TSS Load Removal Calculations

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Office of Compliance and Enforcement
Texas Commission on Environmental Quality

Edwards Program Review

Chapter 30 of the Texas Administrative Code §**213.1.**

The purpose of this chapter is to regulate activities having the potential for polluting the Edwards Aquifer and hydrologically connected surface streams in order to protect existing and potential uses of groundwater and maintain Texas Surface Water Quality Standards. The activities addressed are those that pose a threat to water quality.

Edwards Program Review

Zones Requiring Water Quality Treatment:

- **Recharge Zone**
- **Contributing Zone**
- **Contributing Zone within the Transition Zone**

Note: water quality treatment not required in the Transition Zone unless surface water drains to Recharge Zone

Rule for 80% removal

30TAC§213.5(b)(4)(D)(ii)(I):

BMPs and measures must be implemented to control the discharge of pollution from regulated activities after the completion of construction. These practices and measures must be designed, constructed, operated, and maintained to insure that 80% of the incremental increase in the annual mass loading of total suspended solids from the site caused by the regulated activity is removed. These quantities must be calculated in accordance with technical guidance prepared or accepted by the executive director.

TCEQ RG-348: "Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices"

All the load calculations are based on Equation 3.1

Equation 3.1: $L = A \times P \times Rv \times C \times 0.226$

where:

L = annual pollutant load (pounds)

A = Contributing drainage area (acres)

P = Average annual precipitation (inches)

Rv = Appropriate runoff coefficient

C = Average TSS concentration (mg/L)

0.226 = units conversion factor

TCEQ RG-348: "Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices"

Equation 3.2: $L_M = (0.8 \times 0.226)(A_N \text{ x P x } 0.9 \text{ x } 170 - A_N \text{ x P x } 0.03 \times 80)$

where:

L_M = Required TSS removal (pounds)

A_N = Net increase in impervious area (acres)

P = Average annual precipitation (inches)

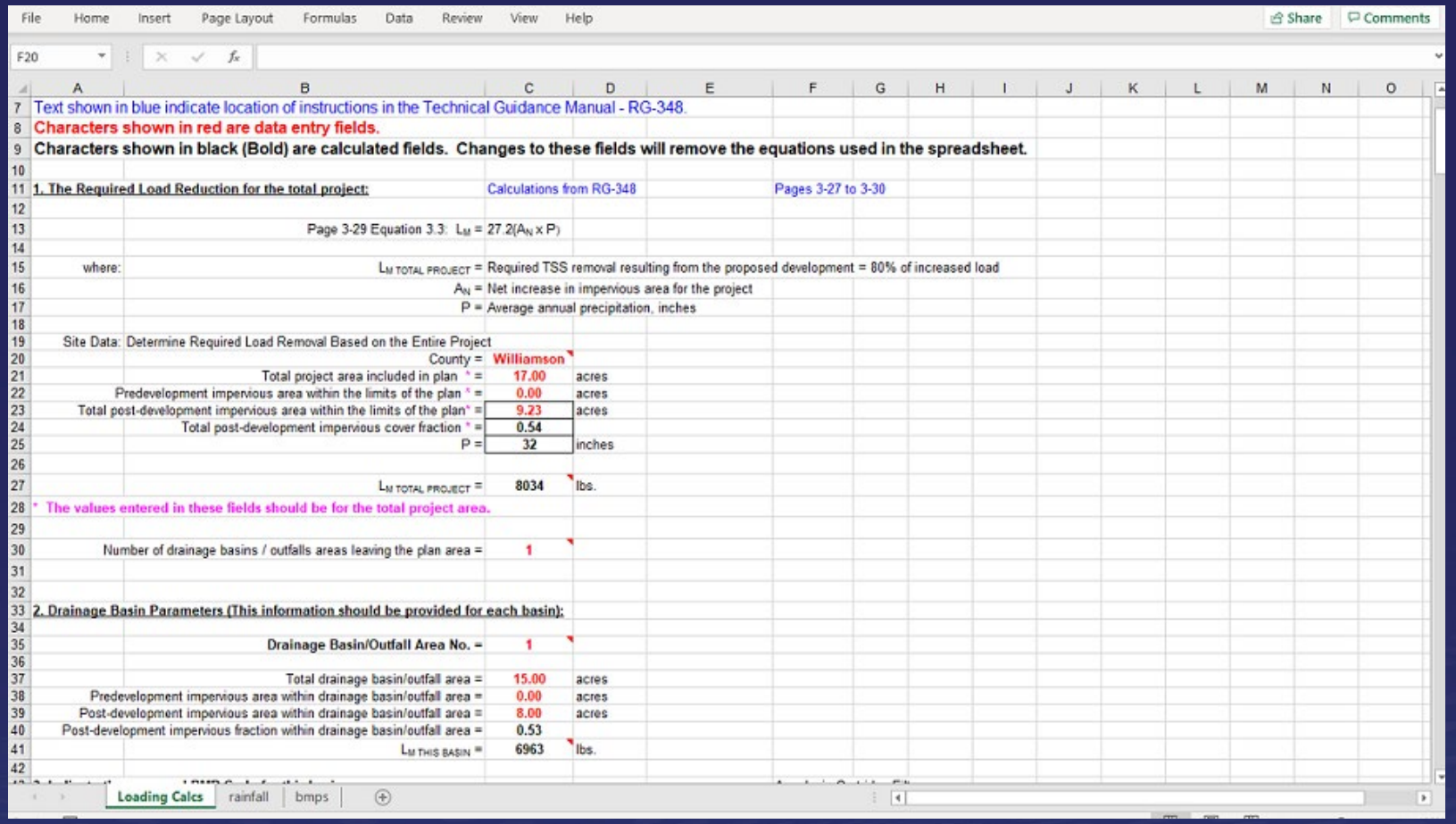
This equation simplifies to:

Equation 3.3: $L_M = 27.2\ (A_N \, x \, P)$

TCEQ TSS Load Removal Spreadsheet Link:

https://www.tceq.texas.gov/permitting/eapp/spreadsheet.html

TCEQ TSS Load Removal Spreadsheet



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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
7	Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.														
8	Characters shown in red are data entry fields.														
9	Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.														
10															
11	1. The Required Load Reduction for the total project:		Calculations from RG-348			Pages 3-27 to 3-30									
12															
13		Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$													
14															
15	where:	$L_{M\ TOTAL\ PROJECT}$ =	Required TSS removal resulting from the proposed development = 80% of increased load												
16		A_N =	Net increase in impervious area for the project												
17		P =	Average annual precipitation, inches												
18															
19	Site Data:	Determine Required Load Removal Based on the Entire Project													
20		County =	Williamson												
21		Total project area included in plan * =	17.00	acres											
22		Predevelopment impervious area within the limits of the plan * =	0.00	acres											
23		Total post-development impervious area within the limits of the plan* =	9.23	acres											
24		Total post-development impervious cover fraction * =	0.54												
25		P =	32	inches											
26															
27		$L_{M\ TOTAL\ PROJECT}$ =	8034	lbs.											
28	* The values entered in these fields should be for the total project area.														
29															
30		Number of drainage basins / outfalls areas leaving the plan area =	1												
31															
32															
33	2. Drainage Basin Parameters (This information should be provided for each basin):														
34															
35		Drainage Basin/Outfall Area No. =	1												
36															
37		Total drainage basin/outfall area =	15.00	acres											
38		Predevelopment impervious area within drainage basin/outfall area =	0.00	acres											
39		Post-development impervious area within drainage basin/outfall area =	8.00	acres											
40		Post-development impervious fraction within drainage basin/outfall area =	0.53												
41		$L_{M\ THIS\ BASIN}$ =	6963	lbs.											
42															

Loading Calcs | rainfall | bmps

Example:

Site Data:	Determine Required Load Removal Based on the Entire Project		
	County =	Williamson	
	Total project area included in plan * =	9.50	acres
	Predevelopment impervious area within the limits of the plan * =	0.00	acres
	Total post-development impervious area within the limits of the plan* =	7.60	acres
	Total post-development impervious cover fraction * =	0.80	
	P =	32	inches
	$L_{M\ TOTAL\ PROJECT}$ =	6615	lbs.

