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Examples of WinSLAMM use for Small Stormwater Controls at SERDP ER18-1371 Monitoring Locations and Spreadsheet Calculations

WinSLAMM was developed and has been used to evaluate stormwater controls for a variety of scales. Prior to the current project, WinSLAMM was used to calculate the stormwater characteristics at a number of naval facilities. The model was calibrated and verified using detailed site characterizations at 19 drainages on 11 Navy Bases in the Southwest, Mid-Atlantic, and Northwest regions of the US. The sites evaluated ranged from 1 to 1400 acres in size. During the current project, biofilters at the San Diego, proprietary media filters at the Puget Sound Naval Bases, and the larger site pond at the Reese Technology Center, are currently being modeled.

Simplified spreadsheets previously developed for the navy will be expanded to include stormwater control production functions and stormwater control costs. An example of a prior version is attached.

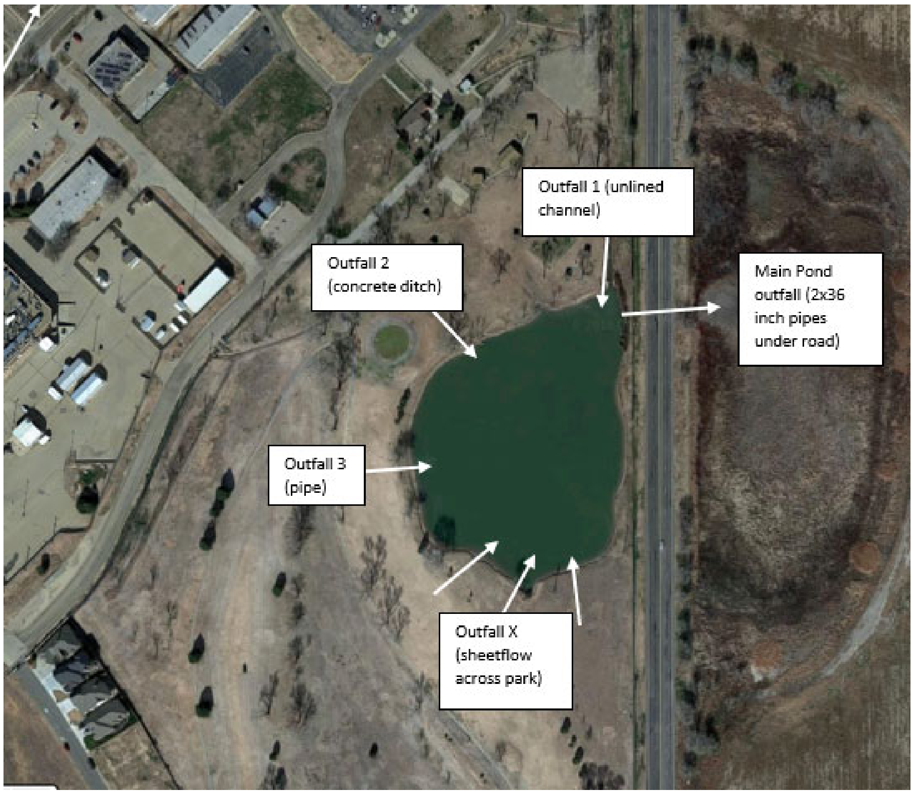
The following is a brief summary of the preliminary evaluation for Picnic Lake at Reese, and for the commissary biofilter at NBSD, showing how WinSLAMM is used for these types of areas and stormwater controls.

Picnic Lake, Reese Technology Center, WinSLAMM Evaluation

WinSLAMM evaluated a wide range of rains at the Reese Technology Center to identify sources of stormwater contaminants. The major sources examined includes flat roofs, paved parking areas, streets, large turf areas, and the old airfield apron. The runoff volume, and especially the particulate sources, are the most important and drive the discharges for the pollutants of interest.

