Recommendations for the Conservation Tillage Phase 6.0 Expert Panel

Prepared for the Chesapeake Bay Program Partnership's Agriculture Workgroup by the
Conservation Tillage Phase 6.0 Expert Panel Establishment Group
March 19, 2015

Background

The current version of the Chesapeake Bay Program (CBP) partnership's Watershed Model (Phase 5.3.2) includes three management levels for crop residue management. High till (0-29% crop residue) otherwise known as conventional tillage, and low till (30+% crop residue) known as conservation tillage, are both simulated as land uses and not as BMPs. A subset of the low till acreage is eligible for the High Residue, Minimum Soil Disturbance Tillage (HRTill) Management BMP, which is defined as "a crop planting and residue management practice in which soil disturbance by plows and implements intended to invert residue is eliminated. Any disturbance must leave a minimum of 60% crop residue cover on the soil surface as measured after planting. This annual practice involves all crops in a multi-crop, multi-year rotation and the crop residue cover requirement (including living and dead material) is to be met immediately after planting of each crop." The HRTill practice can be combined with other associated, applicable BMPs for additional reductions, including nutrient management and cover crops.

The Phase 5.3.2 Conservation Tillage Expert Panel (EP) recognized the potential for including additional management levels for crop residue management in the Phase 6 modeling tools, which have been documented by USDA-NRCS and implementation data captured by the Conservation Tillage Information Center (CTIC). The ability to potentially incorporate a more diverse representation of crop residue management in the Phase 6 models, and to recognize these as BMPs versus land uses, is an area of interest for the partnership. Crop residue implementation data is currently represented in the CTIC database for the following categories:

- Conventional Tillage — 0 - 15% Residue
- Reduced Tillage — 15 - 30% Residue
- Mulch Tillage — >30 % Residue
- Ridge Tillage — >30 % Residue

The Conservation Tillage Expert Panel Establishment Group (EPEG) was formed to:

- Identify priority tasks for the Conservation Tillage Phase 6.0 EP,
- Recommend areas of expertise that should be included on the Conservation Tillage Phase 6.0 EP, and
- Draft the Conservation Tillage Phase 6.0 EP's charge for the review process.

From February 10, 2015 through March 2, 2015 the EPEG met 3 times by conference call and worked collaboratively to complete this charge for presentation to the Agriculture Workgroup (AgWG) on March 18-19, 2015. Members of the EPEG are listed in Table 1.

Table 1. Conservation Tillage Phase 6.0 Expert Panel Establishment Group membership and affiliations.

Member	Affiliation
Dale Gates	US. Department of Agriculture-Natural Resources Conservation Service
Jeff Hill	Lancaster County Conservation District
Tim Sexton	Virginia Department of Conservation and Recreation
Wade Thomason	Virginia Tech
EPEG Support Staff	
Mark Dubin	University of Maryland
Emma Giese	Chesapeake Research Consortium
Jennifer Ferrando	Tetra Tech, Inc.

Method

The Conservation Tillage EPEG developed its recommendations in accordance with the process specified by the AgWG (AgWG 2014). This process is informed by the strawman proposal presented at the December 11, 2014 AgWG meeting, the Water Quality Goal Implementation Team (WQGIT) Best Management Practice (BMP) protocol, input from existing panelists and chairs, and the process recently undertaken by the AgWG to develop the charge for the Manure Treatment Technologies EP.

The collective knowledge and expertise of EPEG members formed the basis for the recommendations contained herein. Most of the EPEG members have had experience on BMP expert panels, including the Phase 5.3.2 Conservation Tillage EP. EPEG members and the technical support team also have knowledge and/or expertise in state and federal programs, the Chesapeake Bay model, and conservation tillage practices within the Chesapeake Bay watershed.

Communication among EPEG members was by conference call and email. All decisions were consensus-based.

Recommendations for Expert Panel Member Expertise

The AgWG expert panel organization process directs that each expert panel is to include eight members, including one non-voting representative each from the Watershed Technical Workgroup (WTWG) and Chesapeake Bay Program modeling team. Panels are also expected to include three recognized topic experts and three individuals with expertise in environmental and water quality-related issues. A representative of USDA who is familiar with the USDA-Natural Resources Conservation Service (NRCS) practice standards should be included as one of the six individuals who have topic- or other expertise.

In accordance with the WQGIT BMP protocol, panel members should not represent entities with potential conflicts of interest, such as entities that could receive a financial benefit from Panel recommendations or where there is a conflict between the private interests and the official responsibilities of those entities. All Panelists are required to identify any potential financial or

other conflicts of interest prior to serving on the Panel. These conditions will minimize the risk that Expert Panels are biased toward particular interests or regions.

The Conservation Tillage EPEG recommends that the Conservation Tillage Phase 6.0 EP should include members with the following areas of expertise:

- Tillage and cropping practices in the Chesapeake Bay watershed jurisdiction(s).Knowledge of the CTIC National Crop Residue Management Survey.
- Experience with carrying out research projects relating to conservation tillage.
- Expertise in fate and transport of nitrogen, and/or phosphorus, and/or sediment in agricultural systems under various tillage management systems.
- Knowledge of how BMPs are tracked and reported, and the Chesapeake Bay Program partnership's modeling tools.
- Experience with verification of conservation tillage practice implementation.
- Knowledge of, and experience with, USDA-NRCS conservation practice standards and codes.