Table 1 - Impervious Cover Table

Impervious Cover of Proposed Project	Sq. Ft.	Sq. Ft./Acre	Acres
Structures/Rooftops	43,560	÷ 43,560 =	1
Parking	87,120	÷ 43,560 =	2
Other paved surfaces	200,376	÷ 43,560 =	4.6
Total Impervious Cover	331,056	÷ 43,560 =	7.60

Total Impervious Cover 7.60 **÷ Total Acreage** 9.50 **X 100 = 80% Impervious Cover**

Step 1: The Required Load Reduction for the total project:

1. The Required Load Reduction for the total project:		Calculations from RG-348		Pages 3-27 to 3-30
	Page 3-29 Equation 3.3: L_M =	$27.2(A_N \times P)$		
where:	$L_{M\ TOTAL\ PROJECT}$ =	Required TSS removal resulting from the proposed development = 80% of increased load		
	A_N =	Net increase in impervious area for the project		
	P =	Average annual precipitation, inches		
Site Data:	Determine Required Load Removal Based on the Entire Project			
	County =	**Williamson**		
	Total project area included in plan * =	**9.50**	acres	
	Predevelopment impervious area within the limits of the plan * =	**0.00**	acres	
	Total post-development impervious area within the limits of the plan* =	**7.60**	acres	
	Total post-development impervious cover fraction * =	**0.80**		
	P =	**32**	inches	
	$L_{M\ TOTAL\ PROJECT}$ =	**6615**	lbs.	
* **The values entered in these fields should be for the total project area.**				

Pre-existing IC:

"Predevelopment impervious area within the limits of the plan"

The impervious cover on site prior to rule implementation.*

9-1-1977	RZ for Kinney, Walden, Medina, Bexar, Comal, and Hays Counties
7-2-1986	RZ for Williamson County
3-21-1990	RZ for Travis County
6-1-1999	CZ in all EAPP Counties

*Must be present at time of site assessment

Step 2

Specific to the drainage basin(s), NOT the entire project.

Please note that the L_M value in Step 2 is for one drainage basin. This value can be met via overtreatment- more on that later.

Step 2

2. Drainage Basin Parameters (This information should be provided for each basin):		
Drainage Basin/Outfall Area No. =	**?**	
Total drainage basin/outfall area =	**11.00**	acres
Predevelopment impervious area within drainage basin/outfall area =	**0.00**	acres
Post-development impervious area within drainage basin/outfall area =	**7.60**	acres
Post-development impervious fraction within drainage basin/outfall area =	**0.69**	
$L_{M\ THIS\ BASIN}$ =	**6615**	lbs.

Step 2 – further examples (multiple drainage basins)

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	**Drainage Basin 1**	
Total drainage basin/outfall area =	**12.00**	acres
Predevelopment impervious area within drainage basin/outfall area =	**0.00**	acres
Post-development impervious area within drainage basin/outfall area =	**4.00**	acres
Post-development impervious fraction within drainage basin/outfall area =	**0.33**	
$L_{M\ THIS\ BASIN}$ =	**3482**	lbs.

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	**Drainage Basin 2**	
Total drainage basin/outfall area =	**5.00**	acres
Predevelopment impervious area within drainage basin/outfall area =	**0.00**	acres
Post-development impervious area within drainage basin/outfall area =	**3.60**	acres
Post-development impervious fraction within drainage basin/outfall area =	**0.72**	
$L_{M\ THIS\ BASIN}$ =	**3133**	lbs.

Step 3

3. Indicate the proposed BMP Code for this basin.		
Proposed BMP =	Wet Basin	
Removal efficiency =	93	percent

3. Indicate the proposed BMP Code for this basin.		
Proposed BMP =	Sand Filter	
Removal efficiency =	89	percent

3. Indicate the proposed BMP Code for this basin.		
Proposed BMP =	Vegetated Filter Strips	
Removal efficiency =	85	percent

Step 4

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.			
	RG-348 Page 3-33 Equation 3.7: L_R =	(BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)	
where:	A_C =	Total On-Site drainage area in the BMP catchment area	
	A_I =	Impervious area proposed in the BMP catchment area	
	A_P =	Pervious area remaining in the BMP catchment area	
	L_R =	TSS Load removed from this catchment area by the proposed BMP	
	A_C =	11.00	acres
	A_I =	7.60	acres
	A_P =	3.40	acres
	L_R =	7880	lbs

L_R Represents the maximum amount of TSS that can be removed by the BMP in the drainage basin.

*Step 4 should match step 2 unless preexisting IC is present and will remain in tact

Step 5 – Desired Lm

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area		
Desired $L_{M\ THIS\ BASIN}$ =	6615	lbs.
F =	0.84	

Desired L_M can be thought of as the design of the BMP

F-Value = Desired L_M / L_R

F-Values greater than 1 **are not** approvable.

