BOARD OF WATER AND SOIL RESOURCES

PTMApp-Desktop QA/QC Methodology

Revised March 2021

Methods for Completing Quality Assurance & Quality Control of Prioritize, Target and Measure Application (PTMApp) Products

There are many required Geographic Information System (GIS) inputs required, and outputs created, while using the Prioritize, Target and Measure Application Desktop (PTMApp-Desktop) toolbar. Ensuring quality products are used during, and produced from, the toolbar can be challenging and time intensive. Quality assurance and quality control (QA/QC) is used to statistically and visually evaluate the input and output products. This document provides guidance on recommended values for inputs and outputs for PTMApp products generated in the State of Minnesota. Often, a QA/QC review consists of plotting, charting histograms, or generating descriptive statistics of raster or feature class attribute values. These can be summarized, and the minimum and maximum values evaluated to determine whether there are outliers.

The Clip Watershed tool has internal checks to ensure input raster data meet PTMApp-Desktop's formatting requirements, as well as fit within the expected values for data in the State of Minnesota. The Clip Watershed tool will create a text file when it is complete which provides information that includes warnings about input data that do not meet the requirements or expected values as listed in the table below.

Table 1 PTMApp-Desktop Input Data Definition and QAQC Notes

PTMApp-Desktop Input Data Name	What it is?	Range* or value	Notes
bound_1w1p	Boundary for 1W1P planning area, or watershed boundary for analysis		Inputs should have full coverage of this layer. Verify that all outputs clip to this feature.
curve_num	Curve number raster	30 - 100	Refer to SCS Curve Number tables for more detail (PTMApp - Theory and Development Documentation - Appendix D).
ds_tt	Downstream travel time raster	10's of hours in HUC 10s, 100-200 hours in HUC 8s	Furthest upstream areas should contain the highest values and should be approximately equal to the maximum us_tt values.

PTMApp-Desktop Input Data Name	What it is?	Range* or value	Notes
fac_surf	Flow accumulation from the hydroconditioned DEM, accounting for non-contributing areas		This layer should have values for every cell within the bound_1w1p. Values should increase downstream with regard to the flow direction raster layer, with some areas accumulating flow to non-contributing basins.
fac_total	Flow accumulation from the hydroconditioned DEM		This layer should have values for every cell within the bound_1w1p. Values should increase downstream with regard to the flow direction raster layer, with all flow accumulating to the watershed outlet.
fdr_surf	Flow direction raster from the hydroconditioned DEM, accounting for non-contributing areas		This layer should have values for every cell within the bound_1w1p.
fdr_total	Flow direction raster from the hydroconditioned DEM		This layer should have values for every cell within the bound_1w1p.
hyd_dem	Hydrologically conditioned digital elevation model (DEM)		Small depressions in the landscape that contribute to downstream flow will be filled.
p_res_pts	Priority resource points used as locations to assess loadings and reductions		All p_res_pts need to be on a fac_total or fac_surf line (i.e., the highest nearby cell value), depending on flow accumulation grid used.
raw_dem	Non-conditioned digital elevation model (DEM)		All raster layers should be snapped to the raw_dem. Check raster layer cell alignment.

PTMApp-Desktop Input Data Name	What it is?	Range* or value	Notes
rusle_c	RUSLE cover management factor raster	0 - 0.2	Recommend using landuse/landcover lookup table in PTMApp documentation unless better local knowledge exists.
rusle_kw	RUSLE soil erodibility factor raster	0 - 0.65	Based upon SSURGO data.
rusle_m	RUSLE weighting factor	1	Can be adjusted between 0 and 1 based upon local knowledge.
rusle_p	RUSLE support and conservation practice factor	1	Can be adjusted between 0 and 1 based upon local knowledge.
rusle_r	RUSLE rainfall runoff erosivity factor raster	50 - 150	Values should range from 50 to 150.
ssurgo_cpi	Soil Survey Geographic Database crop productivity index raster	0 - 100	This layer may not have full coverage (i.e., some areas without data).
ssurgo_dtgw	Soil Survey Geographic Database depth to groundwater raster	0 - 500	This layer may not have full coverage (i.e., some areas without data).
ssurgo_hs	Soil Survey Geographic Database hydric soils raster	0 or 1	Values of 1 represent areas on the landscape with a hydric soils. This layer may not have full coverage (i.e., some areas without data).