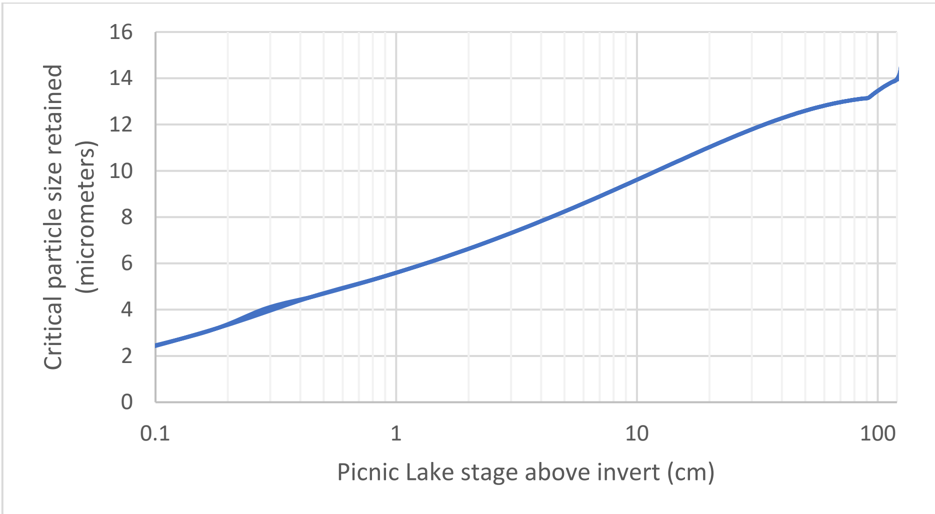
- For the smallest rains, most of the flows originate from the paved parking and old airport apron areas. At the rain depth increased to about 25mm, flat roofs and streets were also important with some runoff originating from the large turf areas. For the largest rains. The paved parking areas contributed about 27%, the old airport apron contributed about 22%, large turf areas contributed about 17%, and the flat roofs contribute about 13% of the total.
- Particulate solids sources were quite different, especially for the large rains. For the smallest rains, paved parking and the old airfield apron were the major sources, with streets being important for small rains up to about 13 mm. For the 25 mm rain, these two areas still comprised the majority of the particulate solids discharges, while for the largest rains, the large turf areas were the major source, with the two large paved areas also important. Roofs were never significant sources (due to low concentrations.
- Phosphorus sources during the small rains were dominated by the streets and the large paved areas, while the large turf areas become major sources for rains greater than about 25mm.
- Copper and zinc sources were similar, with paved parking areas being most important, along with streets for all rains. Roofs, landscaped areas, and the old airfield apron each contributed about 10% of the zinc sources, and much smaller fractions of the copper sources.

Four main areas drain into Picnic Lake, three through discharge points and one as sheetflow. The total drainage area is about 255 acres and the lake is about 4 acres (1.6% of the drainage area). About half of the total area is comprised of directly connected paved areas (mainly parking areas and the old airfield apron, plus streets, roofs, and walkways). The following is an aerial photograph of Picnic Lake.

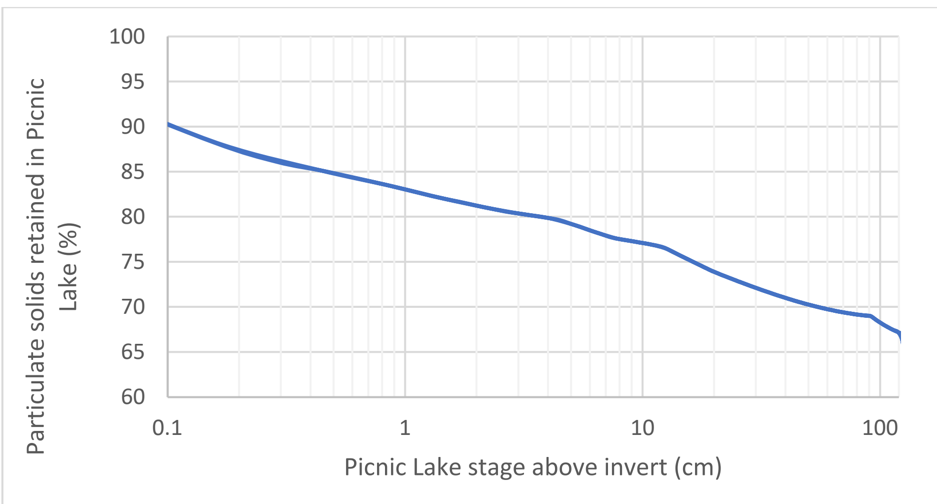


Picnic Lake and outfall locations

Picnic Lake retention production functions were also prepared using WinSLAMM, as shown on the following two figures. The first plot is a plot of the critical particle size retained in Picnic Lake for different water surface elevations above the outlet invert. The maximum 6-cm increase is associated with 9 µm particles, and the second figure indicates that this stage would be associated with about an 80% reduction in particulate solids. Again, this is the maximum value associated with peak inflow rates and would be greater for most of the rain event. This calculated worst-case removal compares to the observed average performance of about 93% for the complete event.