F-Values are asymptotic relative to pond sizing.

Step 6 - Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area.

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area.		
Rainfall Depth =	**1.26**	inches
Post Development Runoff Coefficient =	**0.50**	
On-site Water Quality Volume =	**24990**	cubic feet
	Calculations from RG-348	
Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**4998**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**29988**	cubic feet

In this example, there is no offsite IC.

Step 6 - Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area.

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area.		
Rainfall Depth =	**1.26**	inches
Post Development Runoff Coefficient =	**0.50**	
On-site Water Quality Volume =	**24990**	cubic feet
	Calculations from RG-348	
Off-site area draining to BMP =	**5.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0.00**	
Off-site Runoff Coefficient =	**0.02**	
Off-site Water Quality Volume =	**457**	cubic feet
Storage for Sediment =	**5089**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**30537**	cubic feet

In this example, there is off-site area draining to the BMP, but not off-site IC.

Next Step: BMP-Specific

11. Wet Basins	Designed as Required in RG-348			Pages 3-66 to 3-71
Required capacity of Permanent Pool =	**29988**	cubic feet	**Permanent Pool Capacity is 1.20 times the WQV**	
Required capacity at WQV Elevation =	**54978**	cubic feet	**Total Capacity should be the Permanent Pool Capacity plus a second WQV.**	

9. Filter area for Sand Filters	Designed as Required in RG-348			Pages 3-58 to 3-63
9A. Full Sedimentation and Filtration System				
Water Quality Volume for sedimentation basin =	**35700**	cubic feet		
Minimum filter basin area =	**1653**	square feet		
Maximum sedimentation basin area =	**14875**	square feet	**For minimum water depth of 2 feet**	
Minimum sedimentation basin area =	**3719**	square feet	**For maximum water depth of 8 feet**	
9B. Partial Sedimentation and Filtration System				
Water Quality Volume for combined basins =	**35700**	cubic feet		
Minimum filter basin area =	**2975**	square feet		
Maximum sedimentation basin area =	**11900**	square feet	**For minimum water depth of 2 feet**	
Minimum sedimentation basin area =	**744**	square feet	**For maximum water depth of 8 feet**	

Next Step: BMP-Specific

Vegetative Filter Strip

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: L_R = (BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)

where:

A_C =	Total On-Site drainage area in the BMP catchment area	
A_I =	Impervious area proposed in the BMP catchment area	
A_P =	Pervious area remaining in the BMP catchment area	
L_R =	TSS Load removed from this catchment area by the proposed BMP	
A_C =	11.00	acres
A_I =	7.60	acres
A_P =	3.40	acres
L_R =	7202	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	7202	lbs.
F =	1.00	

Stage Storage Tables: Does the sizing work for your project?

NOD Item

Overall Pond Storage Table			
Stage (ft msl)*	Area (sf)	Incremental Volume (cf)	Storage (cf)
706.50	85.47	0.00	0.00
707.00	20,348.41	5,108.47	5,108.47
708.00	76,873.54	48,610.98	53,719.45
709.00	85,378.23	81,125.89	134,845.33
710.00	92,681.67	89,029.95	223,875.28
711.00	100,099.65	96,390.66	320,265.94
712.00	107,632.15	103,865.90	424,131.84
713.00	115,279.19	111,455.67	535,587.51
714.00	123,040.76	119,159.98	654,747.49
715.00	137,560.00	130,300.38	785,047.87

NOD Response

Overall Pond Storage Table				
Stage (ft msl)*	Area (sf)	Incremental Volume (cf)	Storage (cf)	
706.50	244.54	0.00	0.00	
707.00	21,416.13	5,415.17	5,415.17	
707.50	55,926.46	19,335.65	24,750.82	
708.00	76,876.97	33,200.86	57,951.67	
708.50	81,477.19	39,588.54	97,540.21	
708.75	83,496.91	20,621.76	118,161.98	Permanent Pool Elevation
709.00	85,383.29	21,110.03	139,272.00	
709.50	89,021.24	43,601.13	182,873.13	
709.75	90,850.89	22,484.02	205,357.15	Total Water Quality Volume
710.00	92,687.65	45,427.22	228,300.36	
710.50	96,382.52	47,267.54	275,567.90	
711.00	100,105.84	49,122.09	324,689.99	
711.50	103,857.62	50,990.87	375,680.85	
712.00	107,637.86	52,873.87	428,554.72	
712.50	111,446.55	54,771.10	483,325.83	
713.00	115,283.70	56,682.56	540,008.39	
713.50	119,149.30	58,608.25	598,616.64	
714.00	123,043.36	60,548.17	659,164.80	
714.50	126,965.88	62,502.31	721,667.11	
715.00	137,560.00	66,131.47	787,798.58	

