TECHNICAL APPENDIX_TABLES

Table T1: Model factors, equations, definitions, and units for the stocks, flows, and parameters associated with the knowledge phase of technology adoption.

Model Factors	Equation and Definition	Units
Unaware of RR systems (Pop_{UN})	$$Pop_{UN} = \int (-Aw_{RATE}) dt$$ A stock comprised of the entire Initial unaware population that is reduced by the awareness rate (Aw_{RATE}).	household
Awareness rate (Aw_{RATE})	$$Aw_{RATE} = Adv \times (1 - AwF)$$ A rate function that is driven, in part, by advertising (Adv) and the magnitude of the fraction of the population becoming aware of RR systems (AwF). Information about the Advertising (i.e. Advertising effectiveness and Advertising frequency) was derived from survey data and participatory observations.	household / time
Aware of RR systems (Pop_{AW})	$$Pop_{AW} = \int Aw_{RATE}\, dt$$ The population of individuals in the community that become aware of RR systems each year.	household

Table T2: Model factors, equations, definitions, and units for the stocks, flows, and parameters associated with the persuasion phase of technology adoption.

Model Factors	Equation and Definition	Units
Aware but not persuaded (ANP)	$ANP = Pop_{AW} - PerA$ The population of individuals in the community that have become aware of RR systems each year but are not yet persuaded to adopt the technology (*ANP*).	household
Stakeholder power (SP)	$SP = parameter\ estimated\ from\ analysis\ of\ survey\ data$ The value reflects the stakeholder's ability and willingness to contribute to decision-making about their own wastewater systems. It directly influences the stakeholder's perceived behavioral control, and indirectly impacts the rate at which they are persuaded about the RR system. (According to analysis of survey data, *SP* is equal to 0.48 for Placencia)	unitless
Stakeholder attitudes about RR systems (*SA*)	$SA = PE + PR$ This factor is the sum of the stakeholders' previous knowledge and access to information. Knowledge is represented by their previous experience (*PE*) with wastewater systems and the previous research (*PR*) is reflective of the information they have gathered to develop an understanding of RR systems; each factor implicitly shows their access to information. Each factor also has an associated frequency and effectiveness values derived from survey questions and interview responses.	1 / time
Perceived behavioral control (*PBC*)	$\mathrm{PBC} = SP \times SA$ This concept captures Rogers' notion of a technology's "compatibility" because it directly represents the potential adopter's persuasion regarding the RR systems' ability to help a potential adopter fulfill some particular goal (i.e. reduce impacts of nutrients to environment or pollutants to human health).	1 / time
Persuasion rate (Per_{RATE})	$Per_{RATE} = ANP \times PBC$ This is the rate at which those who are Aware but not yet persuaded (ANP) to adopt become persuaded about adopting RR systems.	household / time
Persuaded about adopting RR systems ($PerA$)	$PerA = \int (Per_{RATE}) dt$ The population of individuals that are positively persuaded about adopting a RR system.	household

Table T3: Model factors, equations, definitions, and units for the stocks, flows, and parameters associated with the decision phase of technology adoption.

