Practical Application of Modeling Results to Land Development Policies in Contra Costa County

California Water Environmental Modeling Forum
Watershed and Urban Hydrology Modeling Workshop
22 June 2007

Dan Cloak Environmental Consulting

Topics

- Stormwater NPDES requirements
- Low Impact Development
- Model approach and features
- Using results for LID design
- Enhancements in progress

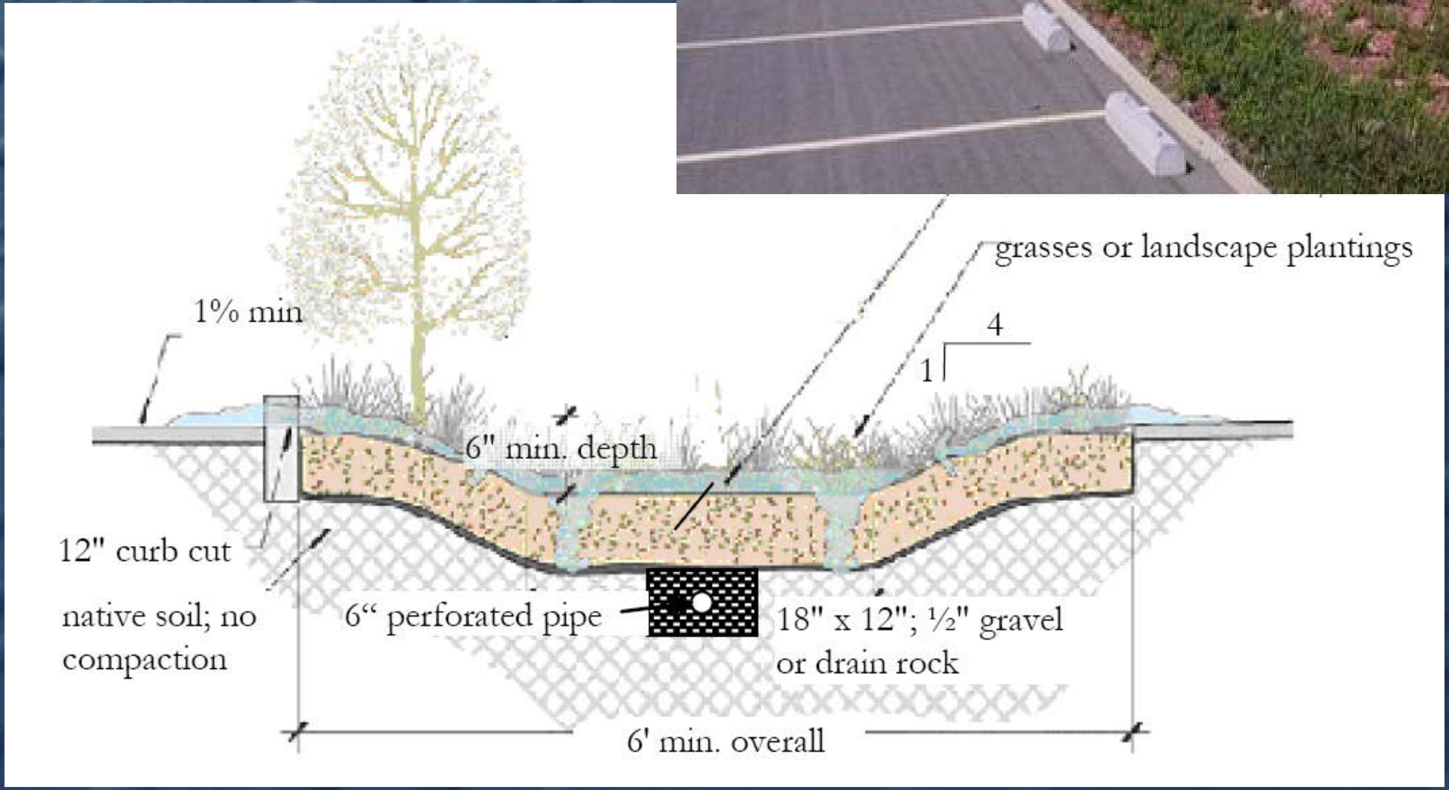
NPDES requirements for new developments

- Minimize imperviousness
- Control pollutant sources
- Treat stormwater prior to discharge from the site
- Match peaks and durations to pre-project conditions (HMP)
- Maintain treatment and flow-control facilities in perpetuity

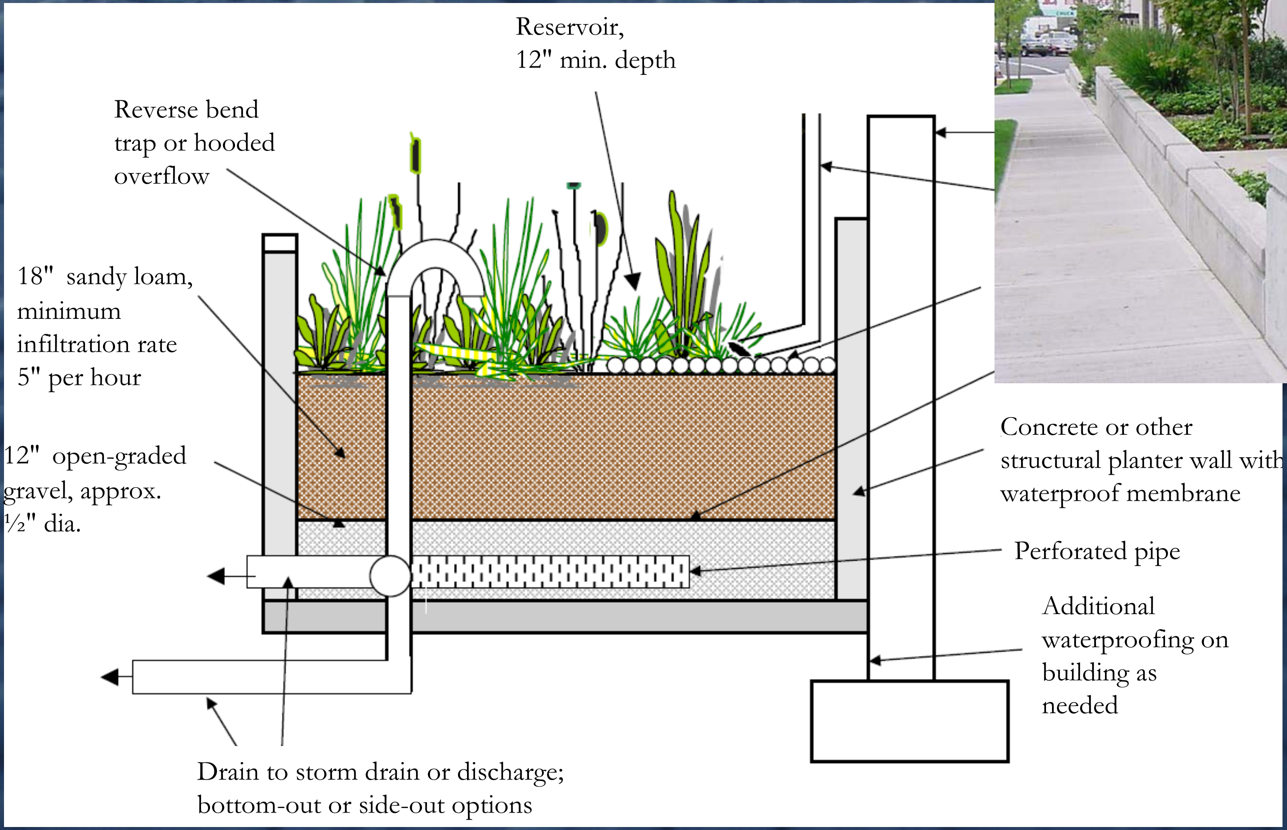
Low Impact Development

- Stormwater treatment *and* flow control
- Minimize imperviousness
- Disperse runoff
- Use Integrated Management Practices (IMPs)

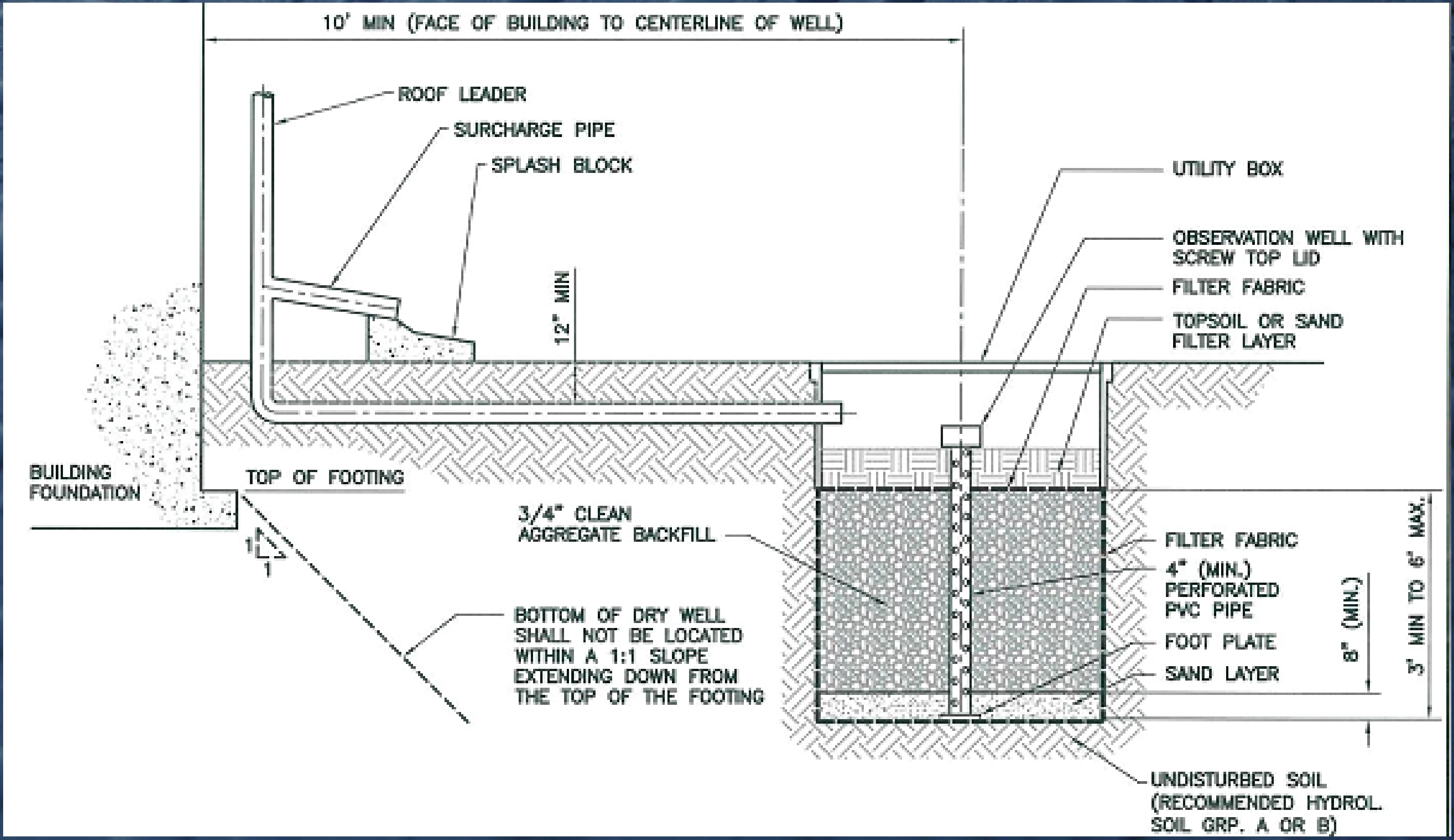
Swale


grasses or landscape plantings
1% min
4
1
6" min. depth
12" curb cut
native soil; no compaction
6" perforated pipe
18" x 12"; ½" gravel or drain rock
6' min. overall

Planter Box


Reservoir,
12" min. depth
Reverse bend
trap or hooded
overflow
18" sandy loam,
minimum
infiltration rate
5" per hour
12" open-graded
gravel, approx.
½" dia.
Concrete or other
structural planter wall with
waterproof membrane
Perforated pipe
Additional
waterproofing on
building as
needed
Drain to storm drain or discharge;
bottom-out or side-out options