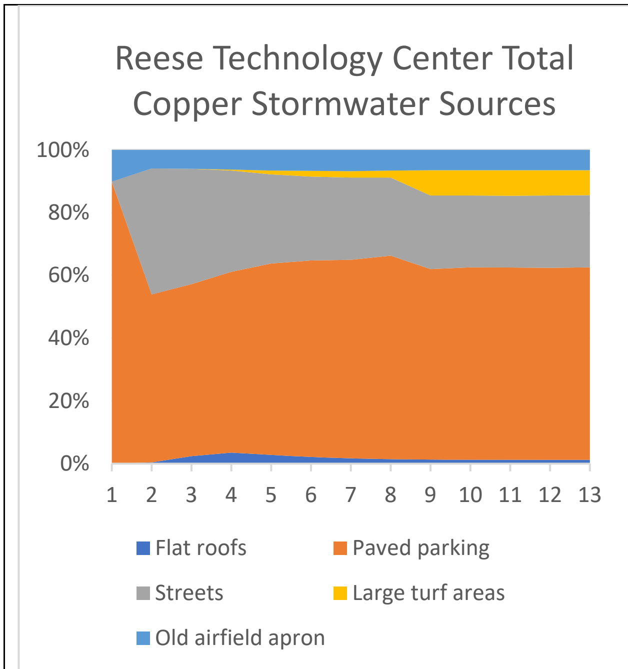


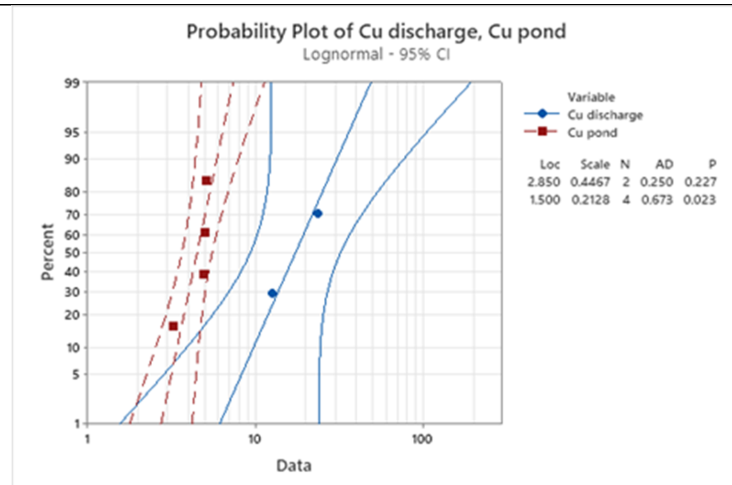
Critical particle size (µm) vs. Picnic Lake stage above invert (cm)



Percent particulate solids controlled vs. Picnic Lake stage above invert (cm)

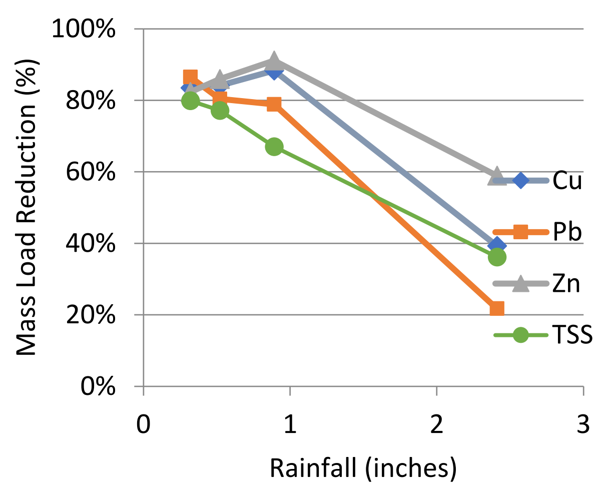
The following is an example plot of the WinSLAMM source calculations for copper, indicating the paved parking areas at Reese Technology Center are the predominant source. Source area controls, such as biofilters, can be constructed at these locations to decrease their discharges, as an alternative to the pond (pond performance for copper also shown on the group probability plot).