PTMApp-Desktop Input Data Name	What it is?	Range* or value	Notes
ssurgo_hsg	Soil Survey Geographic Database hydrologic soils group	1 - 7 (whole number)	Values correspond with A, B, C, D, A/D, B/D, and C/D soils types. This layer may not have full coverage (i.e., some areas without data).
tt_grid	Cell to cell travel time raster	0 - 149	Cell value is in seconds.
us_tt	Soil Survey Geographic Database upstream travel time raster	10's of hours in HUC 10s, 100-200 hours in HUC 8s	Furthest downstream areas should contain the highest values and should be approximately equal to the maximum ds_tt values.

*ranges for Minnesota

Listed in the table below are the recommended checks for PTMApp outputs. Many of these checks have been coded into the tools so that a user is alerted to data range or average values that differ from the expected results. The internal checks currently coded into PTMApp should not replace a thorough review of data generated by the PTMApp modeler.

Table 2 PTMApp-Desktop output data files including definition and QAQC notes

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
adj_catchment	Adjoint hydrologic catchment boundaries		Only present if adjoint catchments were generated. The catch_id field in the adj_catchment attribute table should match the catch_id of the catchment attribute table for the catchments contained within the adjoint catchment‘s furthest downstream point.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
bin_ raster layers (e.g., bin_pond, bin_wascob, etc.)	Binary layer(s) showing locations suitable for NRCS_coded practices	0 or 1	A value of 1 indicates a suitable location for a BMP based on the suitability criteria for the specific NRCS_code. Check to see that areas with a value of 1 seem reasonable for a potential BMP and that areas with a value of 0 do not miss opportunities for potential BMPs. bin_denit, bin_drain, bin_filtst, bin_gwater, bin_inftrench, and bin_protect will be missing data in cells closest to the bound_1W1P.
bmp_ feature classes (e.g., bmp_pond, bmp_wascob, etc.)	Feature class layer(s) showing locations suitable for NRCS_coded practices		Polygons should overlap locations in the associated bin_ layer that contained a value of 1, and also meet BMP size and watershed area screening criteria. For example, all bmp_pond polygons should overlap areas where bin_pond = 1. However, polygons with very small surface area or drainage area are screened and removed from the bmp_ layer during bmp_suitability. See the BMP Suitability Enhancement Memo for additional details.
bmp_implementation	User provided input for treatment train analysis (optional)		BMP records within the bmp_implementation feature class must contain all fields present in the bmp_ feature class(es).
bmp_null	User provided input for the screen BMP tool (optional)		Polygon where BMPs are to be excluded from analysis.
catchment	Individual hydrologic catchment boundaries	Mean catchment area ~ 40 acres	A few in-channel catchments maybe > 200 acres. The entire extent of your study area should be covered by catchments unless fac_surf and fdr_surf files were ingested.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
catchmentraster	Raster layer representing the location of catchments, with cell values equal to the catch_id attribute		Raster values should match the catch_id field in the catchment attribute table. Catchment boundaries should match the boundaries between different cell values.
cti	Compound topographic index (CTI). Cells are relative dimensionless values		Depressional areas on the landscape should have the highest values. Negative values are acceptable.
ds_fl	Downstream flow length (in meters)	100's to 1,000s of meters in HUC 12s, up to 1,000,000's of meters in HUC 8s	Values will vary depending on the size of the study area. Largest values should be at the furthest upstream point and should be equal (or very close) to the highest us_fl value. The change in value between cells should correlate to the cell size dimension or the square root of the sum of the squares [sqrt(x^2 + y^2)].
landseg_polygon	User provided input feature class for the scale loads tool (optional).		Distribution of land segments with yields data attached.
ls_factor	Length-Slope factor, calculated and used in RUSLE	0.03 to 52.7	Largest values should be along steeper slopes. The mean cell value for the layer should be between 0.5-5 depending on the grade in watershed. If the mean is just outside this range, the value should be lower for flat watersheds and higher for hilly watersheds.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
overland_sdr	Delivery ratio of mobilized sediment to the flowline as a percent of sediment delivered to a concentrated flowpath	0 - 1	Largest values should be near catchment outlets.
p_res_catchment	Hydrologic boundaries of the priority resource catchments and/or plan regions		Check to see that each point feature in the p_res_pts layer has an upstream contributing area delineated in this file.
p_res_snap	Outlet point of priority resource catchment and/or plan regions		Check to see that the cells in this file are aligned with the cells from the hyd_dem and are snapped to a major flowline (highest nearby fac_total or fac_surf).
pp_catchment	Outlet pour points for catchments.		Cell values should match catch_ID.
PeakQ_10yr	Peak flow from upstream contributing drainage area for 10-yr 24-hour rainfall event (ft^3/sec)		Verify 10-yr peak discharge is reasonable compared to data from nearby, similarly sized gauge, if available (e.g., USGS Current Conditions - streamflow gauges).
PeakQ_2yr	Peak flow from upstream contributing drainage area for 2-yr 24-hour rainfall event (ft^3/sec)		Verify 2-yr peak discharge is reasonable compared to data from nearby, similarly sized gauge, if available (e.g., USGS Current Conditions - streamflow gauges).

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
RO_vol_10yr	Runoff volume from upstream contributing drainage area for 10-yr 24-hour rainfall event (ft^3)		Multiply a runoff_depth_10yr raster cell value (convert in. to m) by the upstream contributing area to that cell. The product (convert m^3 to ft^3) should approximately match the corresponding RO_vol_10yr raster cell value.
RO_vol_2yr	Runoff volume from upstream contributing drainage area for 2-yr 24-hour rainfall event (ft^3)		Multiply a runoff_depth_2yr raster cell value (convert in. to m) by the upstream contributing area to that cell. The product (convert m^3 to ft^3) should approximately match the corresponding RO_vol_2yr raster cell value.
runoff_depth_10	Runoff depth associated with the 10-yr 24-hour rainfall event (in.)		All values should be < the input precipitation depth which is listed in the processing results. Values can be verified using the SCS runoff depth equation.
runoff_depth_2	Runoff depth associated with the 2-yr 24-hour rainfall event (in.)		All values should be < the input precipitation depth which is listed in the processing results. Values can be verified using the SCS runoff depth equation.
sed_mass	Sediment mass leaving the landscape, adjusted by calibration factor if applicable (tons/acre/year)		Flat areas should generally have mean values < 5 tons/acre with most being < 2 tons/acre. Values should increase where slope and flow length increase. Maximum values vary greatly by watershed and should generally be < 50 tons/acre. Some values may be in 100's of tons/acre, but should only occur due to outliers in the LS factor.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
sed_mass_fl	Sediment mass delivered to the catchment outlet (tons/acre/year)		Values should be less than sed_mass values, relative to the overland_sdr.
sed_mass_fl_acc	Sediment mass delivered to the catchment outlet and accumulated from all upstream cells (tons/year)		Values should steadily increase as you move downstream.
sed_mass_fl_rank	Rank of sediment reaching the flow line	0 - 1	Areas with the highest sed_mass_fl values will have the highest sed_mass_fl_rank.
sed_mass_rank	Rank of sediment leaving the landscape	0 - 1	Areas with the highest sed_mass values will have the highest sed_mass_rank.
sed_mass_raw	Sediment mass leaving the landscape (tons/acre/year)		This should only differ from the sed_mass raster if a calibration factor was used.
slope	Slope of the raw_dem as a percent		Maximum slope may be large (>100%) but the mean should be 5% or less in most areas.
spi	Stream power index (SPI)		Areas with the highest values are relative to the individual study area. Areas with high slopes and large contributing areas should have the highest values. Negative values are acceptable.
spi_ranks	Rank of the SPI raster	0 - 1	Areas with the highest spi values should have the highest spi_ranks.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
table_adj_catchment	Adjoint catchment table		Only present if adjoint catchments were generated. Find the furthest downstream points of an adjoint catchment near a water quality monitoring gauge and compare sediment_sum, tn_sum, and tp_sum estimates to the monitoring data or comparable literature yield values. Estimates should be reasonable approximates of the monitoring data.
table_adj_catchment_route	Routing calculation table for adjoint catchments		Only present if adjoint catchments were generated. A catchment might contribute to multiple downstream adjoint catchments. Loads for downstream adjoint catchments should be < loads delivered to the catchment outlet. Loads from a catchment delivered to a further downstream adjoint catchment should be lower than loads delivered to an adjoint catchment further upstream. The 'delta_tt' field should increase for catchments further upstream in an adjoint catchment. The '_delivery_ratio' fields should decrease for catchments further upstream in an adjoint catchment.
table_ba_bmp_all	Table with load reductions calculated for each BMP as estimated at the catchment outlet.		R_10yr24hr and R_2yr24hr should be between 0-1. SQ2, PQ2, NQ2, etc. should be between 0-1. C_SQ2_10 should be >= C_SQ2_02. Same for other similar (C_) attributes. Records should match values presented in the bmp_ layer attribute table.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
table_BA_BMP_All_Catchment	Table showing one set of values per BMP type (NRCS_code) for each catchment		There should not be more than one NRCS_code record per catchment. Each catchment containing an opportunity for a BMP should have load reduction estimates to all downstream priority resource points.
table_ba_load_red	Table with load reductions calculated for each BMP as estimated at each downstream priority resource catchment outlet.		Each record should have load reduction estimates at all downstream priority resource points. Load reduction estimates to a priority resource outlet (e.g., R_SQ2_02) should not be > load reduction estimates to the catchment outlet (e.g., C_SQ2_02).