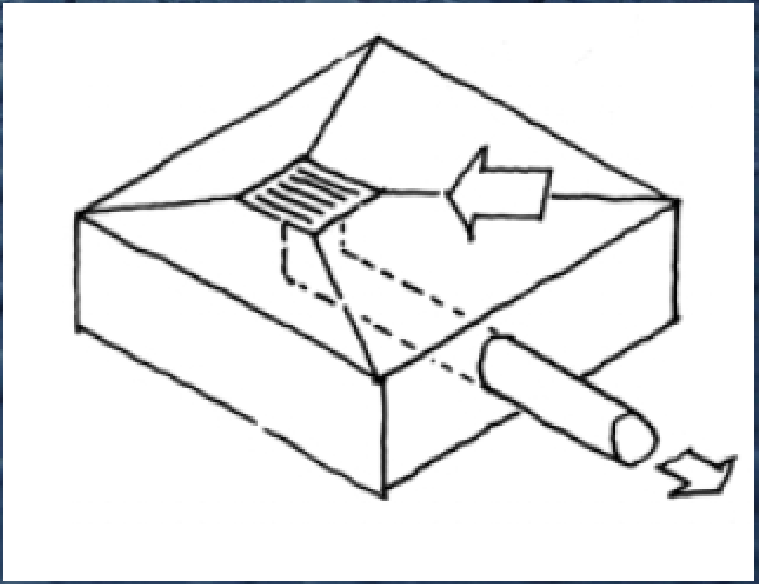
Dry Well



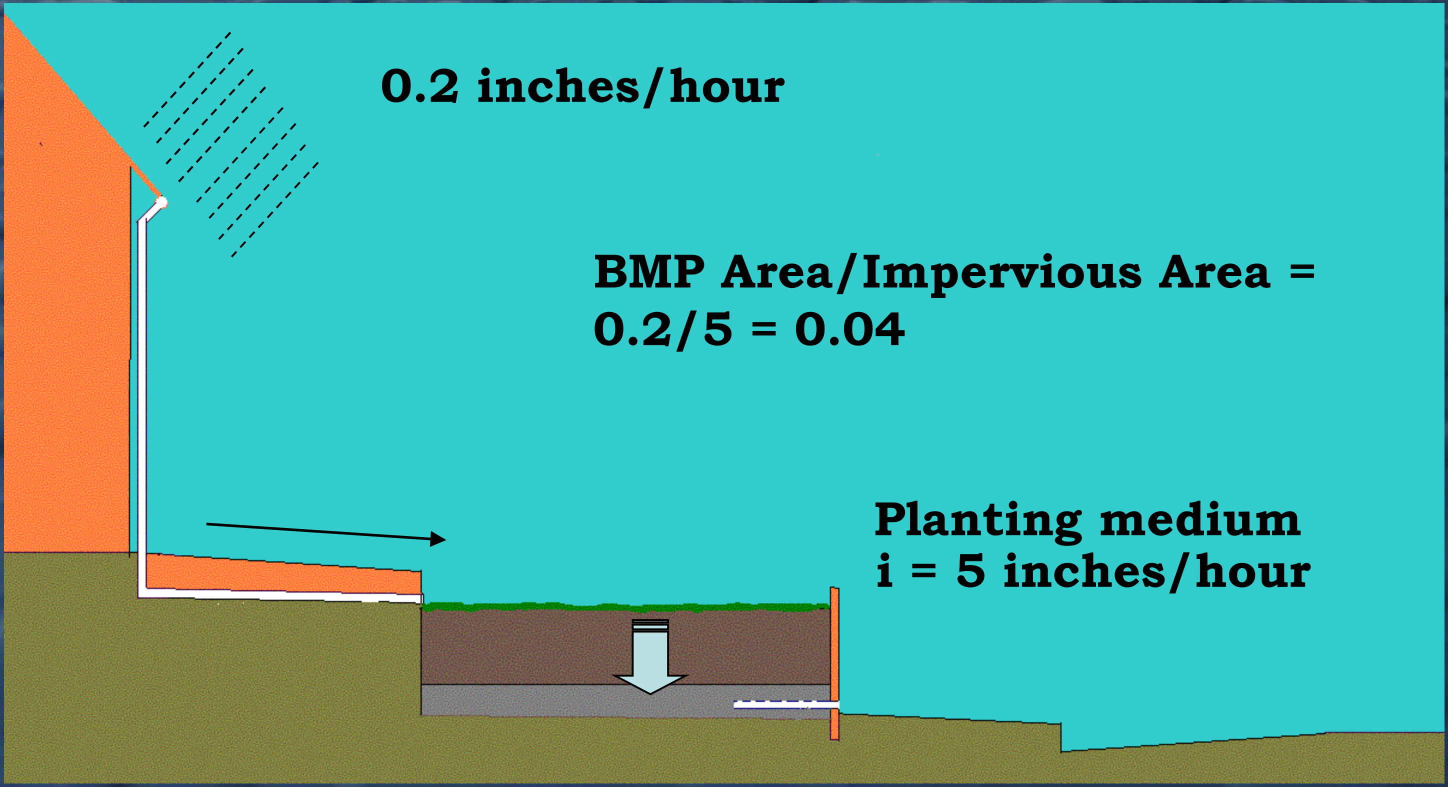
10' MIN (FACE OF BUILDING TO CENTERLINE OF WELL)
ROOF LEADER
SURCHARGE PIPE
SPLASH BLOCK
12" MIN
UTILITY BOX
OBSERVATION WELL WITH SCREW TOP LID
FILTER FABRIC
TOPSOIL OR SAND FILTER LAYER
BUILDING FOUNDATION
TOP OF FOOTING
3/4" CLEAN AGGREGATE BACKFILL
1
1
FILTER FABRIC
4" (MIN.) PERFORATED PVC PIPE
FOOT PLATE
SAND LAYER
8" (MIN.)
3' MIN TO 6' MAX.
BOTTOM OF DRY WELL SHALL NOT BE LOCATED WITHIN A 1:1 SLOPE EXTENDING DOWN FROM THE TOP OF THE FOOTING
UNDISTURBED SOIL (RECOMMENDED HYDROL. SOIL GRP. A OR B)

Showing Treatment Compliance

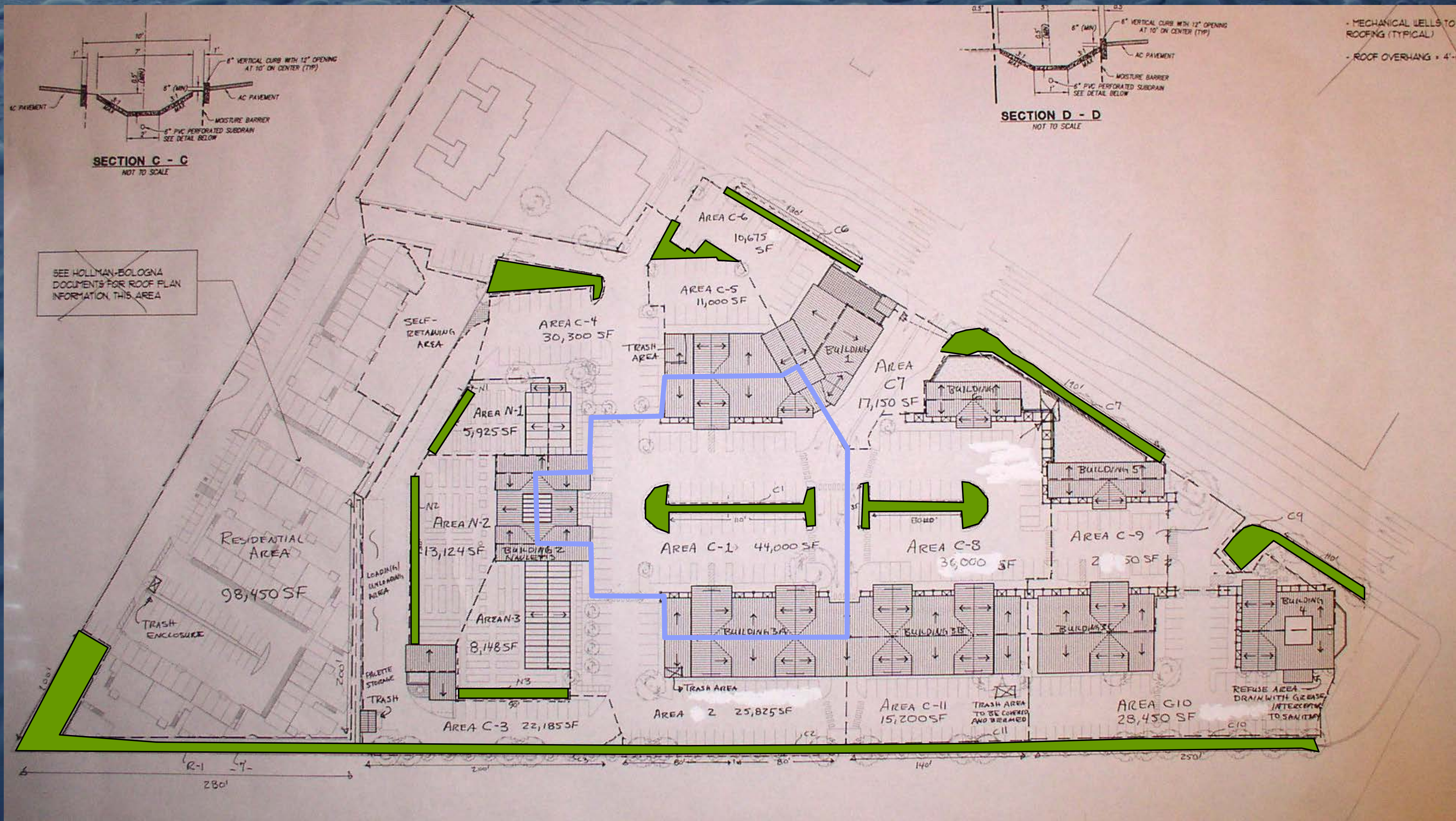
- NPDES Permit sizing criteria for treatment control:
  - "collect and convey" drainage design
  - conventional, "end of pipe" treatment
  - use of "C" factors to determine design inflow or volume



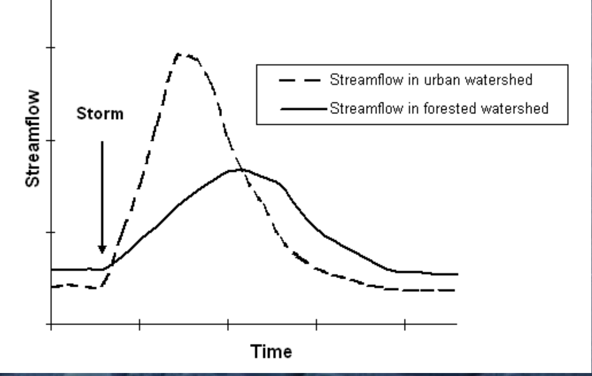
Sizing criterion for treatment



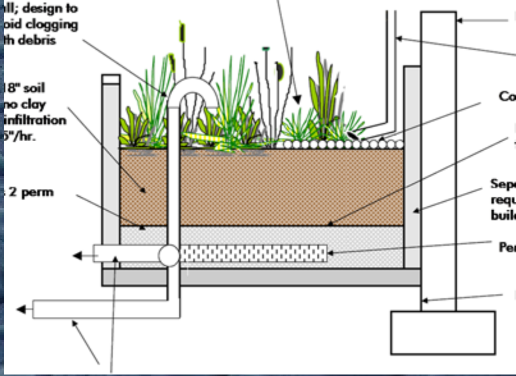
Application of sizing factor



LID for flow control



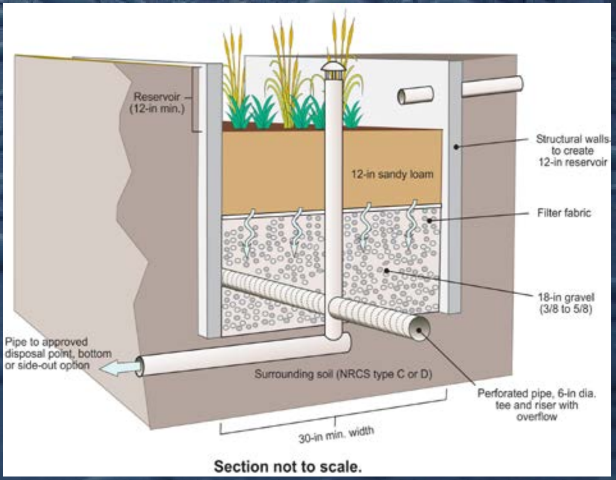
- Can LID facilities mitigate increased peaks and volumes of flows from impervious areas?
- How would we demonstrate that?
- What are the design criteria?



Who needs a model?

- **Needed:** A conservative "best guess" for appropriate sizing factors
- **Proposed solution:** Implied equivalence to pre-project condition by
  - Weighted "C" (rational method)
  - Curve number (NRCS)
  - ΔS (initial storage in NRCS)
  - Any other values for input parameters to a hydrologic model
- **However:** Water Board staff specified continuous simulation

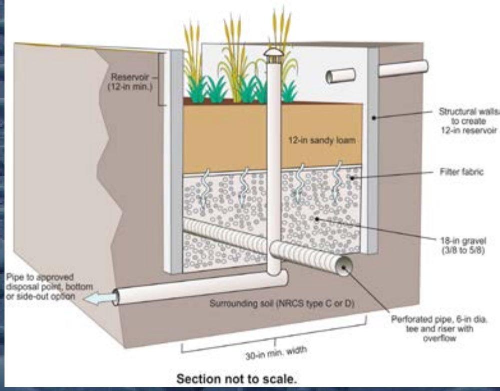
HSPF analysis of unit-acre runoff



Section not to scale.

- 33 years hourly rainfall
- Pre-project condition
- 100% impervious condition
- Hydrologic soil groups A, B, C, D
- Swales, Bioretention Areas, In-ground and Flow-through Planters
  - Underdrain with flow-restrictor in C&D soils
- Dry wells, infiltration trenches and basins