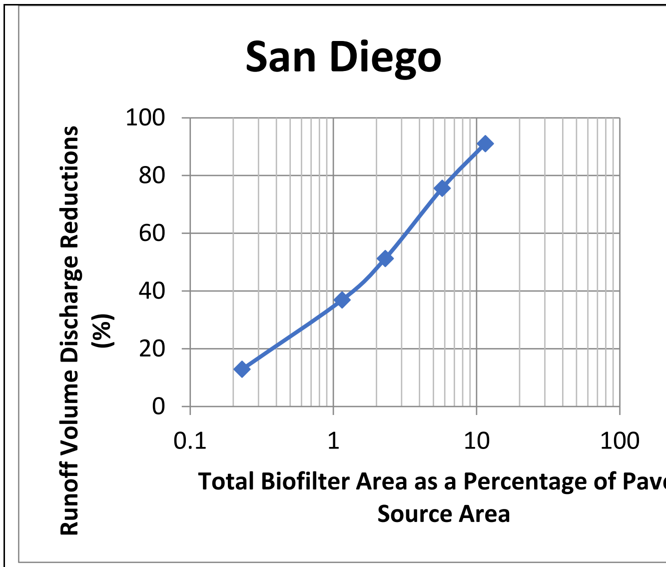
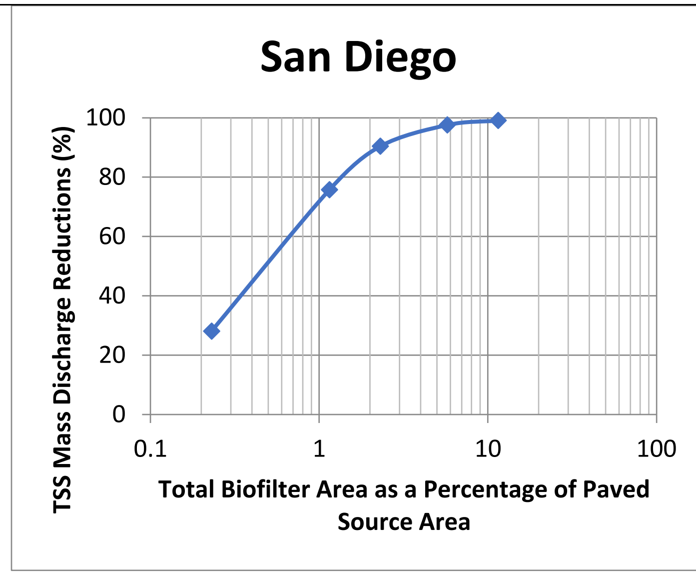
Commissary Biofilter, Naval Base San Diego, WinSLAMM Evaluation

Another example of a WinSLAMM evaluation of small stormwater controls is shown below for the monitored biofilter at the Naval Base San Diego location. The final constructed size of the biofilter cell was about 640 ft^2 with an estimated drainage (paved parking lot) of 0.38 acres based on a topographic survey. The biofilter was therefore about 4% of the paved drainage area. WinSLAMM was calibrated and verified using monitoring data and production functions were developed showing how the performance varies for different site and rain conditions.