Accounting Tables

Water Quality Facility	Ultimate Drainage Area (acres)	Ultimate Impervious Area (acres)	Percent Impervious
Pond A-2	8.48	4.55	54%
Pond B-2	50.02	23.82	48%
Pond C-2	27.58	14.55	53%
Pond D-2	17.75	9.38	53%
Pond E-2	24.77	12.27	50%
Pond F-2	14.93	7.94	53%
Pond G-2	9.41	4.91	52%
Swale 1	2.51	1.06	42%
Sale 3	1.04	0.63	61%
Untreated	27.34	3.33	12%
Total	183.83	82.44	45%

Proposed per this CZP Application (Modification #2)													
Section 1		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7	
IC per Section (acres)	Cummulative IC area (acres)	IC per Section (acres)	Cummulative IC area (acres)	IC per Section (acres)	Cummulative IC area (acres)	IC per Section (acres)	Cummulative IC area (acres)	IC per Section (acres)	Cummulative IC area (acres)	IC per Section (acres)	Cummulative IC area (acres)	IC per Section (acres)	Cummulative IC area (acres)
0.00	0.00	0.56	0.56	0.00	0.56	2.63	3.29	1.35	4.55	0.00	4.55	0.00	4.55
0.00	0.00	1.33	1.33	1.00	2.34	4.46	6.79	15.30	22.09	0.00	22.09	1.73	23.82
0.00	0.00	0.96	0.96	10.58	11.54	0.00	11.54	2.62	14.16	0.39	14.55	0.00	14.55
7.33	7.33	0.09	7.43	1.42	8.85	0.00	8.85	0.00	8.85	0.53	9.38	0.00	9.38
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.20	4.20	0.16	4.36	7.91	12.27
0.00	0.00	0.87	0.87	0.07	0.94	0.00	0.94	0.00	0.94	6.58	7.52	0.42	7.94
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.91	4.91	0.00	4.91
1.06	1.06	0.00	1.06	0.00	1.06	0.00	1.06	0.00	1.06	0.00	1.06	0.00	1.06
0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.63	0.00	0.63	0.00	0.63	0.00	0.63
0.85	0.85	0.55	1.40	1.15	2.55	0.00	2.55	0.00	2.55	0.71	3.26	0.07	3.33
9.24	9.24	4.36	13.61	14.22	27.84	7.72	35.65	23.47	59.03	13.28	72.31	10.13	82.44