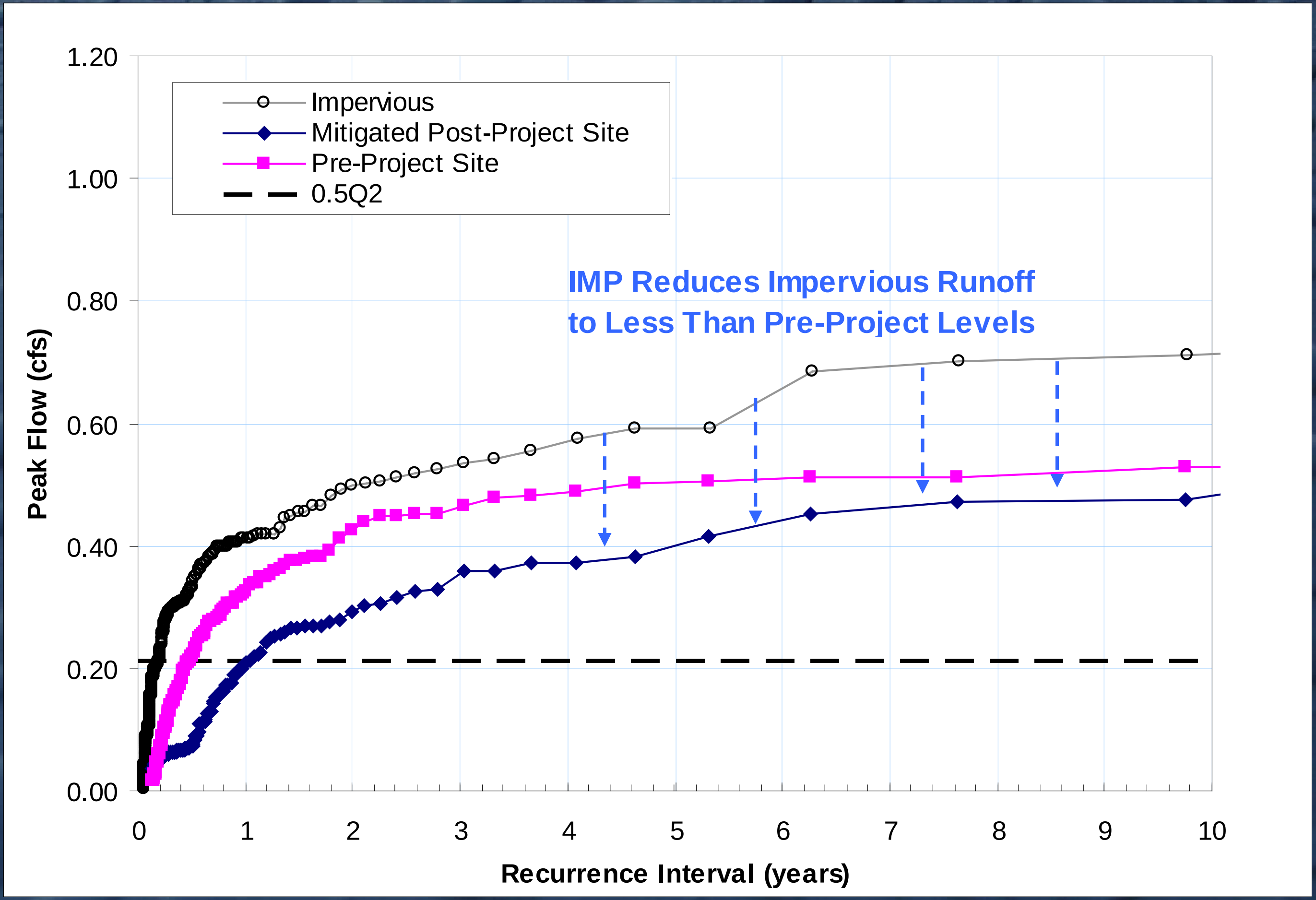
Modeling Approaches



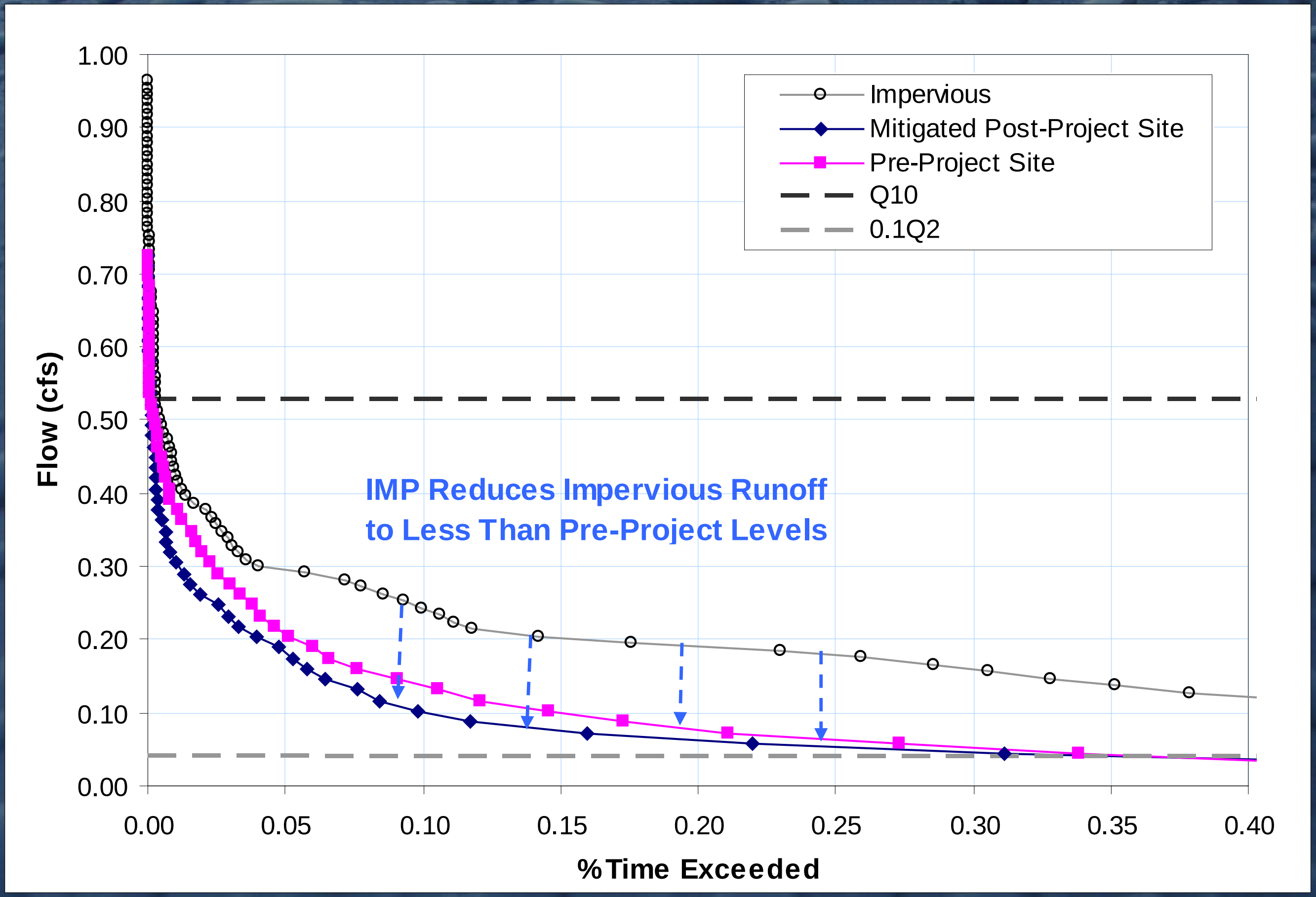
Section not to scale.

- “Bathtub” approach
- Pervious land surface over gravel
- Two-layer approach
  - Stage-storage discharge relationships represented in FTABLEs.
  - Soil moisture content recalculated at each time step
  - Matric head within soil pores and hydraulic conductivity recalculated for each time step

Results: Control of Peak Flows



Results: Flow Duration Control

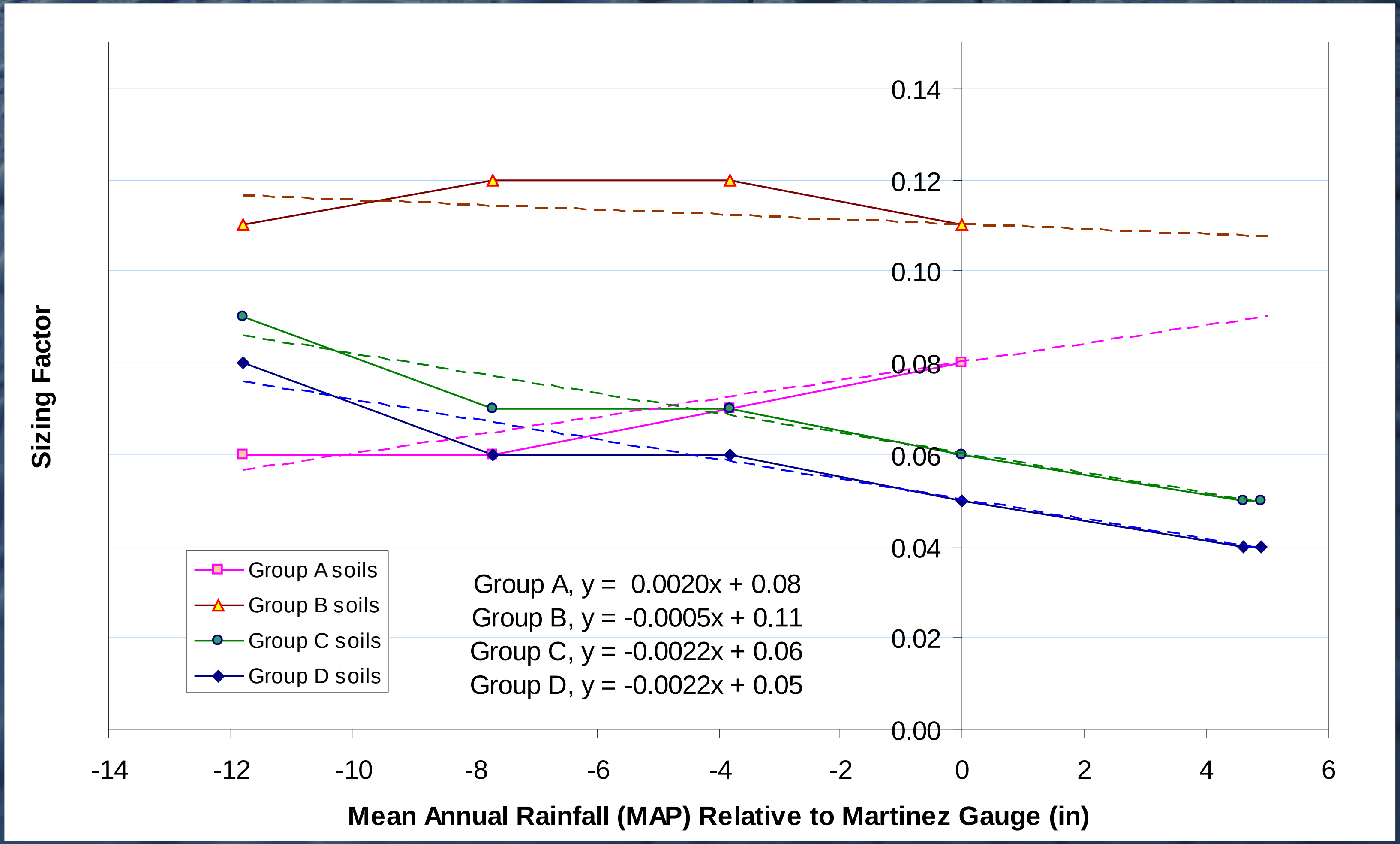


Sizing Factors for Flow Control

IMP	Sizing Factors
In-Ground Planter	Group A: 0.08 Group B: 0.11 Group C: 0.06 Group D: 0.05
Flow-Through Planter	Group C: 0.06 Group D: 0.05
Vegetated/ Grassy Swale	Group A: 0.10 to 0.14 Group B: 0.14 to 0.21 Group C: 0.10 to 0.15 Group D: 0.07 to 0.12
Bioretention Basin	Group A: 0.13 Group B: 0.15 Group C: 0.08 Group D: 0.06

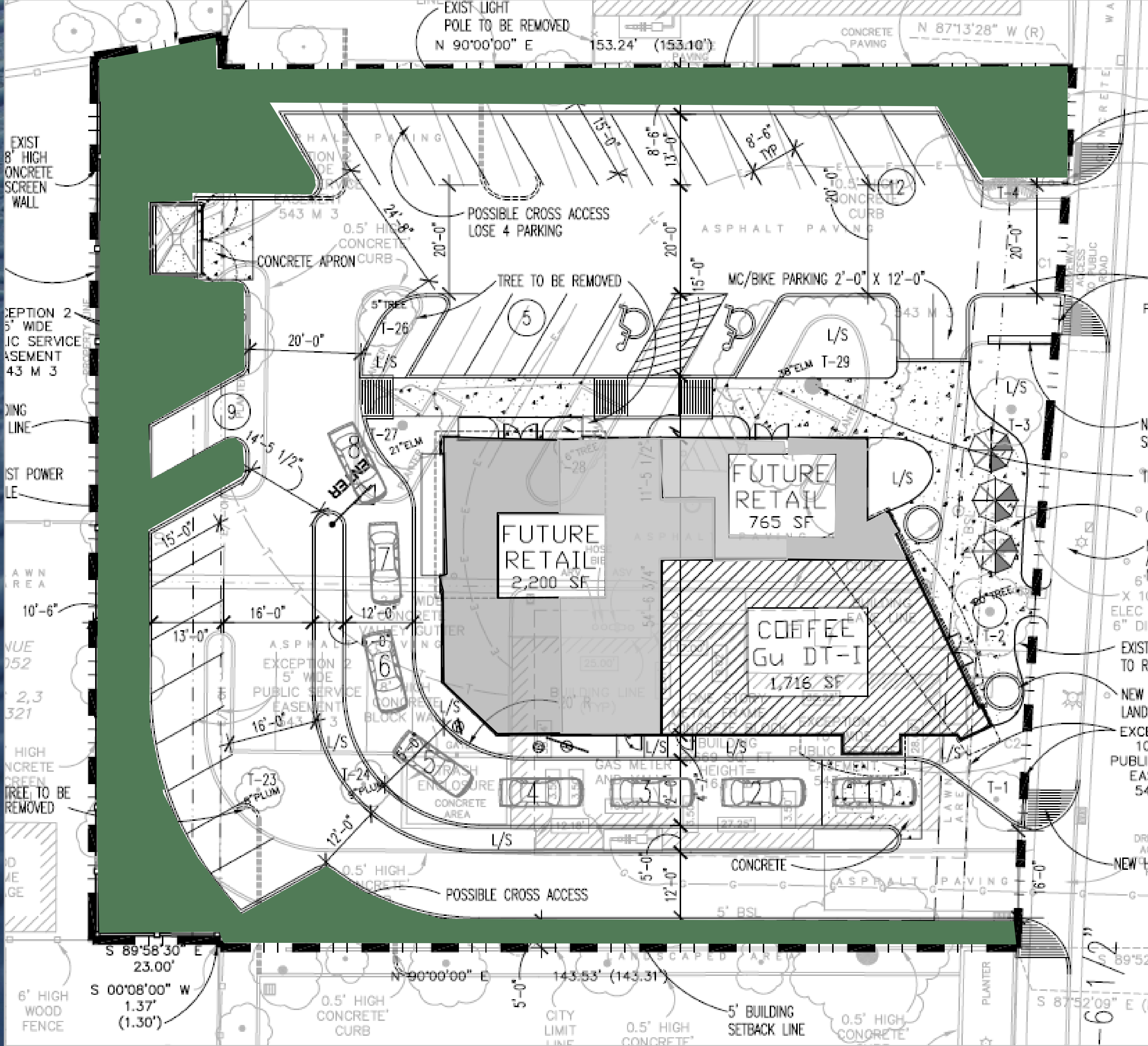
IMP	Sizing Factors
Dry Well	Group A: 0.05 to 0.06 Group B: 0.06 to 0.09
Infiltration Trench	Group A: 0.05 to 0.06 Group B: 0.07 to 0.10
Infiltration Basin	Group A: 0.05 to 0.10 Group B: 0.06 to 0.16

Adjustment to annual rainfall



Using LID with Sizing Factors

- Step-by-step instructions
- Intuitive interface
- Can be used by developer’s designer (engineer, architect, or tech)
- Demonstrates compliance with both treatment and flow-control requirements



EXIST LIGHT POLE TO BE REMOVED
N 90°00'00" E
153.24' (153.10')
CONCRETE PAVING
N 87°13'28" W (R)
EXIST 8' HIGH CONCRETE SCREEN WALL
POSSIBLE CROSS ACCESS LOSE 4 PARKING
CONCRETE APRON
0.5' HIGH CONCRETE CURB
ASPHALT PAVING
TREE TO BE REMOVED
MC/BIKE PARKING 2'-0" X 12'-0"
20'-0"
24'-8"
8'-6" TYP
15'-0"
20'-0"
14'-5 1/2"
15'-0"
13'-0"
10'-6"
16'-0"
12'-0"
5' WIDE CONCRETE VALLEY GUTTER
EXCEPTION 2 5' WIDE PUBLIC SERVICE EASEMENT 543 M 3
FUTURE RETAIL 2,200 SF
FUTURE RETAIL 765 SF
COFFEE Gu DT-I 1,716 SF
ENTER
L/S
T-1
T-2
T-3
T-4
T-23
T-24
T-26
T-27
T-28
T-29
TRASH ENCLOSURE
CONCRETE AREA
GAS METER
BUILDING LINE
CONCRETE
POSSIBLE CROSS ACCESS
5' BSL
TREE TO BE REMOVED
S 89°58'30" E 23.00'
S 00°08'00" W 1.37' (1.30')
N 90°00'00" E
143.53' (143.31')
6' HIGH WOOD FENCE
0.5' HIGH CONCRETE CURB
CITY LIMIT LINE
5' BUILDING SETBACK LINE
LANDSCAPED AREA
PLANTER
S 87°52'09" E


369 South Winchester Blvd, San Jose, CA
© 2006 Navteq
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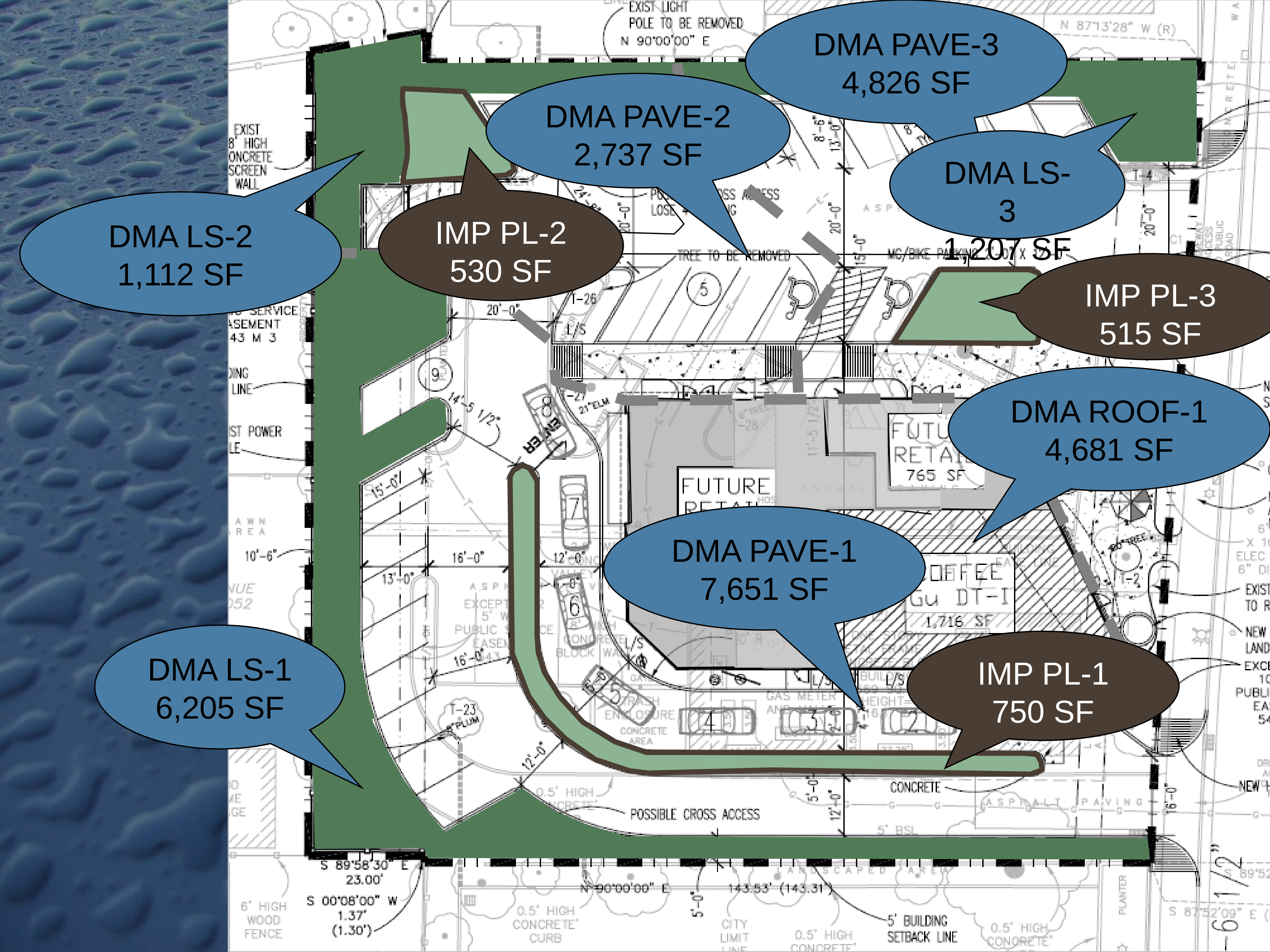
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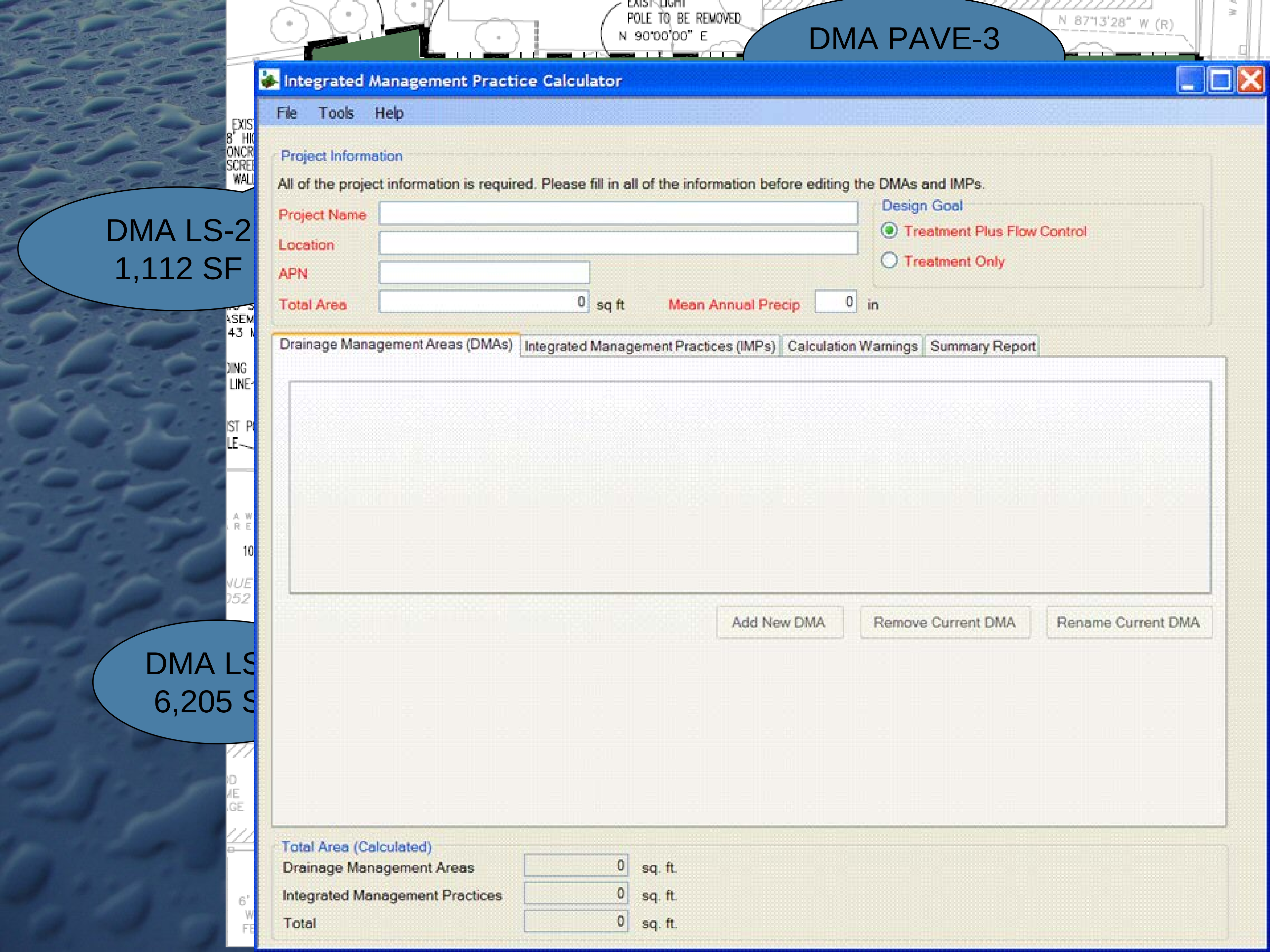
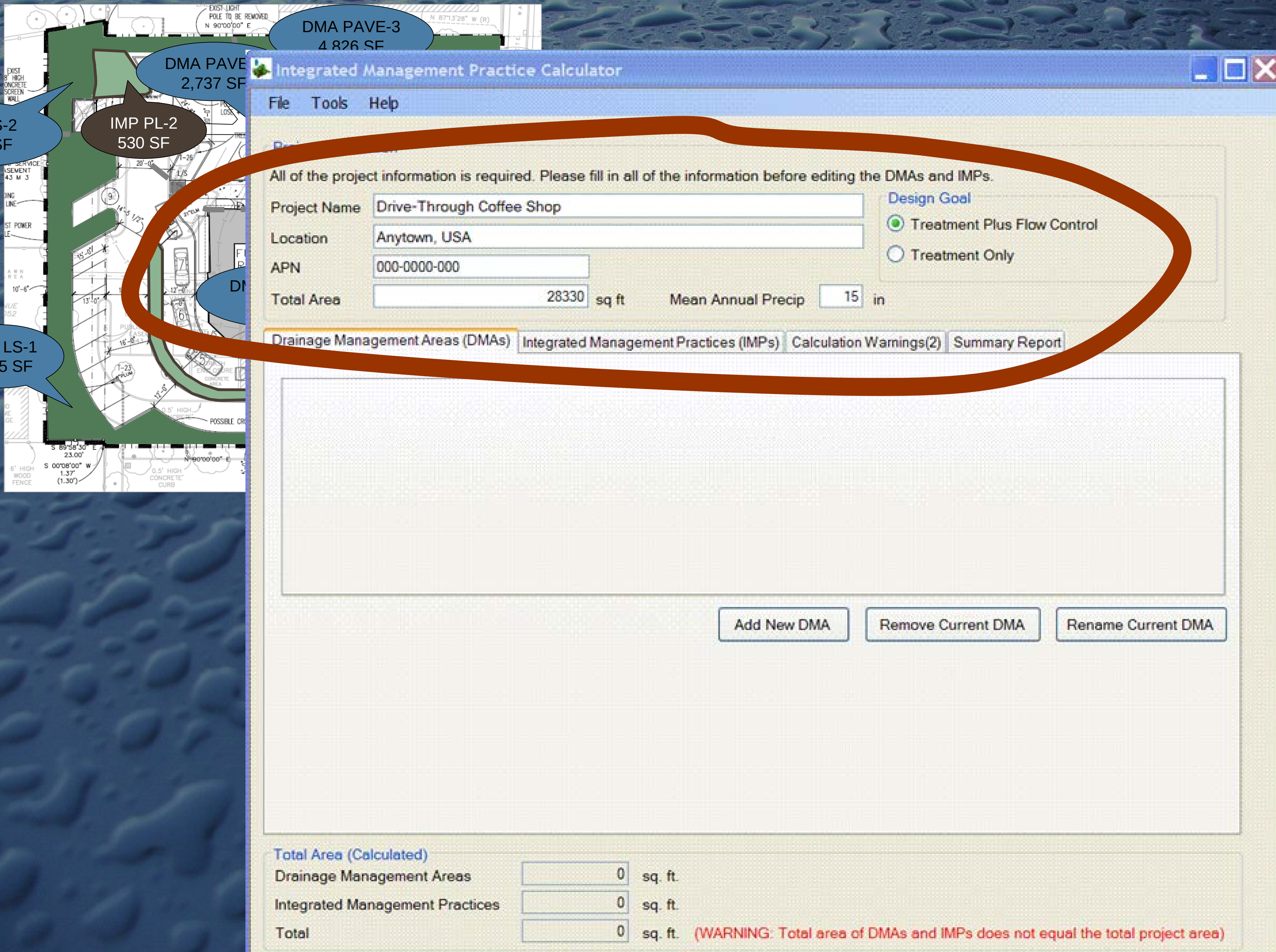
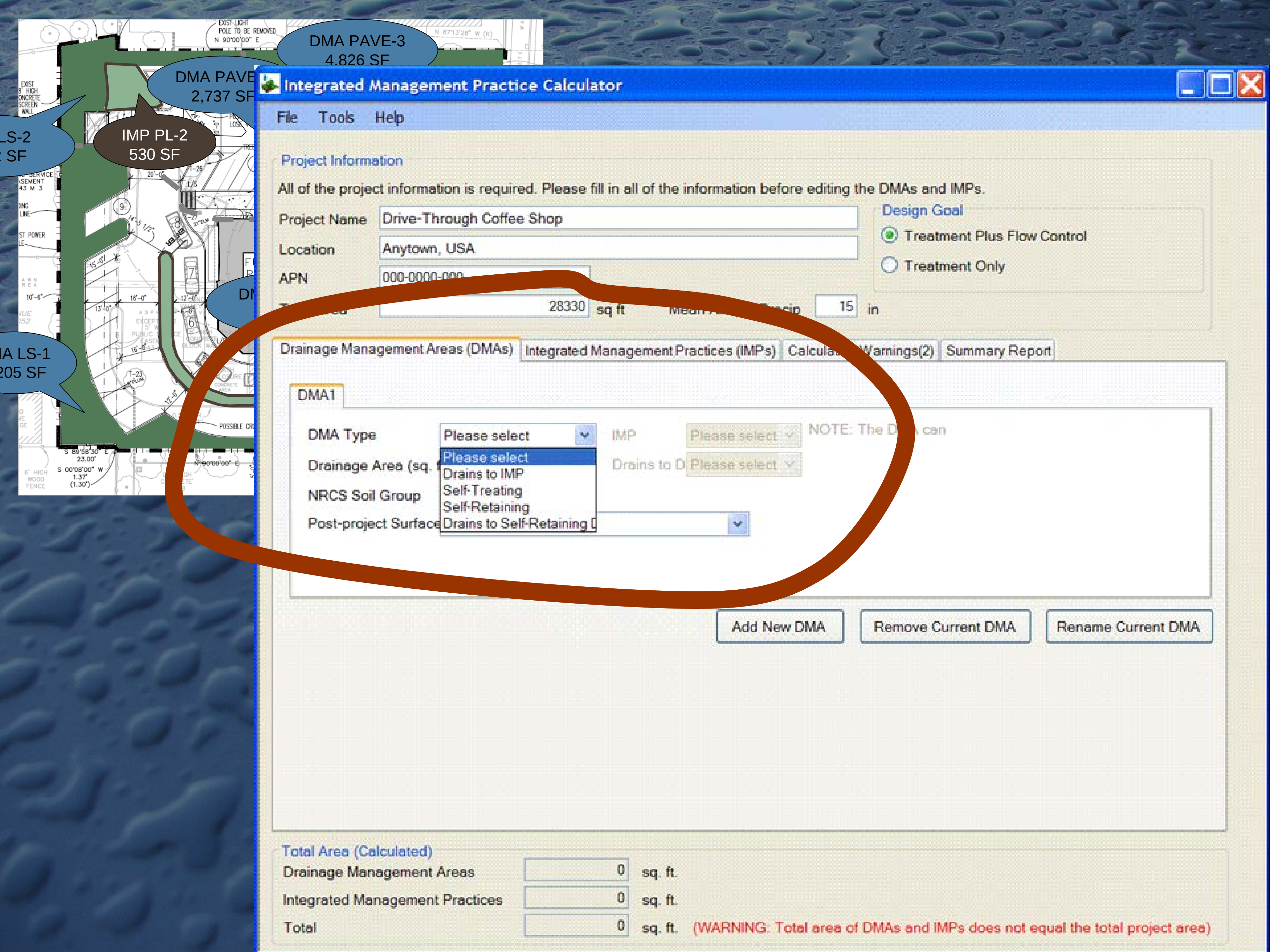
4,826 SF
DMA PAVE-2
2,737 SF
DMA LS-
3
1,207 SF
DMA LS-2
1,112 SF
IMP PL-2
530 SF
IMP PL-3
515 SF
DMA ROOF-1
4,681 SF
DMA PAVE-1
7,651 SF
DMA LS-1
6,205 SF
IMP PL-1
750 SF
POSSIBLE CROSS ACCESS
FUTURE RETAIL
765 SF
CONCRETE
5' BUILDING SETBACK LINE


DMA PAVE-3
DMA LS-2
1,112 SF
POLE TO BE REMOVED
N 90°00'00" E
N 87°13'28" W (R)
Integrated Management Practice Calculator
File Tools Help
Project Information
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name
Location
APN
Total Area 0 sq ft
Mean Annual Precip 0 in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Integrated Management Practices (IMPs)
Calculation Warnings
Summary Report
Add New DMA
Remove Current DMA
Rename Current DMA
Total Area (Calculated)
Drainage Management Areas 0 sq. ft.
Integrated Management Practices 0 sq. ft.
Total 0 sq. ft.


DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
2 SF
A LS-1
205 SF
Integrated Management Practice Calculator
File
Tools
Help
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name
Drive-Through Coffee Shop
Location
Anytown, USA
APN
000-0000-000
Total Area
28330
sq ft
Mean Annual Precip
15
in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Integrated Management Practices (IMPs)
Calculation Warnings(2)
Summary Report
Add New DMA
Remove Current DMA
Rename Current DMA
Total Area (Calculated)
Drainage Management Areas
0
sq. ft.
Integrated Management Practices
0
sq. ft.
Total
0
sq. ft.
(WARNING: Total area of DMAs and IMPs does not equal the total project area)



DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
SF
A LS-1
205 SF
Integrated Management Practice Calculator
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Help
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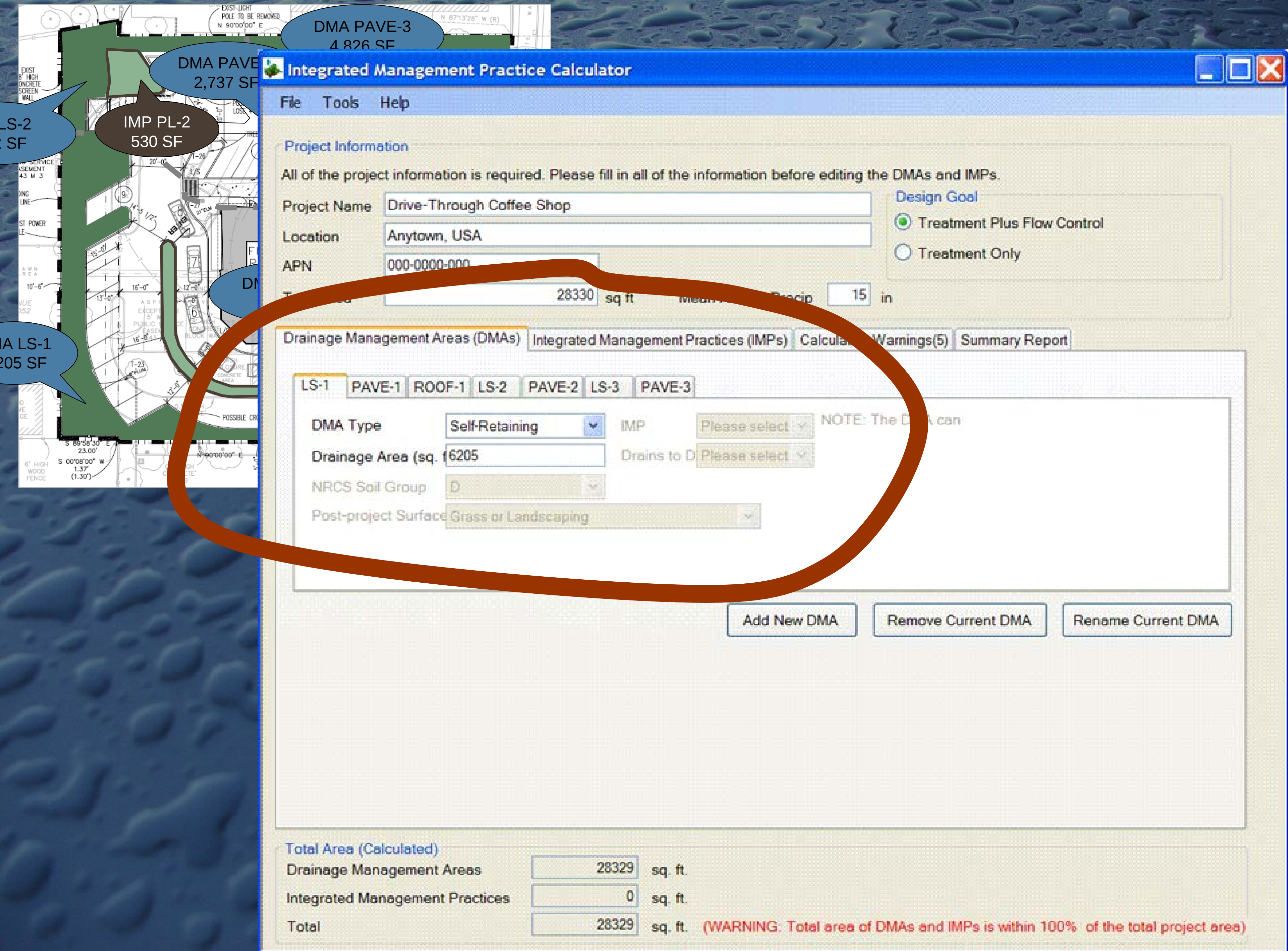
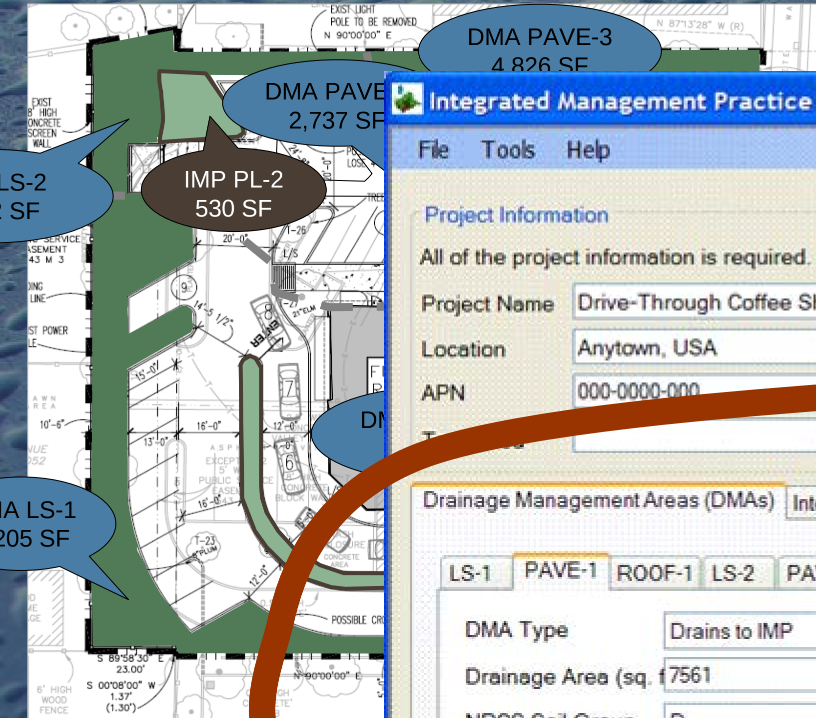
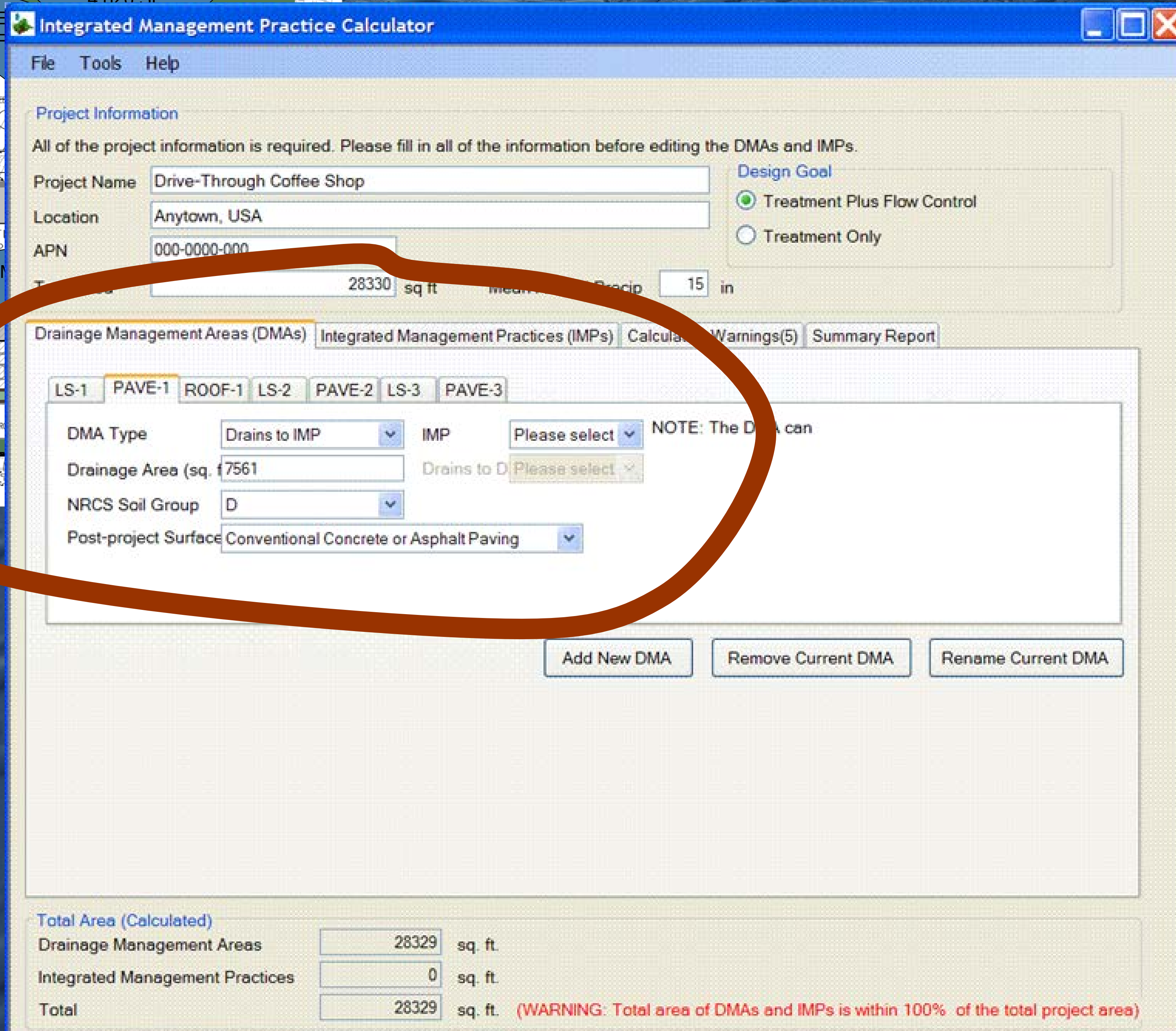
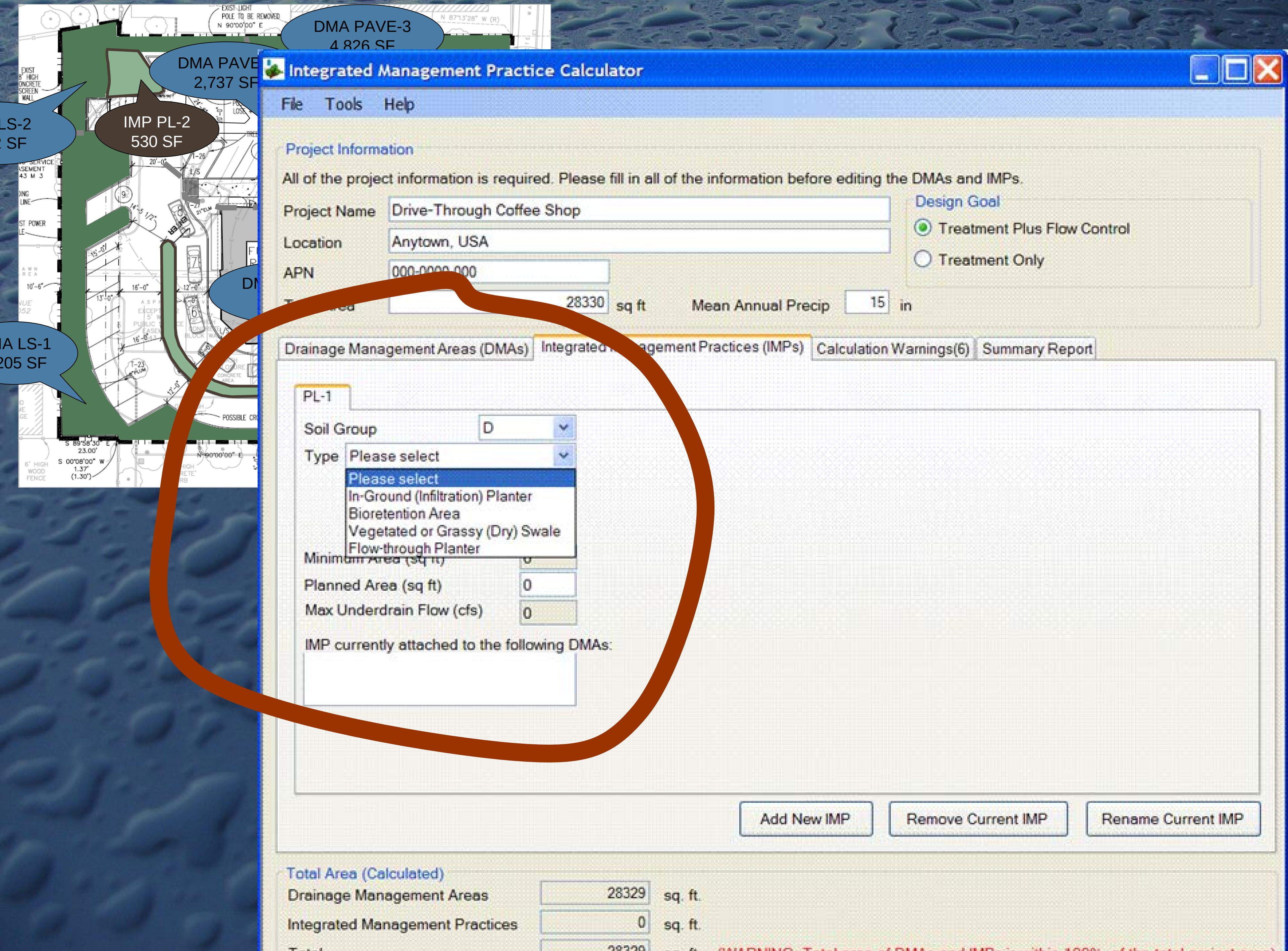
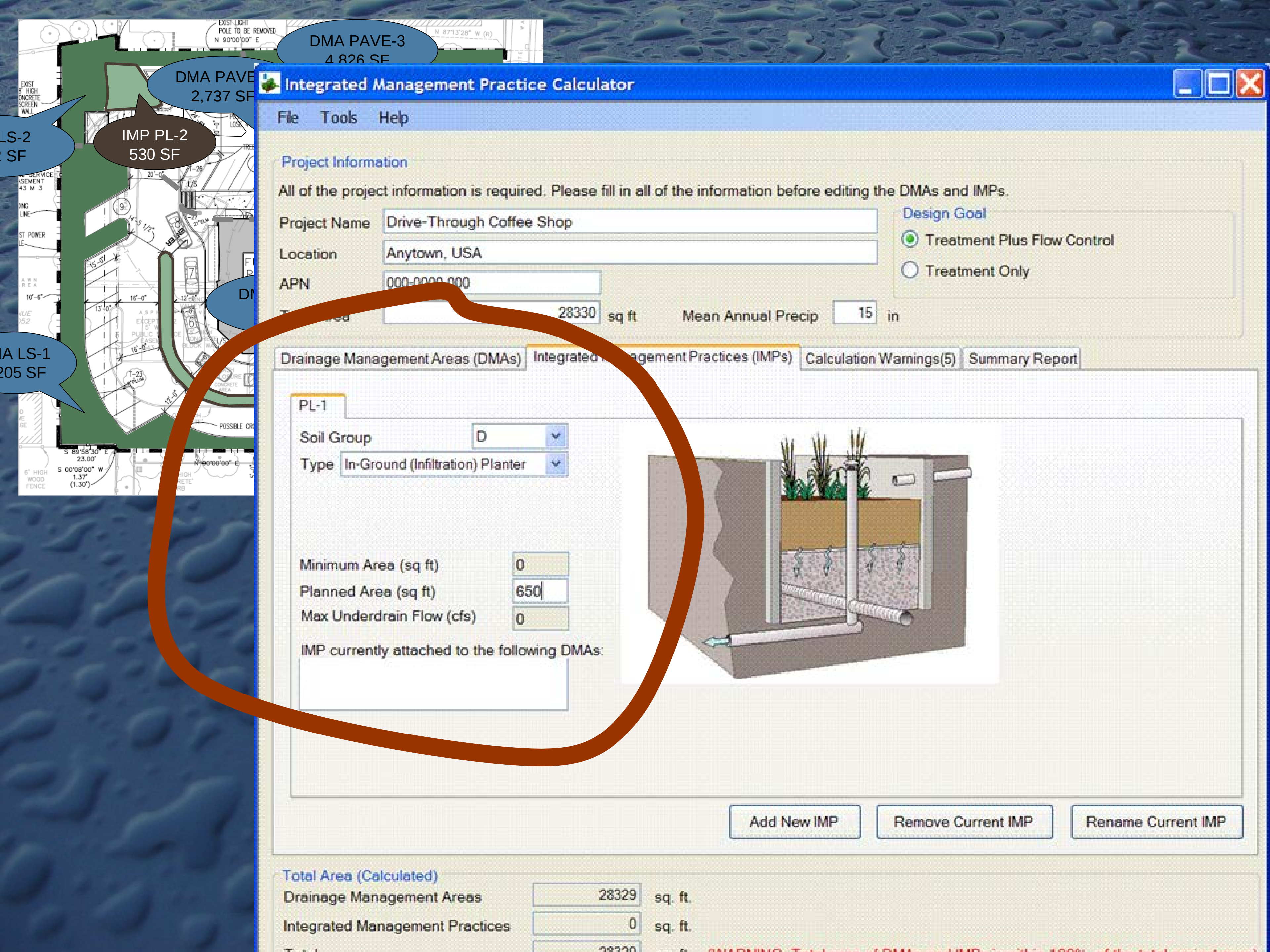
Project Name
Drive-Through Coffee Shop
Location
Anytown, USA
APN
000-0000-000
28330
sq ft
15
in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Integrated Management Practices (IMPs)
Warnings(2)
Summary Report
DMA1
DMA Type
Please select
Please select
Drains to IMP
Self-Treating
Self-Retaining
Drains to Self-Retaining D
IMP
Please select
Drains to D
Please select
NOTE: The D can
Drainage Area (sq.
NRCS Soil Group
Post-project Surface
Add New DMA
Remove Current DMA
Rename Current DMA
Total Area (Calculated)
Drainage Management Areas
0
sq. ft.
Integrated Management Practices
0
sq. ft.
Total
0
sq. ft.
(WARNING: Total area of DMAs and IMPs does not equal the total project area)



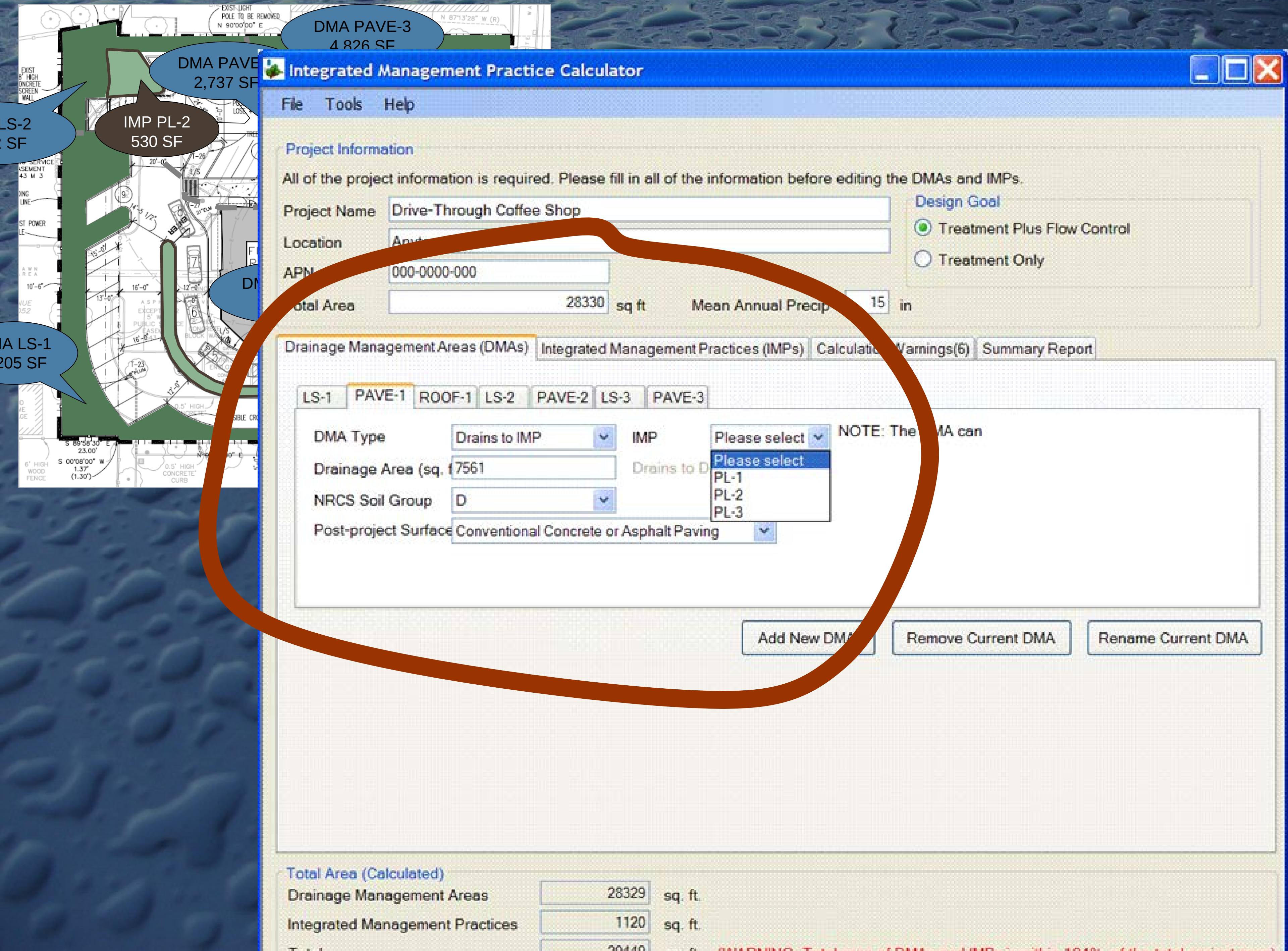
DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
SF
A LS-1
205 SF
Integrated Management Practice Calculator
File
Tools
Help
Project Information
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name
Drive-Through Coffee Shop
Location
Anytown, USA
APN
000-0000-000
28330
sq ft
15
in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Integrated Management Practices (IMPs)
Warnings(5)
Summary Report
LS-1
PAVE-1
ROOF-1
LS-2
PAVE-2
LS-3
PAVE-3
DMA Type
Self-Retaining
IMP
Please select
Drainage Area (sq.
6205
NRCS Soil Group
D
Post-project Surface
Grass or Landscaping
Add New DMA
Remove Current DMA
Rename Current DMA
Total Area (Calculated)
Drainage Management Areas
28329
sq. ft.
Integrated Management Practices
0
sq. ft.
Total
28329
sq. ft.
(WARNING: Total area of DMAs and IMPs is within 100% of the total project area)


DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
2 SF
A LS-1
205 SF
EXIST LIGHT POLE TO BE REMOVED
N 90°00'00" E
S 89°58'30" E
23.00'
S 00°08'00" W
1.37'
(1.30')
N 90°00'00" E
6' HIGH WOOD FENCE
POSSIBLE CR

Integrated Management Practice Calculator
File Tools Help
Project Information
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name Drive-Through Coffee Shop
Location Anytown, USA
APN 000-0000-000
28330 sq ft
15 in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Integrated Management Practices (IMPs)
Warnings(5)
Summary Report
LS-1 PAVE-1 ROOF-1 LS-2 PAVE-2 LS-3 PAVE-3
DMA Type Drains to IMP
IMP Please select
NOTE: The D can
Drainage Area (sq. f 7561
Drains to D Please select
NRCS Soil Group D
Post-project Surface Conventional Concrete or Asphalt Paving
Add New DMA
Remove Current DMA
Rename Current DMA
Total Area (Calculated)
Drainage Management Areas 28329 sq. ft.
Integrated Management Practices 0 sq. ft.
Total 28329 sq. ft. (WARNING: Total area of DMAs and IMPs is within 100% of the total project area)

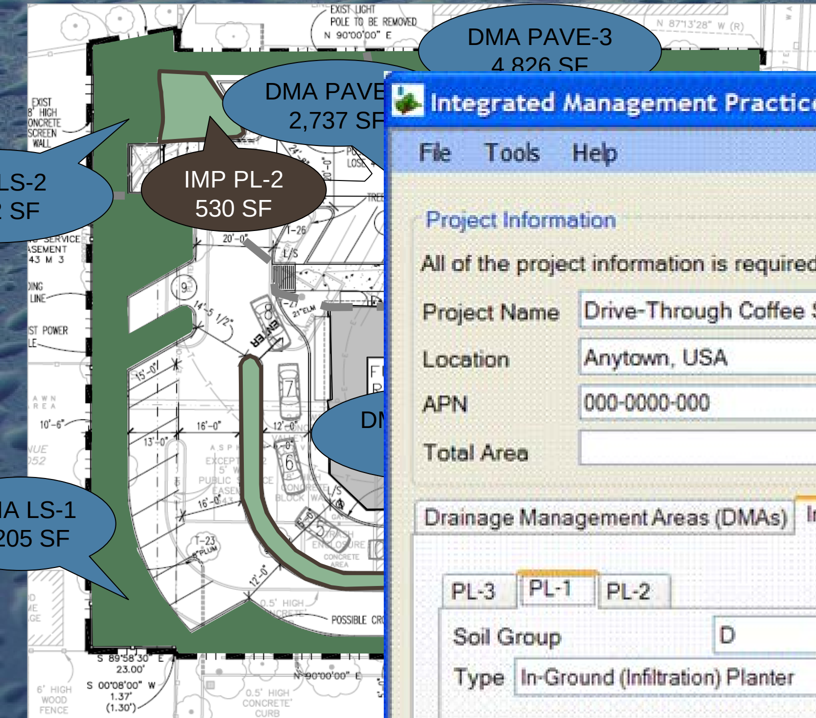

DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
A LS-1
205 SF
Integrated Management Practice Calculator
File
Tools
Help
Project Information
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name
Drive-Through Coffee Shop
Location
Anytown, USA
APN
28330
sq ft
Mean Annual Precip
15
in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Calculation Warnings(6)
Summary Report
PL-1
Soil Group
D
Type
Please select
Please select
In-Ground (Infiltration) Planter
Bioretention Area
Vegetated or Grassy (Dry) Swale
Flow-through Planter
Planned Area (sq ft)
0
Max Underdrain Flow (cfs)
0
IMP currently attached to the following DMAs:
Add New IMP
Remove Current IMP
Rename Current IMP
Total Area (Calculated)
Drainage Management Areas
28329
sq. ft.
Integrated Management Practices
0
sq. ft.



DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
A LS-1
205 SF
Integrated Management Practice Calculator
File
Tools
Help
Project Information
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name
Drive-Through Coffee Shop
Location
Anytown, USA
APN
28330
sq ft
Mean Annual Precip
15
in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Summary Report
PL-1
Soil Group
D
Type
In-Ground (Infiltration) Planter
Minimum Area (sq ft)
0
Planned Area (sq ft)
650
Max Underdrain Flow (cfs)
0
IMP currently attached to the following DMAs:
Add New IMP
Remove Current IMP
Rename Current IMP
Total Area (Calculated)
Drainage Management Areas
28329
sq. ft.
Integrated Management Practices
0
sq. ft.



DMA PAVE-3
4,826 SF
DMA PAVE
2,737 SF
IMP PL-2
530 SF
LS-2
2 SF
A LS-1
205 SF
Integrated Management Practice Calculator
File
Tools
Help
Project Information
All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.
Project Name
Drive-Through Coffee Shop
Location
APN
000-0000-000
Total Area
28330
sq ft
Mean Annual Precip
15
in
Design Goal
Treatment Plus Flow Control
Treatment Only
Drainage Management Areas (DMAs)
Integrated Management Practices (IMPs)
Warnings(6)
Summary Report
LS-1
PAVE-1
ROOF-1
LS-2
PAVE-2
LS-3
PAVE-3
DMA Type
Drains to IMP
IMP
Please select
Please select
PL-1
PL-2
PL-3
Drainage Area (sq. f
7561
NRCS Soil Group
D
Post-project Surface
Conventional Concrete or Asphalt Paving
Add New DMA
Remove Current DMA
Rename Current DMA
Total Area (Calculated)
Drainage Management Areas
28329
sq. ft.
Integrated Management Practices
1120
sq. ft.



Integrated Management Practice Calculator [Drive-throughCoffee.xml]

File Tools Help

Project Information

All of the project information is required. Please fill in all of the information before editing the DMAs and IMPs.

Project Name	Drive-Through Coffee Shop
Location	Anytown, USA
APN	000-0000-000
Total Area	28330 sq ft
Mean Annual Precip	15 in

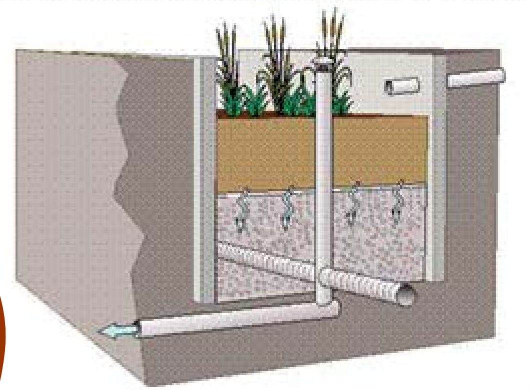
Design Goal

- (•) Treatment Plus Flow Control
- ( ) Treatment Only

Drainage Management Areas (DMAs) | Integrated Management Practices (IMPs) | Calculation Warnings(1) | Summary Report

PL-3 | PL-1 | PL-2

Soil Group	D
Type	In-Ground (Infiltration) Planter



Minimum Area (sq ft)	738
Planned Area (sq ft)	750
Max Underdrain Flow (cfs)	0.0146

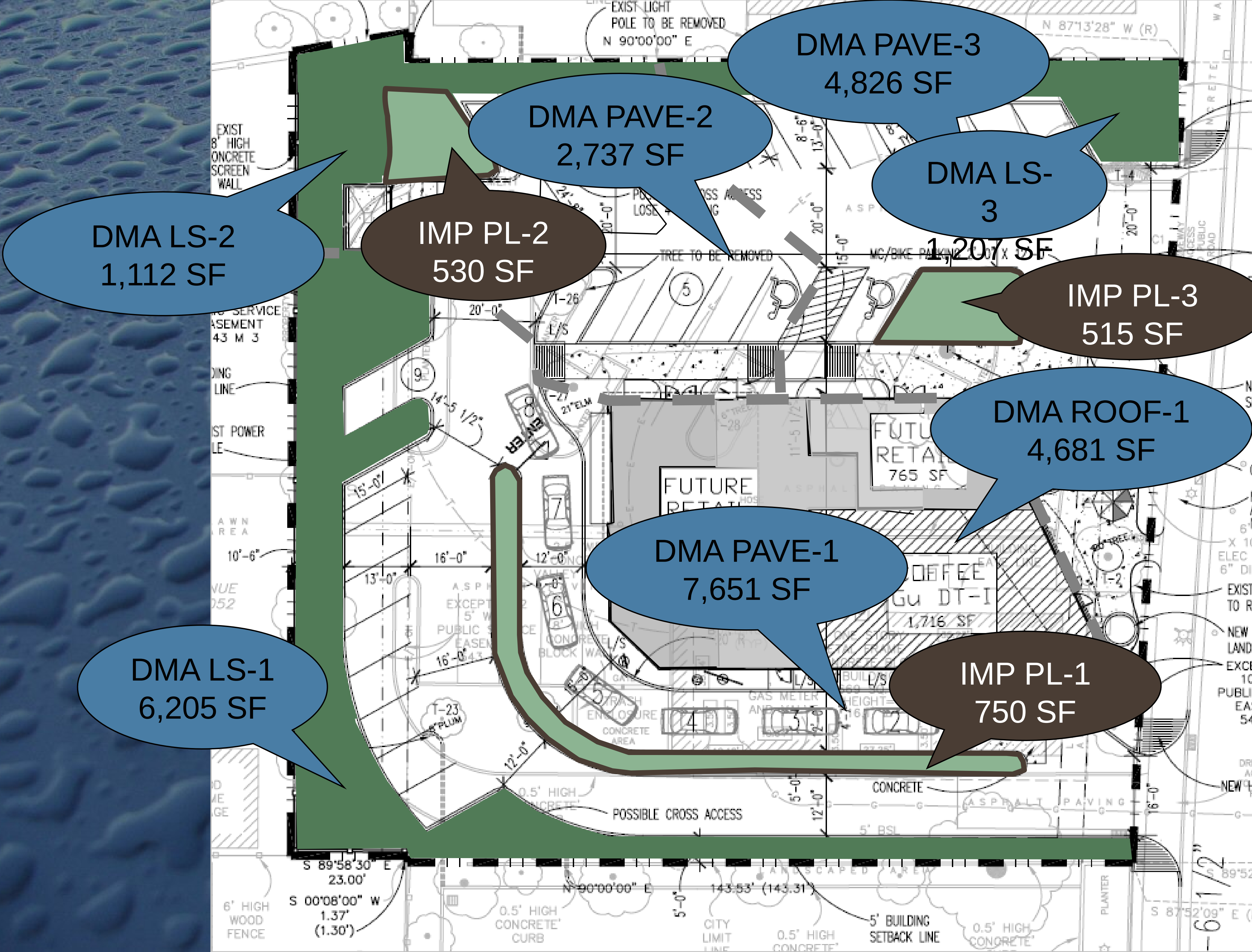
IMP currently attached to the following DMAs:

PAVE-1 ROOF-1

Add New IMP | Remove Current IMP | Rename Current IMP

Total Area (Calculated)

Drainage Management Areas	27609	sq. ft.
Integrated Management Practices	1270	sq. ft.


DMA PAVE-3
4,826 SF
DMA PAVE-2
2,737 SF
DMA LS-
3
1,207 SF
DMA LS-2
1,112 SF
IMP PL-2
530 SF
IMP PL-3
515 SF
DMA ROOF-1
4,681 SF
DMA PAVE-1
7,651 SF
DMA LS-1
6,205 SF
IMP PL-1
750 SF

Contra Costa IMP Calculator Summary Report - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

file:///C:/Data$/Projects/Consulting/SacramentoHMP/Drive-throughCoffee.html

Project Name: Drive-Through Coffee Shop
Project Type: Flow Control and Water Quality
Location: Anytown, USA
APN: 000-0000-000
Drainage Area: 28330 (sf)
Mean Annual Precipitation: 15 (in)

Drainage Management Areas Draining to IMPs

IMP										Tributary DMAs					
Name	**Type**	**Soil Group**	**Rain Adj. Factor**	**Sizing Factor**	**Dim. 1 (ft)**	**Dim. 2 (ft)**	**Min. Size**	**Planned Size**	**Max Underdrain Flow (cfs)**	**Name**	**Surface Type**	**Area**	**Runoff Factor**	**Min IMP Size**	**Contribution to Max Underdrain Flow (cfs)**
PL-3	In-Ground (Infiltration) Planter	D	1.23	0.05	-	-	282 sq ft	300 sq ft	0.0056	PAVE-3	Conventional Concrete or Asphalt Paving	4576	1	282	-
PL-1	In-Ground (Infiltration) Planter	D	1.23	0.05	-	-	738 sq ft	750 sq ft	0.0147	PAVE-1	Conventional Concrete or Asphalt Paving	7311	1	450	-
										ROOF-1	Roofs	4681	1	288	-
PL-2	In-Ground (Infiltration) Planter	D	1.23	0.05	-	-	155 sq ft	220 sq ft	0.0031	PAVE-2	Conventional Concrete or Asphalt Paving	2517	1	155	-

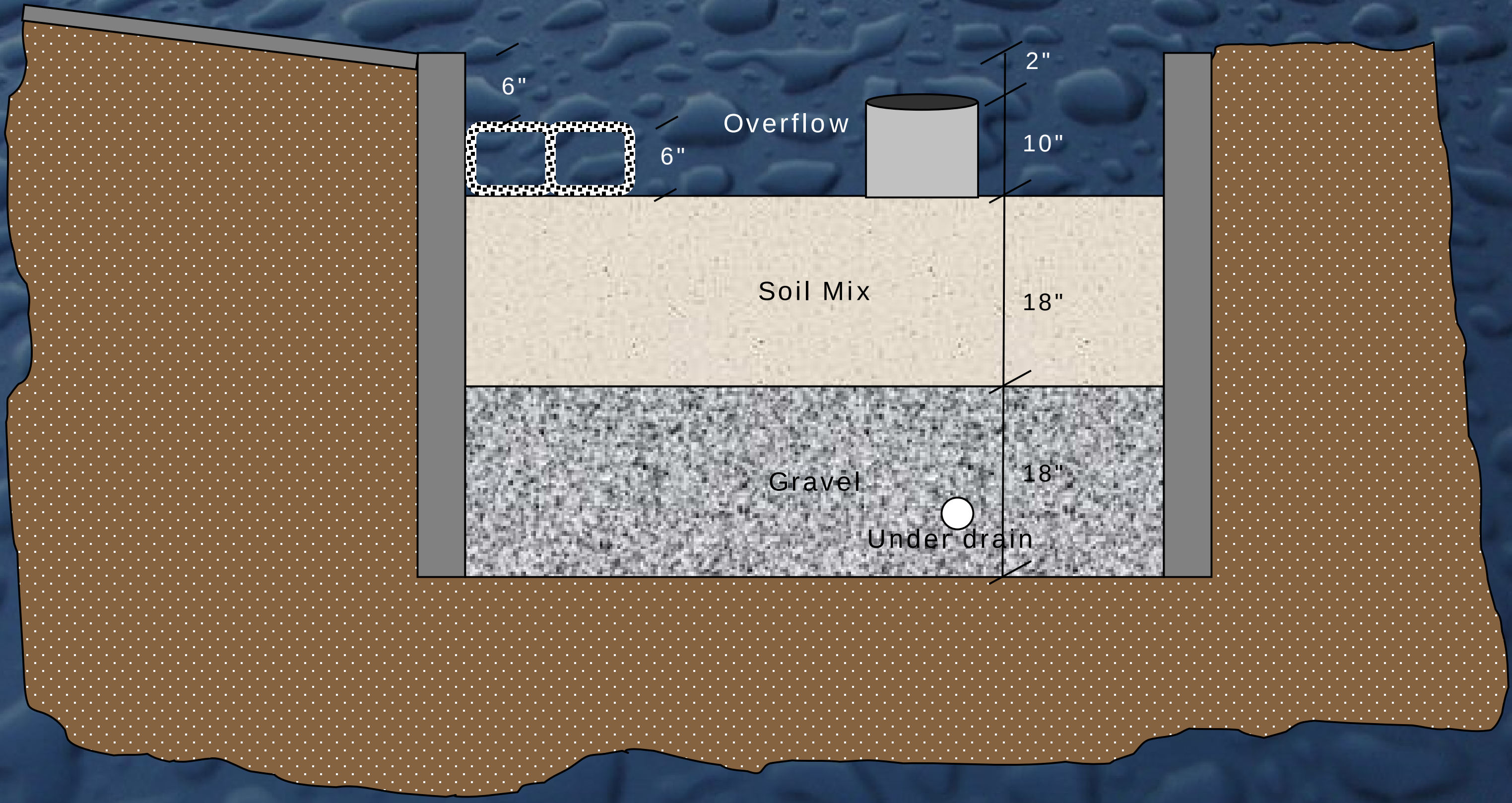
Done

How “real” are sizing factors?

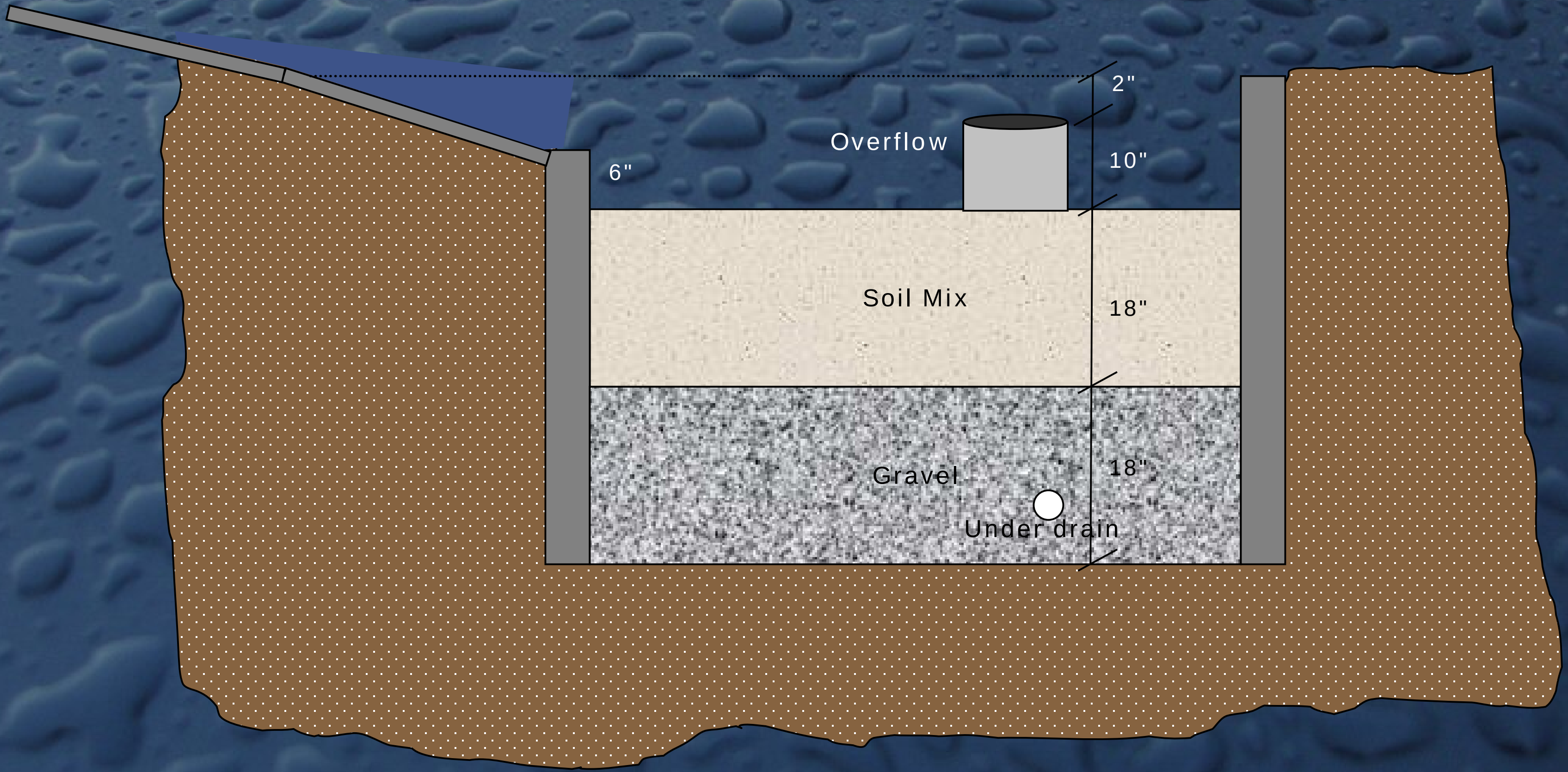
- Applied a model intended for watershed scale to site scale
- Sizing factors are minimums, facilities are actually built larger
- Used textbook or countywide values for input parameters
- Didn’t account for losses or inefficiencies in drainage systems

Next: Improved IMPs

Abating the drop-off problem

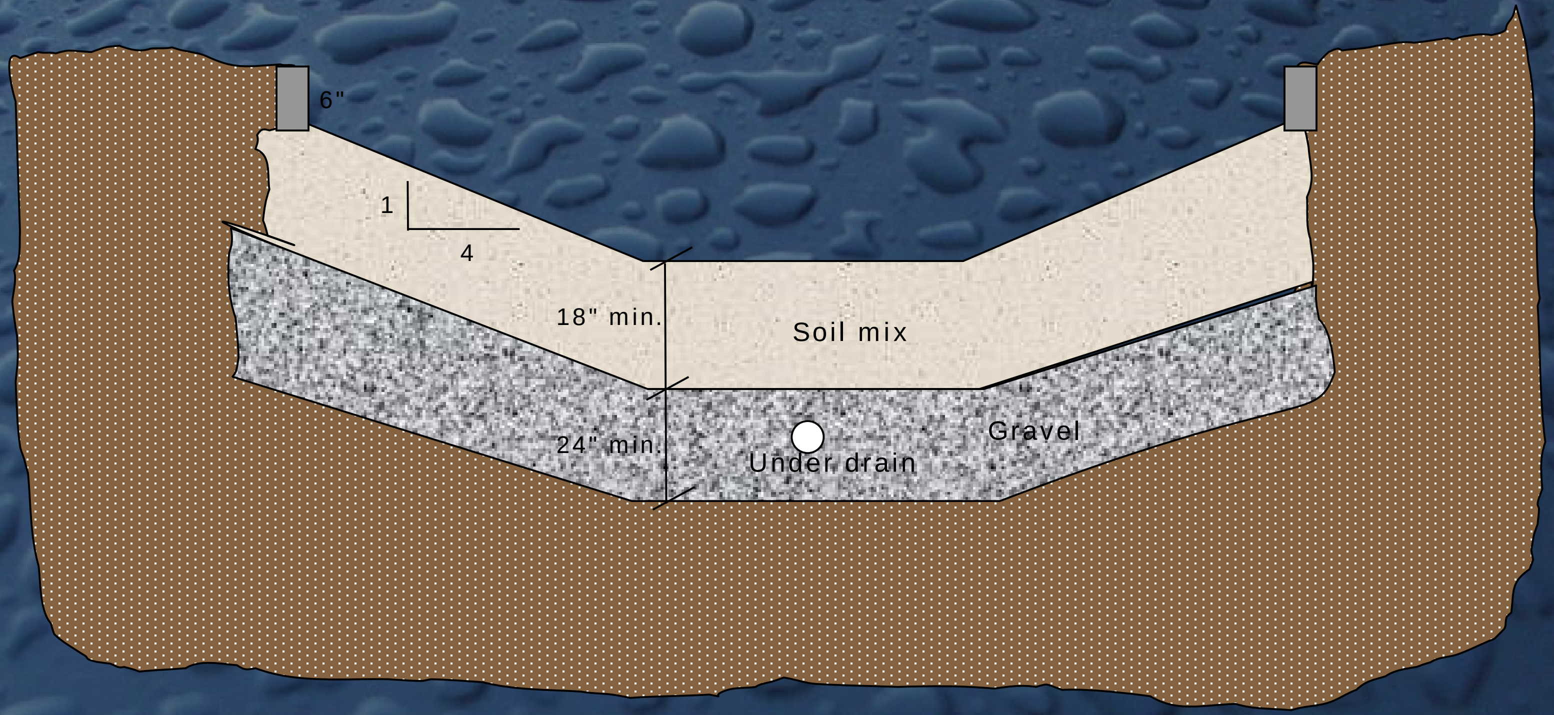


Floodable pavement

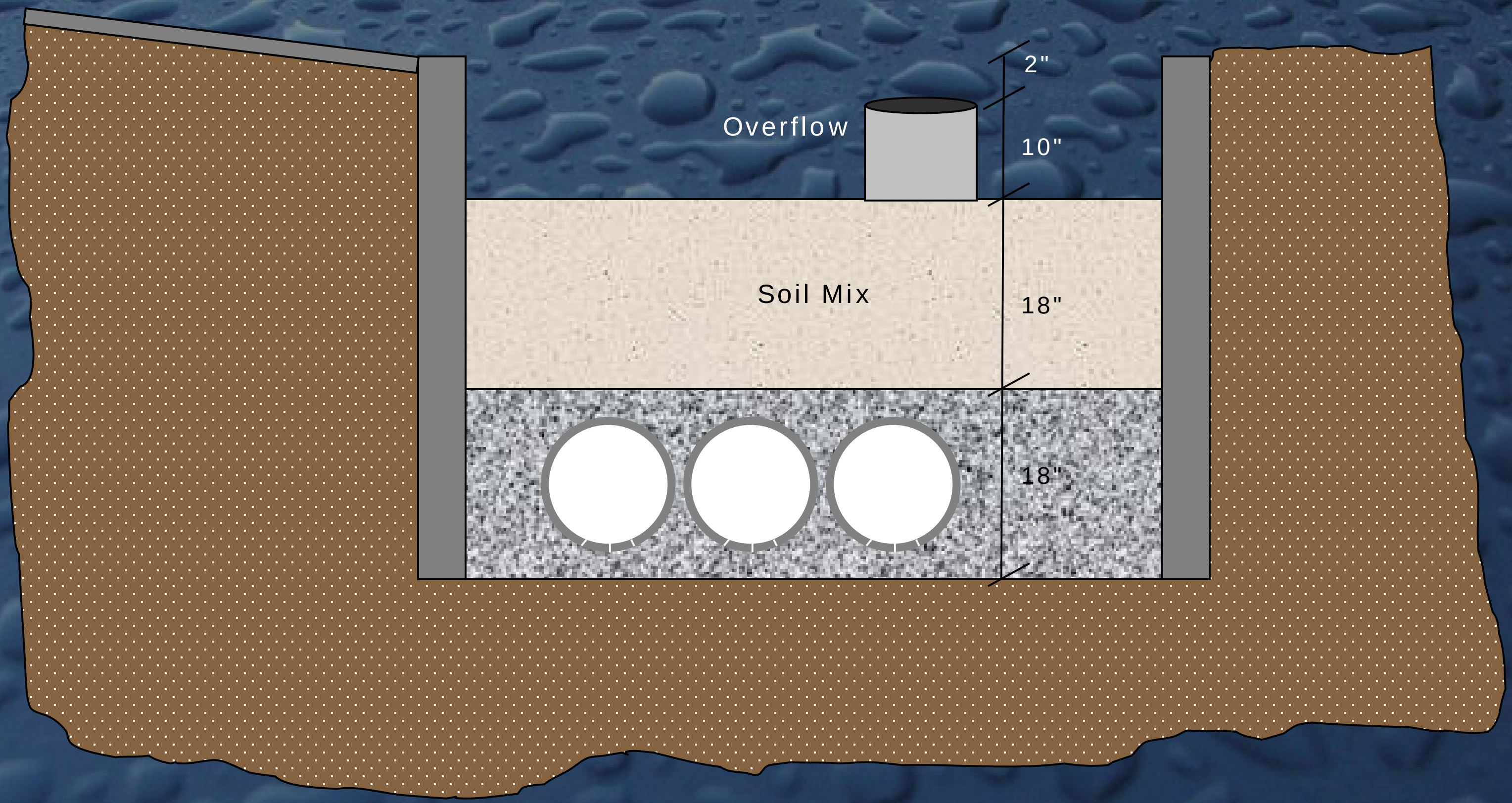


Cistern and bioretention

Enhanced swale section



Enhanced underground storage



Conclusions

- Design criteria for stormwater facilities are always “best professional judgment.”
- Modeling provides some insights, but perhaps just as many illusions.
- More useful insights come from observations and tinkering.
- That requires building and operating many facilities over a long period.