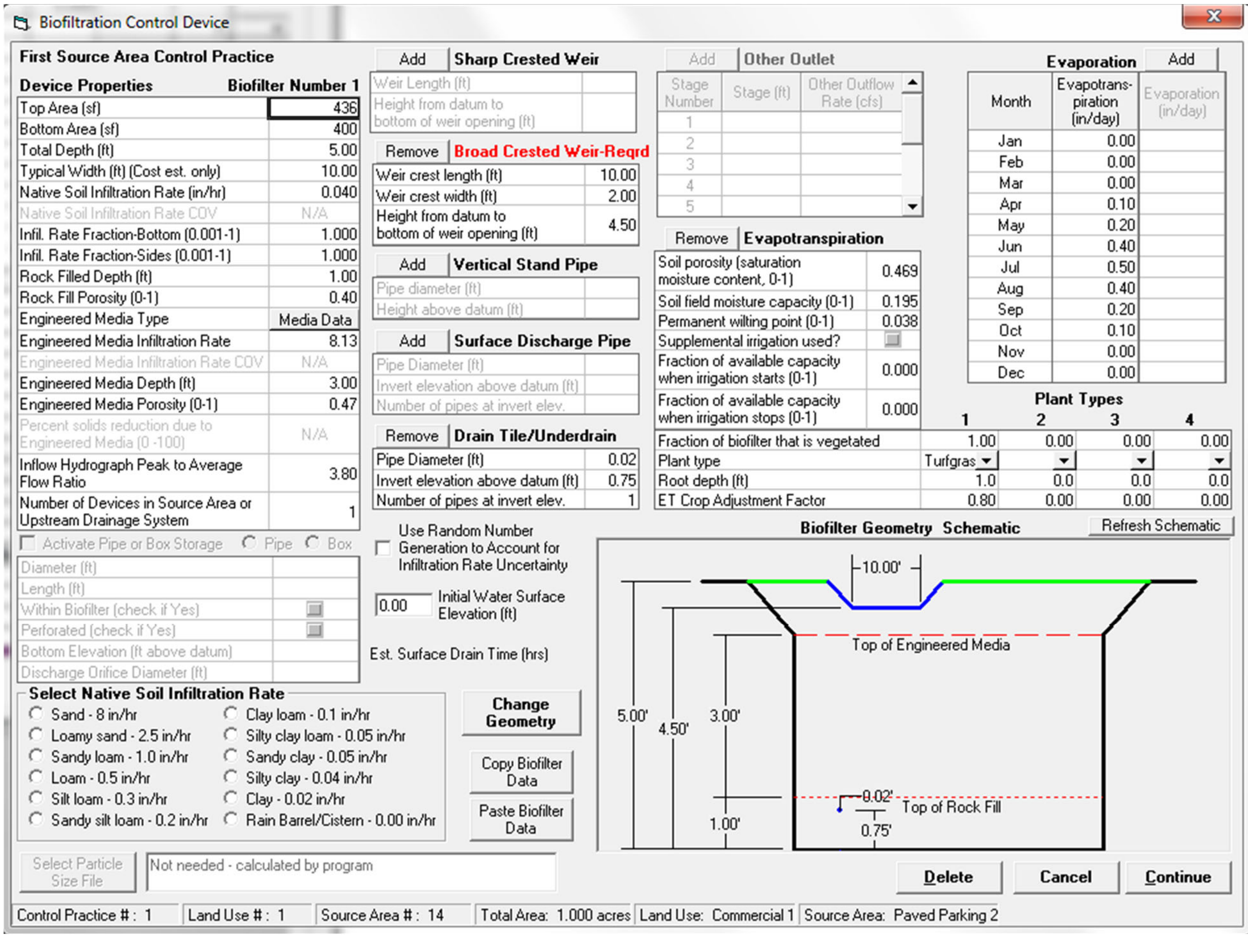
Commissary biofilter at NBSD and WinSLAMM calculated performance for different rains

The following are production functions showing the performance of alternative biofilter sizes for the NBSD location.

 **Runoff volume infiltration for different sized biofilters at San Diego naval facility locations.**	 **Particulate solids retention in biofilters for different sized biofilters at San Diego naval base locations.**

Spreadsheet Calculations for Stormwater Sources at Naval Bases

A spreadsheet was developed for use at naval bases to identify likely sources of stormwater pollutants. The example for the southwest region is attached. These were developed using calibrated and verified versions of WinSLAMM using base monitored data. These were developed to indicate the areas that should be considered for source area stormwater controls, such as biofilters, media filters, hydrodynamic separators, porous pavement, green roofs, street cleaning, or many other alternative stormwater control options. These spreadsheets will be expanded using WinSLAMM developed production functions (a few examples shown above) to indicate discharge reductions for pollutants of concern. Updated cost information will also be developed for use in conjunction with these tools.