table_ca_bmp_costeff	Table with cost index data, representing one set of values per BMP type (NRCS value) for each catchment.		There should not be more than one NRCS_code record per catchment. Each catchment containing an opportunity for a BMP should have cost index estimates to all downstream priority resource points.
table_catchment	Table with catchment information, including water volume and sediment, TP, and TN mass information.		The sed_mass, tp_mass, tn_mass, sed_mass_fl, tp_mass_fl, and tn_mass_fl fields should contain the sum of the corresponding mass raster cell values, for cells within the catchment. The '_acres' fields are loads/acre (yields) and should reflect the _mass and _mass_fl fields, divided by the number of cells in the catchment. 'depth' and 'RO_vol' field values should correspond to the rainfall depth and RO_vol rasters. The PeakQ fields should correspond to the calculated maximum peak discharge in the PeakQ rasters.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
table_p_res_catchment	Loading to priority resource catchment and/or plan regions table		Find the furthest downstream point of a priority resource catchment near a water quality monitoring gauge and compared sediment_sum, tn_sum, and tp_sum estimates to the monitoring data. Estimates should be reasonable approximates of the monitoring data.
table_p_res_catchment_route	Routing calculation table for priority resource catchments		A catchment might contribute to multiple downstream priority resources. Loads for downstream priority resources should be < loads delivered to the catchment outlet. Loads from a catchment delivered to a nearby priority resource catchment outlet should be higher than loads delivered to a priority catchment further downstream.
table_r_catchment	Ranking catchment table (sediment, TP, TN, WQI), ranking based on 1W1P boundary		Rank values should be between 0 and 1. Ideally the distribution of the ranks will approximately fit a bell curve.
table_r_p_res_catchment	Ranking catchment table (sediment, TP, TN, WQI), ranking based on priority resource boundaries		Each catchment should have rank values for all downstream priority resource points. Ranks should be between 0 and 1. Ideally the distribution of the ranks will approximately fit a bell curve.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
table_scaled_load	Lookup table to scale yields based on HSPF/SWAT/etc. models		Only present if the scale loads tool was used. All catchments within the drainage area of the scaled load point or model polygon should have a record in this table with a revised loading value that sums to the input scale load. The sum of the values in "pr_sed_mass_tons, " "pr_tp_mass_lbs," and "pr_tn_mass_lbs" in table "table_p_res_catchment_route" for priority resource point 1 should equal the loads (sed_gauge, tp_gauge, tn_gauge) in the "table_scaled_load".
table_treat	Lookup table to match BMP type (NRCS_code) with literature derived load reduction efficiencies		Each NRCS_code should have a record in this table and have data for sediment, TP, and TN. Values can be edited if users have better data on BMP load reduction efficiencies.
table_treat_train_catch	Table with results of treatment train analysis. Load reduction are presented as estimated at the catchment outlet		Only present if treatment train analysis was performed. Table should contain median load reductions to the catchment outlet for 2 year and 10-year events for all catchments where BMP opportunities were present. These load reductions should not be > the load deliveries in table_catchment. Join resulting table with table_catchment. Compare resulting load reductions with original loading estimates.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
table_treat_train_p_res	Table with results of treatment train analysis. Load reduction are presented as estimated at the priority resource catchment outlets.		Only present if treatment train analysis was performed. Table should contain median load reductions to all downstream priority resource points for each catchment for 2 year and 10-year events for all catchments where BMP opportunities were present. These load reductions should not be > the load deliveries in table_catchment. Compare input BMP expected load reductions with those of the original loading estimates for that catchment, to the downstream priority resource point.
TN_mass	TN mass leaving the landscape (lbs/acre/year)	~1-18 lbs/acre	Values should be > TN_mass_fl
TN_mass_fl	TN mass delivered to the catchment outlet (lbs/acre/year)		Values should be < TN_mass
TN_mass_fl_acc	TN mass delivered to the catchment outlet and accumulated from all upstream cells (lbs/year)		Values should increase towards the outlet of each catchment.
TN_mass_fl_rank	Rank of nitrogen reaching the flow line.	0 - 1	Areas with the highest TN_mass_fl values will have the highest TN_mass_fl_rank.
TN_mass_rank	Rank of nitrogen leaving the landscape	0 - 1	Areas with the highest TN_mass values will have the highest TN_mass_rank.

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
TP_mass	TP mass leaving the landscape (lbs/acre/year)	~0-1.3 lbs/acre	Values should be > TP_mass_fl
TP_mass_fl	TP mass delivered to the catchment outlet (lbs/acre/year)		Values should be < TP_mass
TP_mass_fl_acc	TP mass delivered to the catchment outlet and accumulated from all upstream cells (lbs/year)		Values should increase towards the outlet of each catchment.
TP_mass_fl_rank	Rank of phosphorus reaching the flow line.	0 - 1	Areas with the highest TP_mass_fl values will have the highest TP_mass_fl_rank.
TP_mass_rank	Rank of phosphorus leaving the landscape	0 - 1	Areas with the highest TP_mass values will have the highest TP_mass_rank.
tt_overland	Travel time in hours to the flowline	~0-25 hours	Values should generally decrease towards the catchment outlet. There should be no values over major flowlines.
us_fl	Upstream flow length (in meters)	100's to 1,000s of meters in HUC 12s, up to 1,000,000's of meters in HUC 8s	Values will vary depending on the size of the study area. Largest values should be at the furthest downstream point and should be equal (or very close) to the largest ds_fl value. The change in value between cells should correlate to the cell size dimension or the square root of the sum of the squares [$sqrt(x^2 + y^2)$].

PTMApp-Desktop Output Data Name	What it is?	Range* or value	Notes
WQI_mass_fl_rank	Rank of WQI reaching the flowline	0 - 1	Areas with the highest TP, TN, and sediment values for delivery to flowline, should have the highest ranks.
WQI_mass_rank	Rank of WQI leaving the landscape	0 - 1	Areas with the highest TP, TN, and sediment yields, should have the highest ranks.