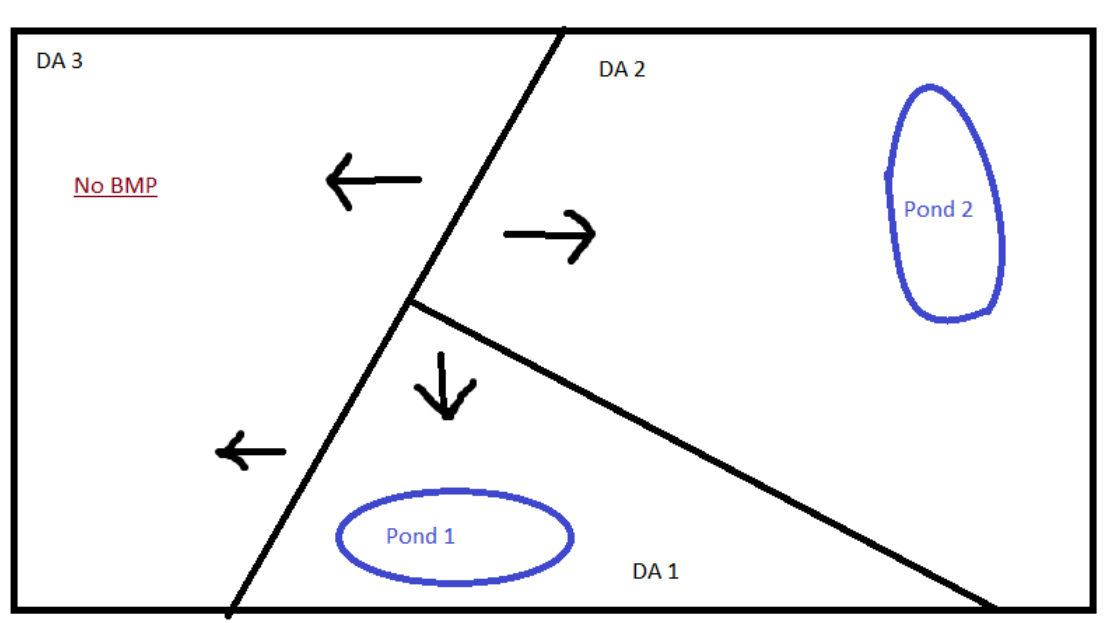
Overtreatment

For those areas which do not drain to a BMP, overtreatment is an option.

For BMPs that have efficiencies greater than 80%, the TSS removed can be applied to meet the L_M requirement.

Overtreatment Example

Overall L_M = 5,658 lbs (6.5 acres IC)



The sum of Desired L_M s = 5,900 lbs > 5,658 lbs = L_M

DA 1

Drainage basin = 5 acres

L_M = 2611 lbs TSS

3.00 acres IC

Pond 1 L_R = 2,987 lbs

Pond 1 Desired L_M = 2,900 lbs

DA 2

Drainage basin = 7 acres

L_M = 2,611 lbs

3.00 acres IC

Pond 2 L_R = 3,018 lbs

Pond 2 Desired L_M = 3,000 lbs

DA 3

Drainage basin = 3 acres

L_M = 435 lbs

0.50 acres IC

L_R = 531 lbs

DA 3 Desired L_M = 0 lbs (Does not drain to a BMP)

BMPs in Series

Extended Detention into Grassy Swale

19. BMPs Installed in a Series	Designed as Required in RG-348		Pages 3-32
E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =	86.38	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	75.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	
THEREFORE, THE NET LOAD REMOVAL WOULD BE: (A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)			
L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =	7318.96	lbs	

3. Indicate the proposed BMP Code for this basin.

Proposed BMP =	Extended Detention
Removal efficiency =	86.38 percent

Vaults

Calculations should be submitted by the proprietary vendor.

Optional Enhanced Measures – TCEQ RG-348A

Differences from standard plans:

- Memorandum Of Understanding
- Stream buffers
- Geologic Assessment required
- Detention
- No pre-rule IC allowance
- Calculations

Optional Enhanced Measures – TSS Load Removal Calculations

TCEQ RG-348

Equation 4.2 $L_M = (0.8 \times 0.226)(A \times P \times 0.9 \times 170)$

Where:

L_M = Required TSS removal (pounds)
A = Impervious area (acres)
P = Average annual precipitation (inches)

This equation simplifies to:

Equation 4.3 $L = 27.7(A \times P)$

Where:

L = Required TSS removal (pounds)
A = Impervious area (acres)
P = Average annual precipitation (inches)

TCEQ RG-348A (OEM)

Equation 3.2 $L_M = (0.8 \times 0.226)(A_N \times P \times 0.9 \times 170 - A_N \times P \times 0.03 \times 80)$

Where:

L_M = Required TSS removal (pounds)
A_N = Net increase in impervious area (acres)
P = Average annual precipitation (inches)

This equation simplifies to:

Equation 3.3 $L_M = 27.2(A_N \times P)$

Optional Enhanced Measures – TSS Load Removal Calculations

TCEQ RG-348

Equation 3.11 Runoff Coefficient = $1.72(IC)^3 - 1.97(IC)^2 + 1.23(IC) + 0.02$

Where: IC = fraction of impervious cover

TCEQ RG-348A

Equation 4.8 $Rv = 0.05 + 0.0085(IC)$

Where:

IC = Percent impervious cover

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area.