Biofiltration Control Device

First Source Area Control Practice

Device Properties	Biofilter Number 1
Top Area (sf)	436
Bottom Area (sf)	400
Total Depth (ft)	5.00
Typical Width (ft) (Cost est. only)	10.00
Native Soil Infiltration Rate (in/hr)	0.040
Native Soil Infiltration Rate COV	N/A
Infil. Rate Fraction-Bottom (0.001-1)	1.000
Infil. Rate Fraction-Sides (0.001-1)	1.000
Rock Filled Depth (ft)	1.00
Rock Fill Porosity (0-1)	0.40
Engineered Media Type	Media Data
Engineered Media Infiltration Rate	8.13
Engineered Media Infiltration Rate COV	N/A
Engineered Media Depth (ft)	3.00
Engineered Media Porosity (0-1)	0.47
Percent solids reduction due to Engineered Media (0 -100)	N/A
Inflow Hydrograph Peak to Average Flow Ratio	3.80
Number of Devices in Source Area or Upstream Drainage System	1

Activate Pipe or Box Storage ○ Pipe ○ Box

Diameter (ft)	
Length (ft)	
Within Biofilter (check if Yes)	
Perforated (check if Yes)	
Bottom Elevation (ft above datum)	
Discharge Orifice Diameter (ft)	

Select Native Soil Infiltration Rate

Sand - 8 in/hr	Clay loam - 0.1 in/hr
Loamy sand - 2.5 in/hr	Silty clay loam - 0.05 in/hr
Sandy loam - 1.0 in/hr	Sandy clay - 0.05 in/hr
Loam - 0.5 in/hr	Silty clay - 0.04 in/hr
Silt loam - 0.3 in/hr	Clay - 0.02 in/hr
Sandy silt loam - 0.2 in/hr	Rain Barrel/Cistern - 0.00 in/hr

Select Particle Size File | Not needed - calculated by program

Add **Sharp Crested Weir**

Weir Length (ft)	
Height from datum to bottom of weir opening (ft)	

Remove **Broad Crested Weir-Reqrd**

Weir crest length (ft)	10.00
Weir crest width (ft)	2.00
Height from datum to bottom of weir opening (ft)	4.50

Add **Vertical Stand Pipe**

Pipe diameter (ft)	
Height above datum (ft)	

Add **Surface Discharge Pipe**

Pipe Diameter (ft)	
Invert elevation above datum (ft)	
Number of pipes at invert elev.	

Remove **Drain Tile/Underdrain**

Pipe Diameter (ft)	0.02
Invert elevation above datum (ft)	0.75
Number of pipes at invert elev.	1

Use Random Number Generation to Account for Infiltration Rate Uncertainty

0.00 Initial Water Surface Elevation (ft)

Est. Surface Drain Time (hrs)

Change Geometry

Copy Biofilter Data

Paste Biofilter Data

Add **Other Outlet**

Stage Number	Stage (ft)	Other Outflow Rate (cfs)
1		
2		
3		
4		
5		

Remove **Evapotranspiration**

Soil porosity (saturation moisture content, 0-1)	0.469
Soil field moisture capacity (0-1)	0.195
Permanent wilting point (0-1)	0.038
Supplemental irrigation used?	
Fraction of available capacity when irrigation starts (0-1)	0.000
Fraction of available capacity when irrigation stops (0-1)	0.000

Evaporation Add

Month	Evapotranspiration (in/day)	Evaporation (in/day)
Jan	0.00	
Feb	0.00	
Mar	0.00	
Apr	0.10	
May	0.20	
Jun	0.40	
Jul	0.50	
Aug	0.40	
Sep	0.20	
Oct	0.10	
Nov	0.00	
Dec	0.00	

Plant Types

	1	2	3	4
Fraction of biofilter that is vegetated	1.00	0.00	0.00	0.00
Plant type	Turfgras			
Root depth (ft)	1.0	0.0	0.0	0.0
ET Crop Adjustment Factor	0.80	0.00	0.00	0.00

Biofilter Geometry Schematic Refresh Schematic

10.00'
Top of Engineered Media
5.00'
4.50'
3.00'
0.02'
Top of Rock Fill
1.00'
0.75'

Delete | Cancel | Continue

Control Practice # : 1 | Land Use # : 1 | Source Area # : 14 | Total Area: 1.000 acres | Land Use: Commercial 1 | Source Area: Paved Parking 2