIOSWALE
DRIP MULCH GUARDS
OCCUPANCY RATES/TPI
INPUT MANAGEMENT
HIGH MULCH INTEGRITY
COMPACTION RATES
HARDWOOD UPTAKE
STAFF MANAGEMENT
STORMWATER EFFECTS
SHUT-DOWN PROTOCOLS
INCIDENTAL FOREST UPTAKE
SIGNAGE



MONITORING PROTOCOLS:

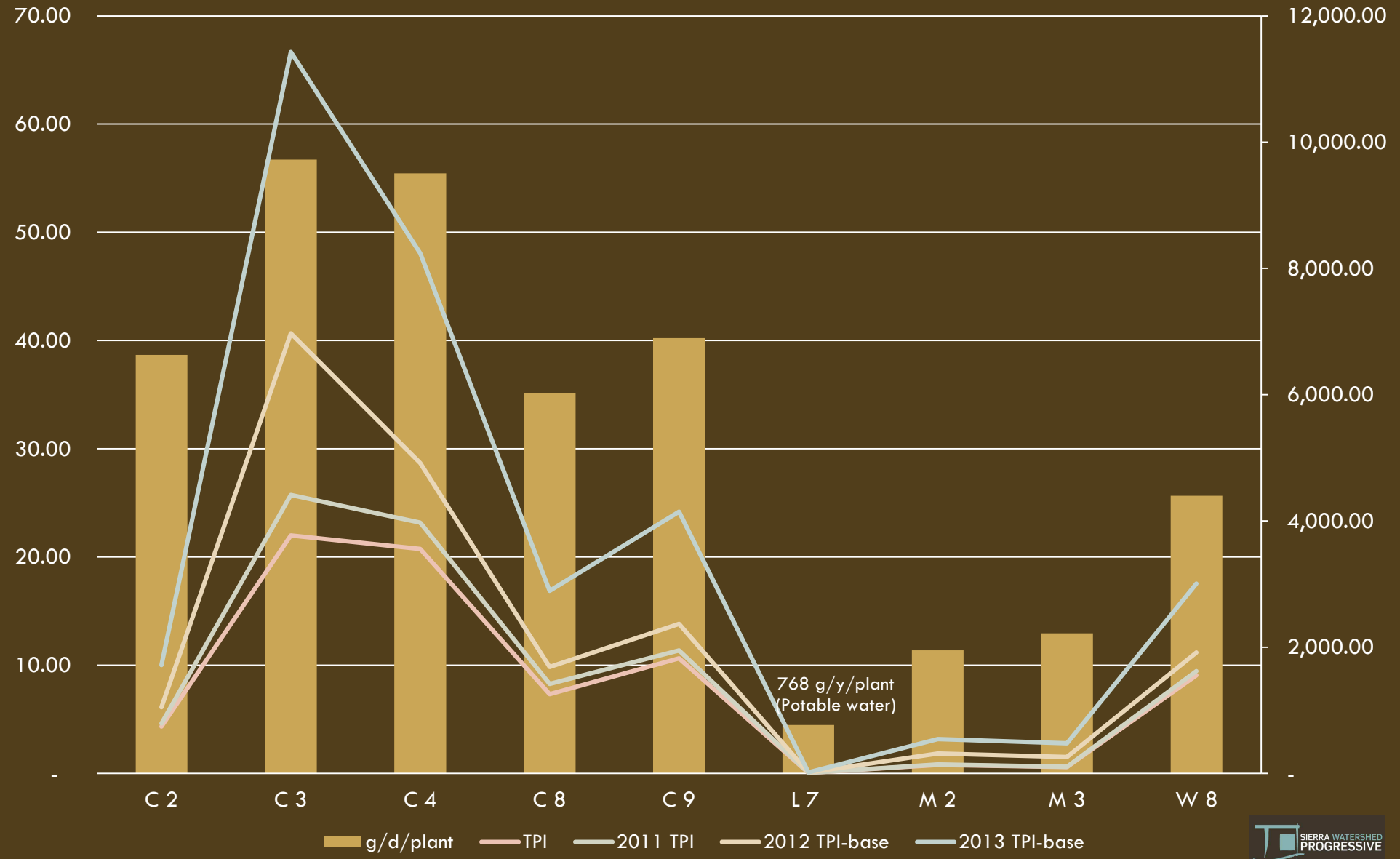
WATER OUTPUT PH
SOIL CONDUCTIVITY
WATER OUTPUT CONDUCTIVITY
PHOSPHATE
NITRATE AS (NO4)
BIOMASS (PLANT) GROWTH (TPI)
SOIL COMPOSITION
SOIL BIODIVERSITY
MULCH INTEGRITY
SOIL COMPACTION (MULCH BASIN)

Preliminary Compaction Testing in CLASS C Soils
Greywater Mulch Basins, Central California ~2010-2015



SIERRA WATERSHED PROGRESSIVE

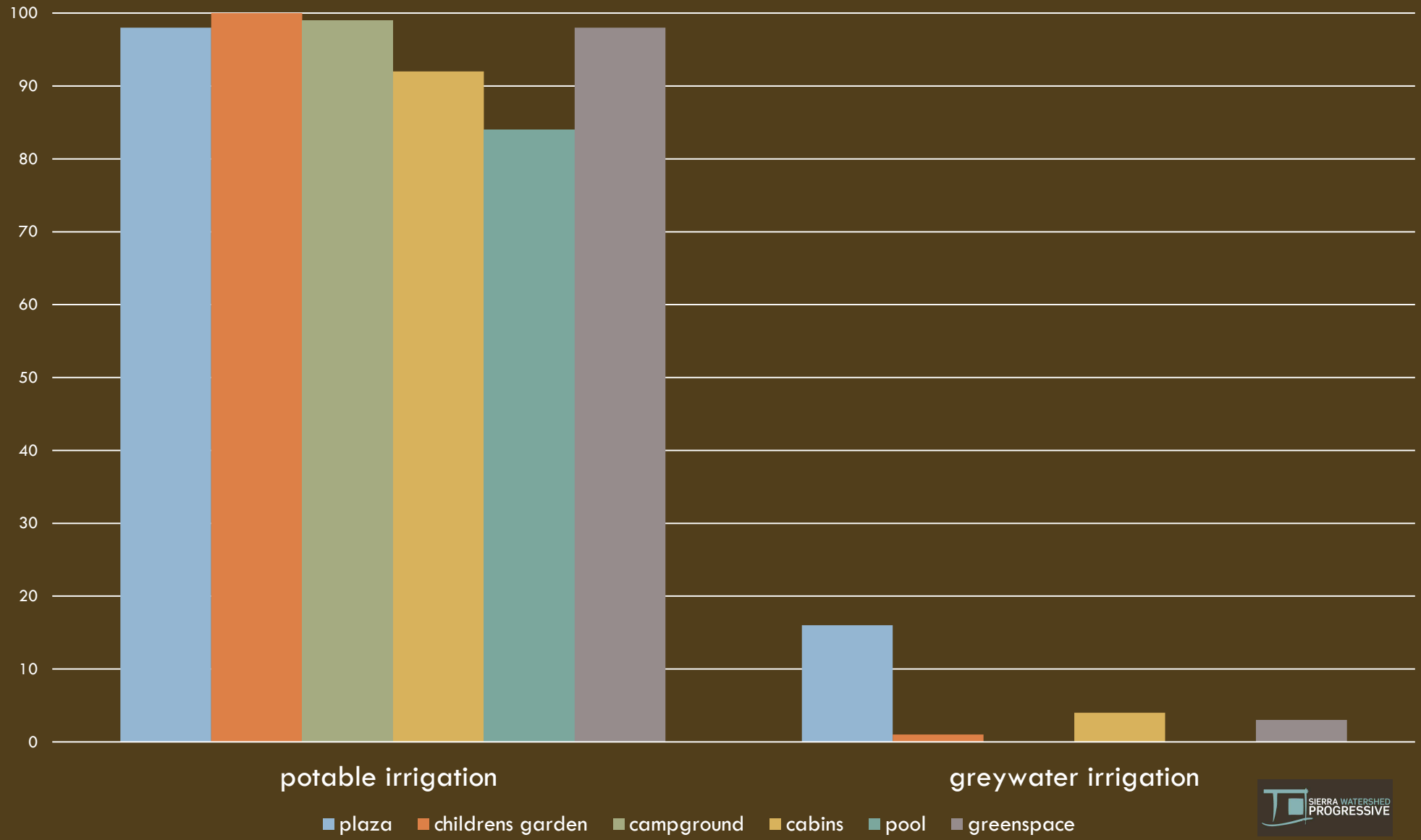
Greywater and Total Plant Productivity Index (TPI)
Evergreen Lodge, Yosemite, CA
2011-2014