Rainfall Depth =	**1.26**	inches
Post Development Runoff Coefficient =	**0.50**	
On-site Water Quality Volume =	**24990**	cubic feet

Summary of important values

- L_M : TSS Removal **REQUIRED** for entire project (80% removal)
- Pre-existing IC: IC that was in place **BEFORE** the Edwards Aquifer Protection Program required treatment
- L_R : TSS Load available for removal from one drainage basin
- **DESIRED** L_M : TSS Removal applied to this BMP in this project (BMP design; summation for multiple BMPs)
- Offsite pervious and impervious cover: Volume must be accounted for

Common mistakes

- Step 1 values do not reflect values in Table 1
- Predevelopment IC means pre-rule, and must be in place at time of site assessment
- L_R interpreted to be the design
- F value is greater than 1.0
- Not signed/sealed/dated by project engineer

Summary

If you don’t understand the spreadsheet, ask questions before you submit! ☺

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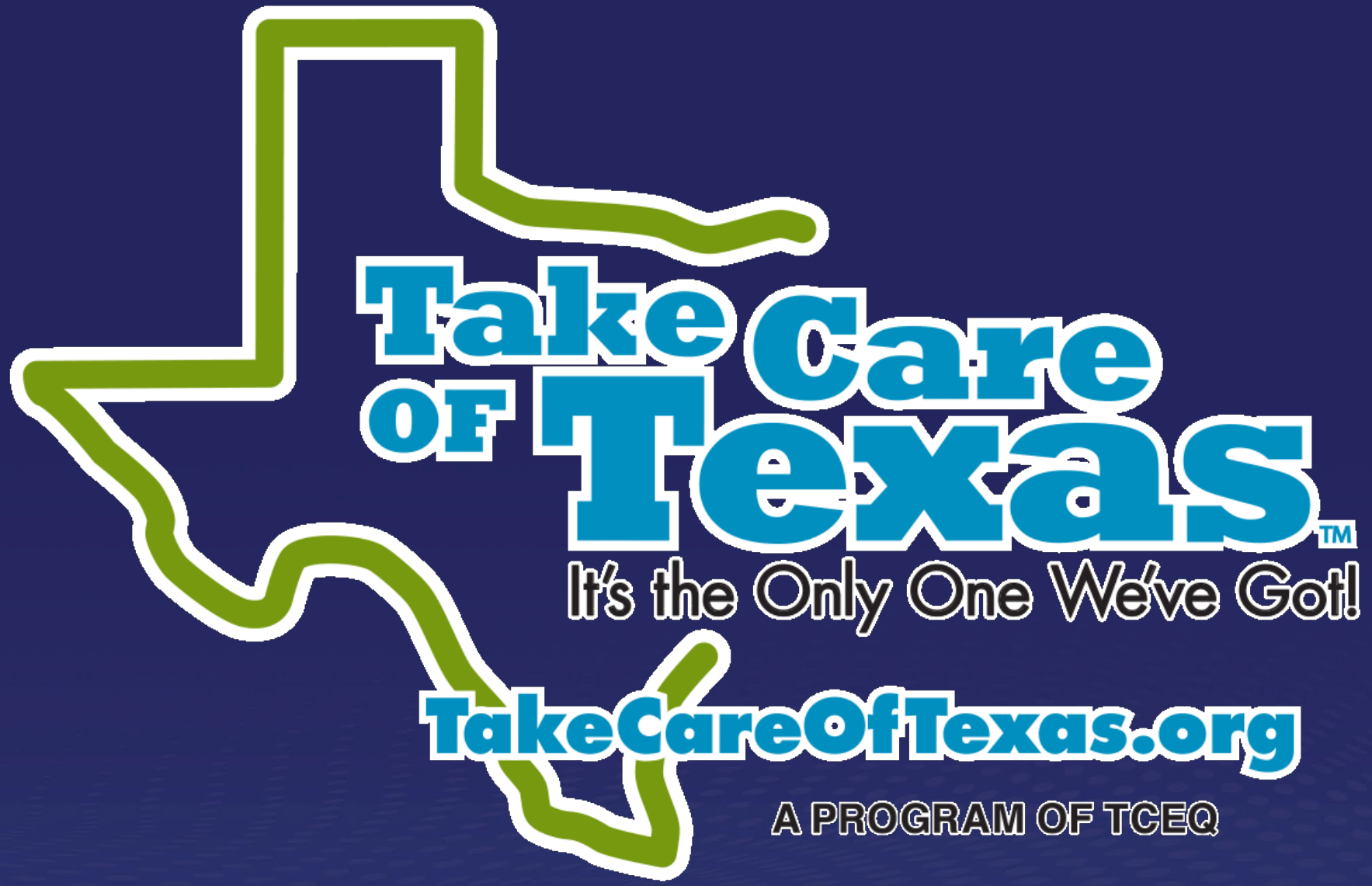

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY