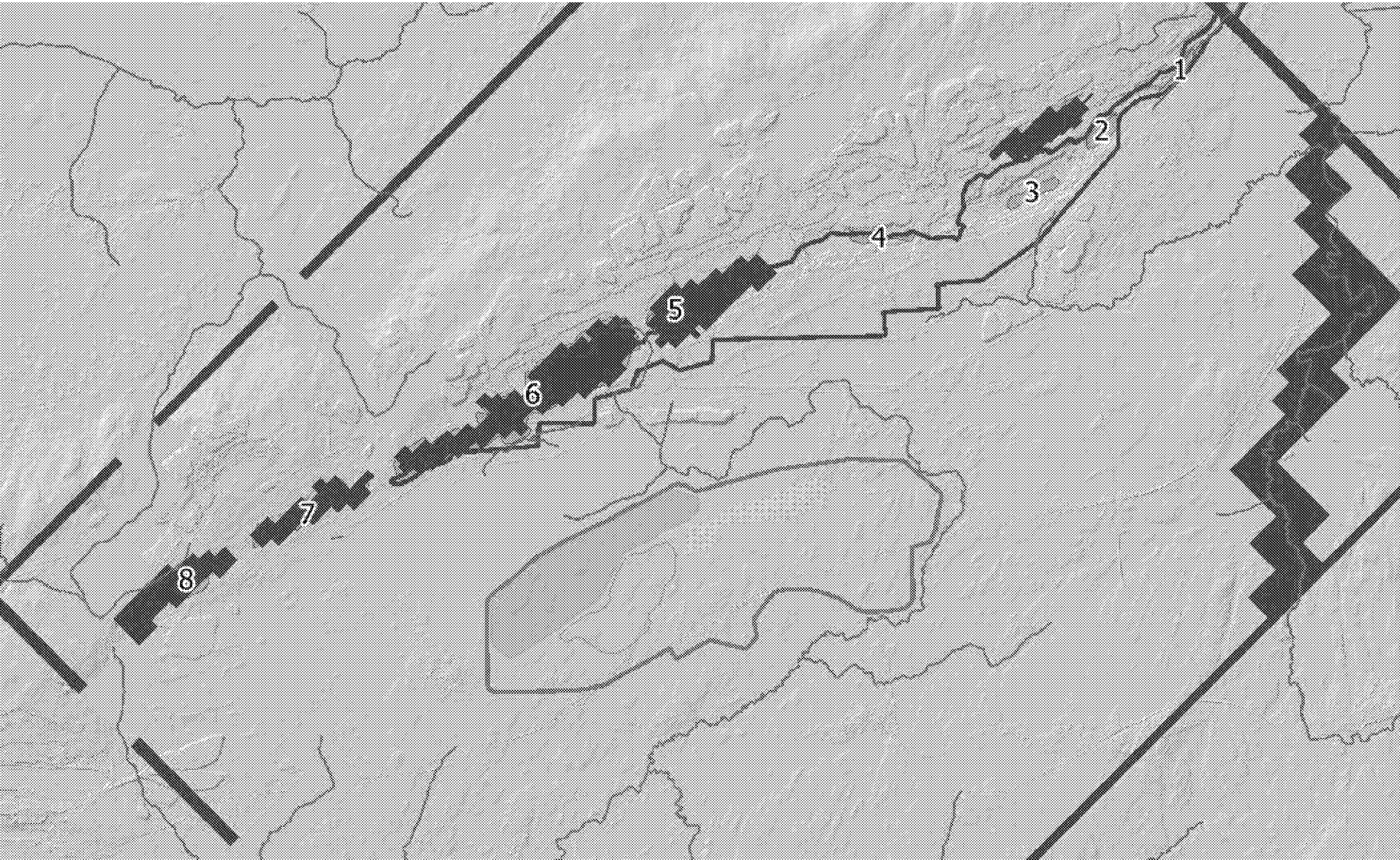
Table 1. Peter-Mitchel pit water levels.

The pit number correspond to the pits in the attached map.

	<-west			pit				east->
	8	7	6*Area3-West	5*Area3-East	4 Area2	3	2	1
year		SD011-12	SD008-10	SD006-7	SD005	SD004		SD002
1978/09		empty	~empty	**empty**	empty	empty	empty	
1979/09		empty	empty	**empty**	empty	empty	empty	
1980/10		empty	empty	**~empty**	empty	empty	empty	
1985/10		~empty	~empty	**<477.9**	~empty	~empty	~empty	~empty
1986/11				**483.4**				
1987/09				**487.7**				
1988/04				488.3				
1989/10				492.6	492.6			
1991/09		499.0	494.0	494.4	492.6			
2011/05	498.74	499.50	494.4	477.6	460.0	425.1	452.3	432.7
Barr MODFLOW runs (1996)	488.3	500.1	492.6	492.6	missing	475.5	475.5	
Partridge @ SW001			489.7					
confluence of Yelp and Partridge			487.0					
Partridge & RR grade (SW002)			486.8					

*headwaters of Partridge River/Yelp Cr.


1
2
3
4
5
6
7
8

horizontal hydraulic conductivity was 4.5 x 10^{-4} feet/day, estimated from the five borehole tests conducted south of the proposed pits, away from the Virginia Formation contact.

3.2.5.5 Calibration Results

Optimized hydraulic conductivity values are summarized in Table 3-4. Because the horizontal hydraulic conductivity of the unconsolidated deposits varies by cell, the range of values and mean value in each zone resulting from the calibration are shown. Large Figure 18 shows the calibrated hydraulic conductivity distribution in Layer 1 for the area of interest, including the average hydraulic conductivity for each of the GoldSim groundwater flow path areas. Table 3-5 provides a comparison between the estimated and calibrated hydraulic conductivity values at locations where prior information was included in the calibration. Calibrated hydraulic conductivity values generally compare well with the estimated values.

Table 3-4 Optimized Hydraulic Conductivity Values

Model Parameter	Value (feet/day)
Horizontal hydraulic conductivity – Upland deposits	Range: 0.056 - 167 Mean: 19.2
Horizontal hydraulic conductivity – Wetland deposits	Range: 0.003 - 224 Mean: 23.7
Vertical hydraulic conductivity – Upland and wetland deposits (1)	0.0028 (1)
Hydraulic conductivity – Giants Range granite	$K_{xx} = K_{yy} = 0.029$ $K_{zz} = 0.0029$
Hydraulic conductivity – Biwabik Iron Formation	$K_{xx} = K_{yy} = 0.87$ $K_{zz} = 0.087$
Hydraulic conductivity – Virginia Formation, Upper Portion	$K_{xx} = K_{yy} = 0.31$ $K_{zz} = 0.031$
Hydraulic conductivity – Duluth Complex	$K_{xx} = K_{yy} = 4.4 \times 10^{-4}$ $K_{zz} = 4.4 \times 10^{-5}$
Hydraulic conductivity – Virginia Formation, Lower Portion	$K_{xx} = K_{yy} = 0.079$ $K_{zz} = 0.0079$
Vertical hydraulic conductivity term of Partridge River Reach 1	41.0
Vertical hydraulic conductivity term of Partridge River Reach 2	32.8
Vertical hydraulic conductivity term of Partridge River Reach 3	25.6
Vertical hydraulic conductivity term of Partridge River Reach 4	18.5
Vertical hydraulic conductivity term of Partridge River Reach 5	13.2
Vertical hydraulic conductivity term of Partridge River Reach 6	10.4
Vertical hydraulic conductivity term of Partridge River Reach 7	8.8
Vertical hydraulic conductivity term of Partridge River Reach 8	10.0

(1) Parameter not allowed to vary during calibration

Table 3. MODFLOW modeling results used for Goldsim modeling of contaminant transport as reported in the water modeling report "Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf".

Establish general groundwater head distribution (e.g. watertable):	Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 124 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf and Large Figs. 14 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 492 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)
Establishing contaminant flow paths:	Section 5.2.3 and Large Figs. 28-29 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 114 and 511 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) and Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 124 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)
Establishing gradients along contaminant flow paths:	Section 5.2.3.1 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 118 Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)
Establishing hydraulic conductivity along contaminant flow paths:	Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 125 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) and Section 3.2.5.5 and Large Fig. 18 of Attachment B Groundwater Modeling of the NorthMet Mine Site (.pdf page 662 and 702 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)
"Infiltration" along contaminant flowpaths for calculation of baseflow:	Section 5.2.4.3.5 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 141 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)

Pit inflows used for "overall water balance in the probabilistic model" (contaminant transport model):	Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 125 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) and Section 6.1.2.3.2 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 177 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)
.....	

Table 4. Parameters used in GoldSim modeling. from the Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Grey cells indicate changes from the previously published version											
Climatic Variables											
Annual_Precip_Cuberoot	[$in^{1/3}$]	Uncertain	Annual	Trunc. Normal	3.05	0.16	0	N/A	Cube root of the annual precipitation	HiDen Climate network for Mine Site (1980-2010 climate normal)	Water Section 5.2.1 *Climate Inputs*
Monthly_Precip_Factors	[%]	Deterministic	N/A	Constant	Vector by month. Reference Table 1-11				Factors for partitioning annual precipitation to monthly	HiDen Climate network for Mine Site (1980-2010 climate normal)	Water Section 5.2.1 *Climate Inputs*
Annual_Evap	[in/yr]	Uncertain	Annual	Normal	20.8	1.33	N/A	N/A	Annual evaporation from open water	HiDen Climate network for Mine Site (1980-2010 climate normal); Baker (1979)	Water Section 5.2.1 *Climate Inputs*
Monthly_Evap_Factors	[%]	Deterministic	N/A	Constant	Vector by month. Reference Table 1-11				Factors for partitioning annual open water evaporation to monthly	Baker (1979) for partitioning ratios	Water Section 5.2.1 *Climate Inputs*
Snowmelt	[--]	Deterministic	N/A	Constant	4	N/A	N/A	N/A	Month when snowmelt occurs	USGS Gage Data	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Freezeup	[--]	Deterministic	N/A	Constant	11	N/A	N/A	N/A	Month when freezeup occurs, consistent with WWTF design team definition	USGS Gage Data	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Background Chemistry											
GW_Conc_Surf	[mg/L]	Uncertain	Realization	Transformed Normal	Vector by Constituent. Reference Table 1-12				Surficial groundwater concentrations in the Partridge River watershed	Analysis of PolyMet background water quality data	Water Section 5.3.1 *Background Groundwater*
GW_Conc_Bed	[mg/L]	Uncertain	Realization	Transformed Normal	Vector by Constituent. Reference Table 1-12				Bedrock groundwater concentrations in the Partridge River watershed	Analysis of PolyMet background water quality data	Water Section 5.3.1 *Background Groundwater*
SW_Conc_RO	[mg/L]	Uncertain	Month	Lognormal	Vector by Constituent. Reference Table 1-13				Calibrated surface runoff concentrations in the Partridge River watershed	Calibration of model to baseline conditions	Water Section 5.3.1 *Background Surface Runoff*
SW_Conc_PMP	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-13				Concentration leaving the Peter Mitchell Pits	2004-2007 WQ modeling at SW-001	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Flow_PMP	[cfs]	Deterministic	N/A	Constant	2.6	N/A	N/A	N/A	Flow from Peter Mitchell Pit dewatering to SW-001	Calibration of model to baseline conditions	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Flow_PMP_end	[yr]	Deterministic	N/A	Constant	55	N/A	N/A	N/A	Mine Year when flow from Peter Mitchell Pit ends, equivalent to year 2070	Northshore Mine Plan	Water Section 5.5.3.1 *Other (Non-Project) Loads*
SW_Conc_Partridge	[mg/L]	Deterministic	N/A	Constant	Matrix by Constituent and location. Reference Table 1-14				Baseline existing chemistry in Partridge River used to evaluate model	2004-2010 Monitoring Data of Partridge River	Water Section 4.4.4.1 *Water Quality ,Partridge River*
Load_Colby	[kg/yr]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-13				Calibrated additional loading to Colby Lake	Calibration of model to baseline conditions	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Groundwater Flowpath Characteristics											
I_ops	[--]	Uncertain	Realization	Uniform	Vector by flowpath. Reference Table 1-15				Average hydraulic gradient along aquifer	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
I_close	[--]	Uncertain	Realization	Uniform	Vector by flowpath. Reference Table 1-15				Average hydraulic gradient along aquifer in closure	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Thick	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Aquifer thickness	Assumed value	Water Section 5.4.1 *Groundwater Flowpath Modeling*
EL_Pit	[ft]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Pit surficial outflow elevation	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Width	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Flowpath width	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Upstream	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length upstream of stockpile	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Stock	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Source (stockpile) length	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Eval_1	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length to Evaluation Point #1	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Eval_2	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length to Evaluation Point #2	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Eval_3	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length to Evaluation Point #3	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Total	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Total flowpath length	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*

Table 4, continued.

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Grey cells indicate changes from the previously published version											
Groundwater Flow Variables											
Bedrock_Porosity	[--]	Deterministic	N/A	Constant	0.05	N/A	N/A	N/A	Porosity of the bedrock flowpaths	Mine Site MODFLOW model (Bedrock units)	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Surficial_Porosity	[--]	Deterministic	N/A	Constant	0.3	N/A	N/A	N/A	Porosity of the surficial flowpaths	Assumed value, e.g. Fetter, 2001	Water Section 5.4.1 *Groundwater Flowpath Modeling*
K_Flowpath	[m/d]	Uncertain	Realization	Triangular	Vector by flowpath. Reference Table 1-15				Hydraulic conductivity of the surficial and bedrock material	Mine Site MODFLOW model (Duluth Complex), constraints discussed in Water Section 5.4.1	Water Section 5.4.4 *Groundwater Transport in GoldSim*
Recharge_min	[in/yr]	Deterministic	N/A	Constant	0.36	N/A	N/A	N/A	Minimum allowed recharge in surficial aquifer (for checking calculated value)	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Recharge_max	[in/yr]	Deterministic	N/A	Constant	1.8	N/A	N/A	N/A	Maximum allowed recharge in surficial aquifer (for checking calculated value)	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Surficial_Density	[kg/m3]	Deterministic	N/A	Constant	1,500	N/A	N/A	N/A	Dry (bulk) Density of the surficial deposits	USDA St. Louis County Soil Survey Database	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Kd_Surficial	[L/kg]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-16				Sorption coefficients for the surficial aquifer (As, Sb, Cu, Ni)	EPA screening-level values	Water Section 5.4.3 *Sorption*
Stream Reach Characteristics											
Segment_Area	[m^2]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Cross sectional area of each segment upstream of each node	RS26 geomorphic surveys	Water Section 5.5 *Surface Water Modeling*
Segment_Length	[m]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Length of river upstream of each node	GIS data	Water Section 5.5 *Surface Water Modeling*
Colby_Volume	[acre-ft]	Deterministic	N/A	Constant	5,300	N/A	N/A	N/A	Colby Lake storage volume from RS73B	DNR bathymetric maps (summarized in RS73B)	Water Section 6.1.5 *Water Balance, Colby Lake*
Contributing_Area	[acre]	Deterministic	N/A	Time Series	Matrix by location and year. Reference Table 1-18				Contributing watershed area to each river node (incremental), used to calculate recharge	XPSWMM Model GIS analysis	Water Section 5.6.4 *Modeling Future Conditions*
Stream Flow Variables											
Streamflow_SW006_(Month)	[cfs]	Uncertain	Timestep	User-defined	Imported from worksheet. Reference Table 1-19				Randomly sampled daily streamflow at SW-006 for each month	USGS gage data (corrected for PMP dewatering)	Water Section 5.6.5 *Developing Probabilistic Model Inputs*
Inc_Flow_Factor_(Month)	[--]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-20a through 1-20l				Factor to multiply Q at SW006 to get the incremental inflow between nodes for each month	XP-SWMM model results (relative differences)	Water Section 5.6.5 *Developing Probabilistic Model Inputs*
GW_Inc_Baseflow	[cfs]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-21				Baseflow adding to evaluation points via natural groundwater	XP-SWMM model results scaled to observed baseflow at SW-006	Water Section 5.6.5 *Developing Probabilistic Model Inputs*