SIERRA WATERSHED PROGRESSIVE

FIRE/DISASTER EFFECTS

Percent Plant Mortality Post Rim Fire Conditions
Greywater v. Potable Irrigation
Evergreen Lodge, Yosemite, CA



SIERRA WATERSHED PROGRESSIVE

SUCCESSES

Very Little Maintenance
Branched Drain System
High Mulch Integrity
High Plant Productivity Trend with Occupancy Rates
County And Landowner Buy-in
Top Down Local Model
Educational To Public
Multiple Systems
Griswold Valving
Drip System
Increased Septic System Effectiveness
Alleviated Stress On Well Withdrawal
Alleviated Stress On Septic System

Tuolumne County Environmental Health Department presents:

GREYWATER IN CALIFORNIA

DESIGNING, MANAGING, MONITORING

SESSION TOPICS INCLUDE:

- A Perspective From the Capital
- Changes on a Regulatory Local Level: A Building and Environmental Health Perspective
- Cost Sharing and Regulatory Partnerships to Assist in Streamlining Funding Implementation
- Designing Greywater/Rainwater for Watershed Health and LID Approaches
- Study Results: Lessons Learned from California Residential Greywater Installations
- Biology of a Septic Tank: How Does Greywater Reuse Affect Your Tank?
- Greywater Plumbing Basics for Plumbers and Non-plumbers
- Hands On Problem Solving: The Greywater Puzzle
- Public Survey Results: How Much Does the Public Know About Greywater?
- Incentives and Data Gap Needs for Long-term Greywater Monitoring
- Community Planning Examples and Incentives for Water Reuse
- State and International Examples of Best Management Practices of Regulated Water Reuse
- Potential Greywater and Rainwater in Urban Water security
- Potential of Greywater Reuse in the Bay Area
- Solving The California Water/Energy Knot with Localized Water Reuse
- The SFPUC Greywater Reuse Model and Greywater in Urban Settings
- Tour of the Greywater System at Evergreen Lodge
- Using the Correct Plants, Dispersal and Balancing for Various Environmental Conditions

NOVEMBER 15-16, 2012

EVERGREEN LODGE, YOSEMITE

$110 Conference Fee (prepaid by November 1, 2012
$135 (after November 1, 2012)
Technical Sessions, Hands-on Workshops, Live Music, Sierra Art & Wine Social, Tours

Agenda and Registration at:

www.tuolumnecounty.ca.gov

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SIERRA ECOSUMMIT & FESTIVAL

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the

Sierra Nevada

sierraecosummit.org

LOCALIZING CALIFORNIA WATERS

A HANDS-ON INTENSIVE FOR CONSERVATION AND REUSE

californiawaterreuse.org

NOV 3-6, 2014

NEEDED IMPROVEMENTS

~~WHITENING AGENTS~~

~~HIGH TEMPERATURES MODIFICATIONS~~

~~STAFF TRAINING~~

FUNDS FOR MONITORING

SIERRA WATERSHED PROGRESSIVE

QUESTIONS?