University of Minnesota

Onsite Sewage Treatment Program

Septic System Improvement Estimator

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Support

- Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR)
- The Trust Fund is a permanent fund constitutionally established by the citizens of Minnesota to assist in the *protection, conservation, preservation, and enhancement of the state's air, water, land, fish, wildlife, and other natural resources.*
- Currently 40% of net Minnesota State Lottery proceeds are dedicated to building the Trust Fund and ensuring future benefits for Minnesota's environment and natural resources.

Project Background

- The Board of Water and Soil Resources (BWSR) funds various practices to improve water quality
- In the last five years, BWSR, through county programs, has been funding many individual and community septic system upgrades

Project Background Cont'd

- BWSR is required to report on improvements in water quality to the legislature
- No standardized method of quantifying removal of contaminants
- LCCMR Grant obtained by BWSR and University of Minnesota to develop an estimation tool for various practices including septic system upgrades

Acknowledgements

- Thanks to the counties and professionals who have provided input to refine the spreadsheet:
  - Dick Hoffman, Chris LeClair, Ryan Lefers, Aaron Jensen, Angie Knish, Chris Pence, Bruce Poppel, Kellie Strobel
  - Minnesota Pollution Control Agency's SSTS Program
  - SSTS Advisory Committee

Septic System Improvement Estimator (SSIE)

- A spreadsheet-based model that:
  - Calculates annual pollutant loads from problematic septic systems
  - Accounts for:
    - benefits of a range of septic system improvement
    - educational efforts
    - programs to identify the problematic systems

Users Guide

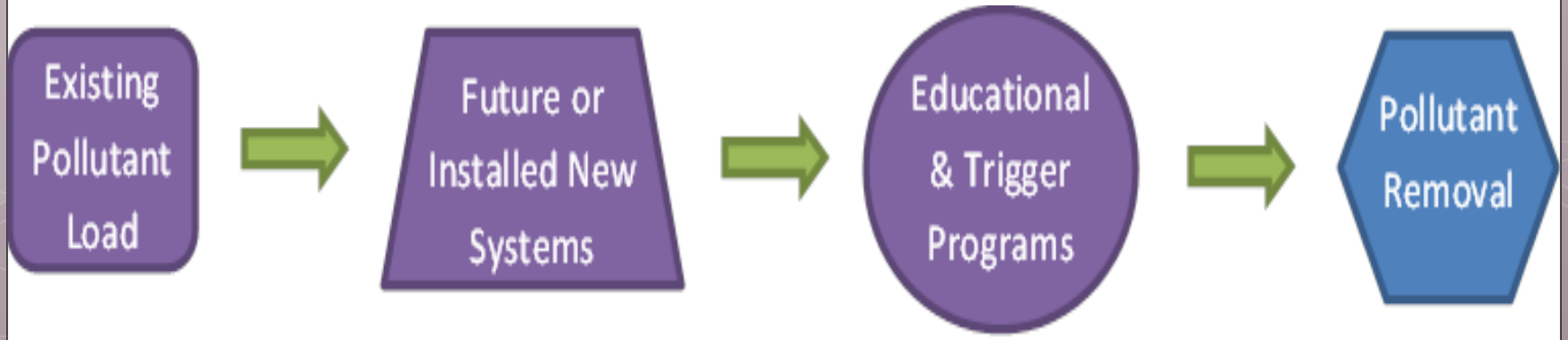
- Guide provides an introduction to the tool
- Tips and instructions for using it
- To assist the user with data entry and interpretation
- A reference list which the spreadsheet is based on is included.

Estimator Structure & Overview

- Three steps:
  1. Calculating Existing Pollutant Loads
  2. Calculating Removals with "Future" or Installed Management Practices
  3. Calculate Impact of Education and Trigger Programs

Estimator Structure & Overview

- The data is entered in the purple cells and the results are reported in the aqua cells
- The aqua page of the worksheet summarize the calculations completed in the purple data entry section



Contaminants of Concern – BOD_5

- **Biochemical oxygen demand, five-day(BOD_5) :** quantitative measure of the amount of oxygen consumed by bacteria while stabilizing, digesting, or treating biodegradable organic matter under aerobic conditions over a five-day incubation period; expressed in milligrams per liter (mg/L) (CIDWT, 2009).
- Assumed value for raw wastewater is 420 mg/l (Lowe, et al., 2009)

Contaminants of Concern – TSS

- **Solids, total suspended (TSS):** measure of all suspended solids in a liquid, typically expressed in mg/L; to measure, a well-mixed sample is filtered through a standard glass fiber filter and the residue retained on the filter is dried to a constant weight at 217 to 221 degrees F (103 to 105 degrees C); the increase in the weight of the filter represents the amount of total suspended solids (CIDWT, 2009)
- Assumed value for raw wastewater is 232 mg/l (Lowe, et al., 2009)

Contaminants of Concern – Fecal

- **Coliform bacteria, fecal:** indicator bacteria common to the digestive systems of warm-blooded animals that is cultured in standard tests to indicate either contamination from sewage or the level of disinfection; generally measured as number of colonies/100 mL or most probable number (MPN) (CIDWT, 2009)
- Assumed value for raw wastewater is 1,580,000 MPN (Lowe, et al., 2009)

Contaminants of Concern Nitrogen

- **Nitrogen (N):** essential chemical element and nutrient for all life forms; molecular formula (N2), constitutes 78 percent of the atmosphere by volume; nitrogen is present in surface water and groundwater as ammonia (NH_3), nitrite (NO_2-), nitrate (NO_3-), and organic nitrogen; excess levels of nitrogen in marine areas may contribute to eutrophication (CIDWT, 2009)
- Assumed value for raw wastewater is 60 mg/L (Lowe, et al., 2009)

Contaminants of Concern Phosphorus

- **Phosphorus (P):** chemical element and nutrient essential for all life forms, occurring as orthophosphate, pyrophosphate ($P_2O_7^{-4}$), tripolyphosphate ($P_3O_{10}^{5-}$), and organic phosphate forms; each of these forms, as well as their sum (total phosphorus), is expressed in terms of milligrams per liter (mg/L) elemental phosphorus; occurs in natural waters and wastewater almost solely as phosphates; excess levels of phosphorous in fresh surface waters may contribute to eutrophication (CIDWT, 2009)
- Assumed value for raw wastewater is 10.4 mg/L (Lowe, et al., 2009)

Summary of Raw Wastewater Characteristics Used in Model

Contaminant	Value
BOD (mg/l)	420
TSS(mg/l)	232
Fecal(MPN)	1,580,000
P (mg/l)	10.4
N (mg/l)	60

Primary Data Sources

- To provide accurate estimates of removal of contaminants three key data parameters are need
  1. Number of bedrooms – used to estimate flow
  2. Existing system status – used to calculate existing pollutant load
  3. Type of new system installed – used to calculate removals
- If any of this data is unknown the spreadsheet will make assumptions

Bedrooms – Flow Estimate

- The spreadsheet uses the number of bedrooms entered by the user and applies Class II flows using the following equation from Minnesota Rules Chapter 7080.1860:
- (Number of bedrooms + 1) X 75 gallons

Bedrooms	Gallons per Day
2 or less	225
3	300
4	375
5	450
6	525

If the number of bedrooms is unknown the spreadsheet assumes 3 with a flow of 300 gpd.

Existing System

Existing System Information

- Imminent threat to public health or safety (ITPHS)
- Failing to protect groundwater (FPGW)
- Complaint system?
  - The model assumes the system is an in-ground Type I system
- If the user does not know the status of the existing system the spreadsheet assumes an IPHT

Managed Septic Tank

- Affects the level of contamination with IPHTS
- Maintenance records for the last 10 years <u>must</u> be available documenting proper maintenance of the septic tank
- Otherwise the unmanaged option should be selected

Removal percentages for existing systems based on compliance

Contaminant	Existing System Compliance Status			
	A. IPHT No Septic Tank	B. IPHT with Managed Septic Tank	C. Failing to Protect Ground-water	D. Compliant SSTS
BOD_5	0	50%	75%	100%
TSS	0	50%	75%	100%
Fecal/E-Coli	0	0	50%	100%
Nitrogen	0	5%	10%	25%
Phosphorous	0	5%	50%	100%

New System

Type of New SSTS

- Type I
  - Trench, bed or at-grade, mound
- Type II
  - Holding tank
- Type III
  - Trench, bed or at-grade or mound
- Type IV
  - Registered to NOT remove nitrogen
  - Registered to remove nitrogen to < 20 mg/l
- Type I installed under an alternative local standard with less than 3 feet of soil treatment

New System

- If the existing system is being hooked up to a WWTP the user enters the discharge limits allowable under their MPCA permit

Removal percentages for new systems

Contaminant	New System			
	Type I or Type III: Trench, Bed, or At-Grade Type IV: with no N Reduction	Mound or Type IV with Nitrogen Reduction	Holding Tank	Type I SSTS Alternative Local Standard
BOD5	100%	100%	100%	100%
TSS	100%	100%	100%	100%
Fecal/E-Coli	100%	100%	100%	50%
Nitrogen	25%	50%	100%	10%
Phosphorous	100%	100%	100%	50%

Calculating Impacts of Management, Education and Triggers

- Under section three of the spreadsheet the model quantifies if the system management will be actively tracked by the local governmental unit (LGU).
- All systems are required to be properly maintained, but the enforcement of this requirement varies.

Other local impacts

- Section four of the spreadsheet computes the impacts of educational and triggers programs initiated by the LGU:

Activity	Impact
Lack of Management Program	-10%
Homeowner Education Program	+2%
Comprehensive County Inventory Project	+2%
Target Area Inventory Projects/TDML	+1%
Property Transfer	+1%
Shore land Permit Request	+1%
Any Building Permit Request	+1%
Other	+0.5%

Basic tips for data entry

- **PURPLE CELLS** must be filled in.
- **AQUA CELLS**
  - Have been calculated, and typically should not be overridden
  - They represent "bottom line" calculations, such as load reductions or final loads
  - If you want to override aqua cells go to the Review Tap and select Unprotect Sheet

Basic tips for data entry "Pop-Up" Guidance and Comments

- Many pieces of input data require a decision on the part of the user
- By clicking on many of the purple cells, a "popup" message will appear with guidance for data values

Septic System Improvement Estimator

1. Enter number of systems

2. Enter system information

Number	County	System Location Identifier Parcel ID # or Address	Number of Bedrooms	Existing System Code	New System Code

Identifier
Enter property identifier. This could be an address or property identification number.

Basic tips for data entry Pull Down Menus

- While many of the data in the SSIE require a number value, some of the inputs are multiple choice such as number of bedrooms or result in a “yes/no”
- The SSIE uses “pull down menus” for both these questions
- For these cells, the user should not (and cannot) select an option that does not appear in the menu

Septic System Improvement Estimator

1. Enter number of systems

2. Enter system information

Number	County	System Location Identifier Parcel ID # or Address	Number of Bedrooms	Existing System Code	New System Code
			NA		
			2		
			3		
			4		
			5		
			6		
			7		
			8		

number
ms. If
elect

Basic tips for data entry – Locked Cells

- To make the spreadsheet application consistent the non-purple cells are locked/write protected.
- The other benefit this provides is that the user can “Tab” from purple cell to purple cell during data entry.
- If the user is applying this model in other applications or needs greater flexibility the worksheets can be unprotected under Review, Unprotect Sheet.

Data entry

- 1. Enter number of systems (<=15/sheet)

Septic System Improvement Estimator

1. Enter number of systems: 5

2. Enter system information

Number	County	System Location Identifier Parcel ID # or Address	Number of Bedrooms	Existing System Code	New System Code
1					
2					
3					
4					
5					

Enter system information

- County or Counties (required for BWSR)
- System location Identifier
  - Parcel identification number or the address or "Unknown"
- Number of bedrooms
  - If it is unknown select NA from the drop down list.
  - The drop down list includes up to 10 bedrooms.

Select existing system code from drop down or enter

Existing System Coding	
NA =	Not available
1 =	Imminent Public Health or Safety Threat
2 =	Imminent Public Health or Safety Threat with Managed Septic Tank
3 =	Failing to Protect Groundwater
4 =	Compliant System

Select new system code from drop down or enter

New System Coding	
NA =	Not available
1 =	Type I or Type III: Trench, Bed, or At-Grade, Type IV: with no Nitrogen Reduction
2 =	SSTS Mound or Nitrogen reducing Type IV
3 =	Holding Tank
4 =	SSTS with Alternative Local Standard < 3 feet on Type I systems
5 =	Hooked up to Wastewater Treatment Plant

Septic System Improvement Estimator

1. Enter number of systems: 6

2. Enter system information

Number	County	System Location Identifier Parcel ID # or Address	Number of Bedrooms	Existing System Code	New System Code
1	Hope	1234 Happy Way, Joy, MN 55555	2	1	1
2	Hope	1235 Happy Way, Joy, MN 55555	3	2	2
3	Hope	1236 Happy Way, Joy, MN 55555	4	2	3
4	Hope	1237 Happy Way, Joy, MN 55555	5	2	4
5	Hope	1238 Happy Way, Joy, MN 55555	6	1	5
6	Hope	Unknown	NA	NA	1

A few more items

- Yes or No for active management
- Yes or No for Educational and Trigger Programs
- If you skip these two the worksheet will not work.

Results

- The table provides the removal of:
  - Biochemical Oxygen Demand
  - Total Suspended Solids
  - Bacteria measured as Fecal Coliform
  - Nitrogen
  - Phosphorous

Results Continued

- The total removal is summarized for all the systems at the bottom
  - The results are all in pounds of contaminant removed
  - Except for bacteria removed per year which is reported in units of most probable number (MPN) and in scientific units.
    - For example: 1.3 E+14 correspond to 1.3 with 12 zeros behind it or 130,000,000,000,000.

Septic System Improvement Estimator

5. Results - The table below provides the removal of Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Bacteria measured as Fecal Coliform, along the nutrients Nitrogen and Phosphorous based on the data entered above. The total removal is summarized for all the systems at the bottom.

Number	System Location Identifier	Pounds of BOD_5 per Year	Pounds of TSS per Year	Bacteria per Year (MPN)	Pounds of Phosphorus per Year	Pounds of Nitrogen per Year
1	234 Happy Way, Joy, MN 5555	294	162	5.01E+13	7	10
2	234 Happy Way, Joy, MN 5555	196	108	6.68E+13	9	25
3	234 Happy Way, Joy, MN 5555	245	135	8.35E+13	12	66
4	234 Happy Way, Joy, MN 5555	294	162	5.01E+13	7	4
5	234 Happy Way, Joy, MN 5555	612	338	1.17E+14	14	0
6	Unknown	392	216	6.68E+13	10	14
Total		2032	1122	4.34E+14	58	120

More information

Tool & Users Guide

Questions

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Classroom Examples

- Users Guide & SSIE Microsoft Excel file with the title **2013 SSIE_April.xlsx**
- On right, under Pollution Reduction Calculators
- Downloaded at www.bwsr.state.mn.us/outreach/eLINK/