Model Factors	Equation and Definition	Units
Potentially adopting RR systems ($PotA$)	$PotA = PerA - DA$ The population represented by the difference in individuals that are positively persuaded about adopting a RR system (*PerA*) and those who have already decided to adopt (*DA*).	household
Site Demonstrations (*SiteDemo*)	$SiteDemo = f(Demo_{FREQ}, Demo_{EFF}, Demo_{INTERVAL})$ This composite factor incorporates a demonstration frequency ($Demo_{FREQ}$), non-uniform interval between demonstrations ($Demo_{INTERVAL}$), and the effectiveness ($Demo_{EFF}$,) associated with the Site Demonstrations, all of which were derived from interviews and participatory observation.	1 / time
Relative Advantage (*RA*)	$RA = w_1 Env + \ w_2 Econ + w_3 Health$ This term brings together and applies site-specific weights (w_{1-3}) to stakeholders' values for the environmental (Env), economic($Econ$), and health ($Health$) benefits associated with the RR system. The weights are determined from survey data analysis.	unitless
Connectivity of Community	$CC = 0.011$ The rate by which community members come into contact with one another to share information, in this case, regarding household wastewater practices (Sterman, 2000).	1 / time
Word of mouth (*WOM*)	$WOM = CC \times WOM_{EFF} \times AdF \times (PotA - PotS)$ A factor that reflects the connectivity of the community (CC) and the effectivness of the information being shared (WOM_{EFF}), based upon the fraction of people who have already adopted (AdF).	household / time
Adoption Rate ($Adpt_{RATE}$)	$Adpt_{RATE} = ((RA + SiteDemo) \times PotA) \times WOM$ The rate at which individuals adopt RR systems based upon the sum of the impacts that relative advantage (*RA*) and site demonstrations (*SiteDemo*) have on Potential adopters and further influenced by Word of mouth (*WOM*)	household / time
Decided to adopt RR systems (DA)	$DA = \int Adpt_{RATE}$ The population of individuals, per year, that have decided to adopt RR systems (DA).	household

Table T4: Model factors, equations, definitions, and units for the stocks, flows, and parameters associated with the average working volume of the RR system.

Model Factors	Equation and Definition	Units
Volume based on design scale (Vol_{DESIGN})	$$Vol_{DESIGN} = f(DsnScl, TkSz)$$ A rate function that is driven by the interactions between design scale ($DsnScl$)and associated tank size ($TkSz$) of the RR system. This information was gleaned from interviews in the field with system installers.	liters / time
Design scale of RR system ($DsnScl$)	$$DsnScl = RANDOM\ UNIFORM(Design\ number, 15, 9)$$ The details of this parameter are based upon interviews with system installers and adopters as well as participatory observation during field visits. The design scale ($DsnScl$) is the self-reported number of people that is given to the system installers to be used to size the tank size ($TkSz$). A random uniform distribution from a minimum of 5 ($Design\ number$), to a maximum of 15, with an average of 9 is representative of the typical sizes for RR system adopters in Placencia.	people
Actual users of RR system ($ActUsers$)	$$ActUsers = RANDOM\ NORMAL(\ 5, 25, (DsnScl + 5), 5, 8)$$ This random normal distribution reflects the minimum, maximum, average, standard deviation, and seed values used to represent the discrepancy between the Design scale of RR systems ($DsnScl$) and the Actual number of users ($ActUsers$). Field data shows that RR systems were typically designed for a minimum number of users rather than for the realistic, or actual number using the system.	person
Average working volume of RR system ($Vol_{WORKING}$)	$$Vol_{WORKING} = \int (Vol_{DESIGN} - SludgeAcc_{RATE})\ dt$$ The volumetric difference between the volume based on the design scale (Vol_{DESIGN}) and the sludge accumuled in the RR system ($SludgeAcc_{RATE}$).	liters
Sludge accumulation rate ($SludgeAcc_{RATE}$)	$$SludgeAcc_{RATE} = SludgeProd_{RATE} - O\&M_{RATE}$$ The rate at which sludge is accumulating in the system reflected by the difference in the production from all the users of the RR system ($SludgeProd_{RATE}$) and the O&M that evacuates the solids ($O\&M_{RATE}$).	liters / time
Operation & Maintenance rate ($O\&M_{RATE}$)	$$O\&M_{RATE} = Sludge_{EVAC} \times O\&M_{BEHAVIORAL}$$ The rate at which sludge is being evacuated from the RR system based upon the behavioral O&M ($O\&M_{BEHAVIORAL}$) which is aligned with the Actual O&M spending. The behavioral parameter is derived from interviews with system adopters and installers as well as participatory observations.	liters / time

Table T5: Mass balance equations and kinetic parameters for domestic wastewater used to quantify treatment efficiency of the RR system.

Parameter Name	Parameter	Equation
Effluent inert solids concentration	X_{out}^{int}	$\dfrac{X_{in}^{int}}{\left(1+\ k_{sett}^{int}\theta\right)}$
Effluent fecal solids concentration	X_{out}^{fec}	$\dfrac{X_{in}^{fec}}{\left(1+\ k_{sett}^{fec}\theta\right)+\ \left(k_{hydro}^{\prime\ fec}X_{out}^{bact}\theta\right)}$
Effluent bacterial solids concentration	X_{out}^{bact}	$\dfrac{S_{in}-\ S_{out}}{\left(\theta\left(\frac{1}{Y}\right)\mu_{max}^{bact\ gro}\left(\frac{S_{out}}{S_{out}+\ K_{sat}^{sub}}\right)\right)-\ \left(k_{hydro}^{\prime\ fec}X_{out}^{fec}\theta\right)}$
Effluent substrate concentration	S_{out}	$\dfrac{\left[\left(\theta b+\ k_{sett}^{bact}\theta+1\right)\left(k_{sat}^{sub}\right)\right]}{\left[\theta\mu_{max}^{bact\ gro}-\ \theta b-\ \theta k_{sett}^{bact}-1\right]}$

Parameter Name	Parameter	Value	Units	Source
Influent inert concentration	X_{in}^{int}	60	mg/L	Rittmann and McCarty, 2001
Inert settling constant	k_{sett}^{int}	0.1	1/day	Woo, 2015
Hydraulic retention time	θ	4.5	day	Calculated from model
Influent fecal concentration	X_{in}^{fec}	100	mg VSS/L	Rittmann and McCarty, 2001
Fecal settling constant	k_{sett}^{fec}	0.96	1/day	Struck and Borst, 2008
Yield	Y	0.4	mg VSS/ mg BOD	Rittmann and McCarty, 2001; Ergas and Aponte-Morales, 2014
Fecal hydrolysis rate constant	$k_{hydro}^{\prime\ fec}$	0.24	L/mg*day	Ikhazuangbe and Oni, 2015
Influent substrate concentration	S_{in}	420	mg BOD/L	Rittmann and McCarty, 2001
Substrate half saturation	k_{sat}^{sub}	25	mg/L	Ergas and Aponte-Morales, 2014
Bacterial settling constant	k_{sett}^{bact}	0.96	1/day	Struck and Borst, 2008
Flow rate	Q	205.5	L/day	Calculated from model
Maximum bacterial growth rate	$\mu_{max}^{bact\ gro}$	10.8	1/day	Rittmann and McCarty, 2001
Death rate	b	0.13	1/day	Ergas and Aponte-Morales, 2014

Table T6: Model factors, equations, definitions, and units for the stocks, flows, and parameters associated with the confirmation phase of technology adoption.

Model Factors	Equation and Definition	Units
Level of Sustainability ($Sus\ Lvl$)	$Sus\ Lvl\ = Econ_{VIA} + Environ_{VIA}$ A simple weighted summation of economic ($Econ_{VIA}$) and environmental ($Environ_{VIA}$) viability of the behaviors necessary to sustain RR systems. Weights were determined from participatory observations.	unitless
Sustainability rate (Sus_{RATE})	$Sus_{RATE} = \frac{PotS\ \times Sus\ Lvl}{TIMESTEP}$ The rate function based upon the stock individuals potentially sustaining their RR systems ($PotS$) based upon the level of sustainability ($Sus\ Lvl$).	household / time
Potentially sustaining RR systems ($PotS$)	$PotS = DA\ - CS$ The population of individuals that have adopted (*DA*) but are not yet sustaining their RR system.	household
Confirmed by sustaining RR system (CS)	$CS = \int (Sus_{RATE})\ dt$ The population of individuals that have sustained their RR system.	household

TECHNICAL APPENDIX_FIGURES

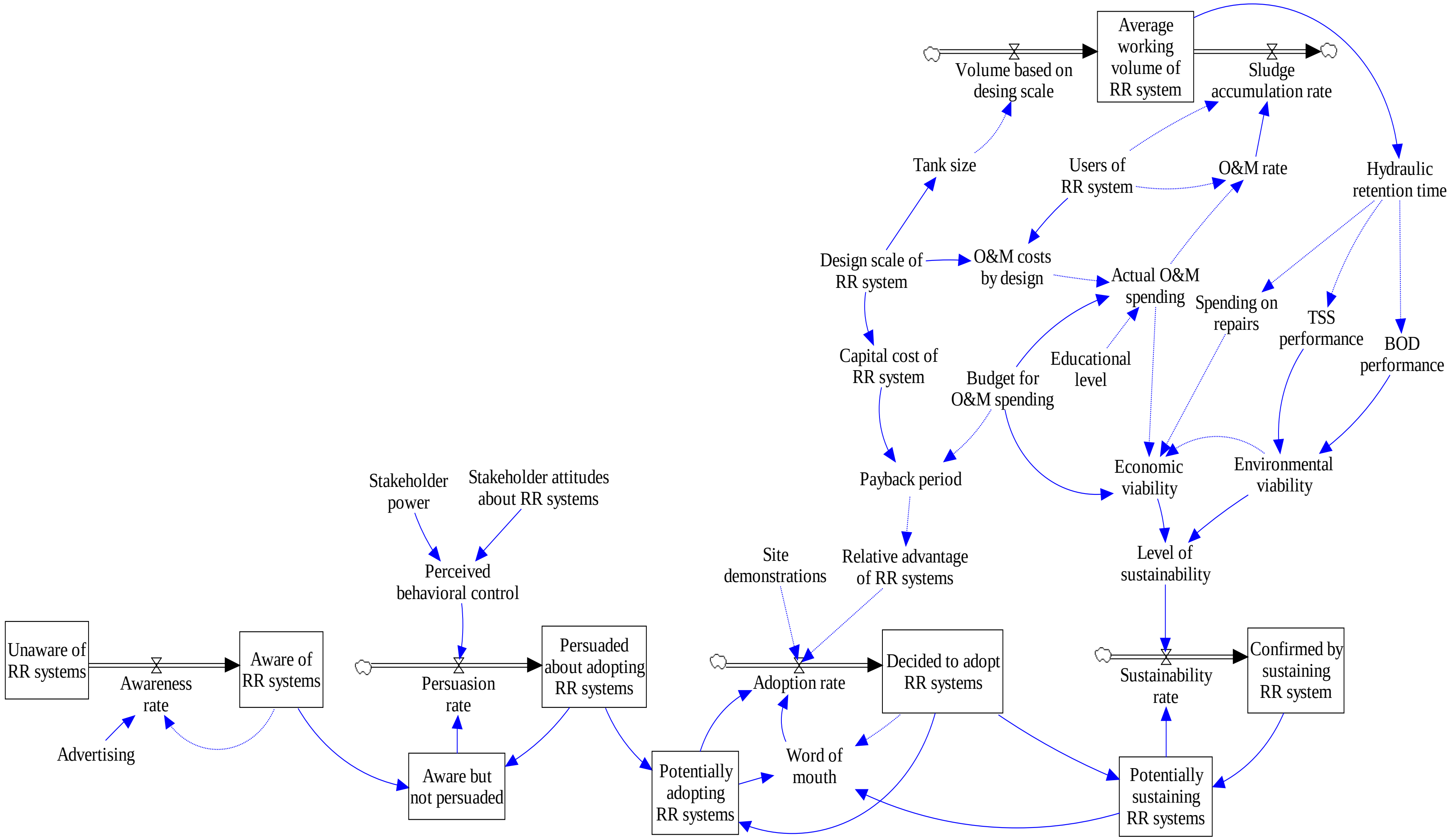

Figure T1: Simplified stock flow diagram of the factors and dynamics influential to the adoption process of RR systems, including the knowledge, persuasion, decision, and confirmation phases.