Staff from the Chesapeake Bay Program and Tetra Tech will provide technical support for the Conservation Tillage Phase 6.0 EP.

Expert Panel Scope of Work

The general scope of work for the Conservation Tillage Phase 6.0 EP will be to define and configure the Conservation Tillage BMPs in the Phase 6.0 model. The EP will review the Phase 5.3.2 definitions and effectiveness estimates for both Conservation Tillage and HRTill and make adjustments or modifications as needed for Phase 6.0. The EP also will determine which Phase 6.0 land uses conservation tillage practices can be applied to. This scope of work addresses conservation tillage reduction efficiencies for N, P, and sediment.

The panel will work with the Agriculture Workgroup and Watershed Technical Workgroup to develop a report that includes information as described in the Water Quality Goal Implementation Team's *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*[1] (see Attachment 1).

Specifically, the Conservation Tillage EPEG recommends the following five charges with associated tasks for the Conservation Tillage Phase 6.0 EP:

1. Evaluate the existing Phase 5.3.2 representation of Conventional Tillage (HiTill) and Conservation Tillage (LoTill) land uses and provide recommendations where scientifically supported to define low residue management systems as BMPs vs. land uses, with associated nutrient and sediment efficiency values, using existing CTIC data and other sources of relevant data as references.

[1] http://www.chesapeakebay.net/documents/Nutrient-Sediment_Control_Review_Protocol_v7.14.2014.pdf

2. Provide recommendations on how to structure Conservation Tillage BMPs to incorporate the HRTill BMP and determine whether the HRTill BMP will need any adjustments to fit with the management levels proposed for Phase 6.0.
3. If feasible, develop a relationship matrix between visual assessments of residue cover (e.g. CTIC) and residue levels predicted by USDA-NRCS index tools (e.g. RUSLE2) to allow cross-referencing between the two assessment methods.
4. If possible, incorporate winter vegetation cover as part of a definition value for enhancing crop residue levels for crediting.
5. If possible, provide recommendations on sediment and nutrient load reductions as a function of soil health.

The first charge relates to the current Phase 5.3.2. Chesapeake Bay Model representing conservation tillage as a land use with the addition of the HRTill as a supplemental BMP. Both the land use and the BMP are currently primarily based on visual observation of crop residue levels at planting. The model calibration runs rely on historic data from CTIC's National Crop Residue Management Survey from 1985 to 2004 and other relevant literature and data. Calibration for the Phase 6.0 model will need to consider historical data beginning in 1995.

The second EP charge considers how to structure the Conservation Tillage BMPs to incorporate the HRTill BMP and whether the HRTill BMP needs any adjustments to fit with the management levels proposed for Phase 6.0. In evaluating the HRTill BMP, the EP should consider the RUSLE2 runs conducted by the Conservation Tillage Phase 5.3.2 panel to support development of the HRTill BMP and additional RUSLE2 runs conducted as part of the EPEG process (Attachment 2). The EP should use the CTIC historic data (from 1995 through 2004 or 2008, as available in the CTIC database) for visual assessment data, in addition to considering data from other relevant sources.

The third charge pertains to the proposed development of a matrix that describes the relationship between observed crop residue cover and predicted residue levels, and, as appropriate, soil disturbance characteristics, predicted by the NRCS tools. In the early- to mid-2000s, NRCS began moving away from field residue measurements in favor of modeled RUSLE2 outputs (Soil Tillage Intensity Rating [STIR]) and indices (e.g. Soil Conditioning Index [SCI]) to predict residue levels. The matrix should reflect the four categories of crop residue implementation represented in the CTIC database (Conventional Tillage, Reduced Tillage, Mulch Tillage, Ridge Tillage) as well as residue management consistent with the HRTill BMP from the Phase 5.3.2 model.

The fourth charge addresses incorporation of winter vegetation cover as part of a definition value for enhancing crop residue levels for crediting. In several of the Chesapeake Bay jurisdictions, typical farming practices include the establishment of a winter vegetative crop that receive manure nutrients in the fall and is harvested in the following spring. These winter vegetative crops are not eligible for crediting based on the current definitions in the Phase 5.3.2 model for either traditional or commodity cover crops. The EPEG believes that the Cover Crops Phase 6.0 EP will not be able to address systems where nutrients are applied to a cover crop in the fall. However, these systems may provide benefits for reduction of sediment and associated particulate phosphorus compared to fields left fallow over the winter

with reduced crop residues. If possible, the EP should develop BMP definition and effectiveness values to account for sediment and nutrient reductions achieved when winter cover is provided in supplement to reduced crop residues using a vegetative crop that receives fall nutrient applications. The EP should use the USDA-NRCS Soil Health Literature Summary, Matrix of Soil Properties, Matrix Data Dictionary and Summaries and Citations along with other appropriate references and resources in addressing this charge.

A variety of factors, in addition to residue cover, can affect rates of soil loss under various conservation tillage systems. The last panel charge to consider soil health considers soil cover as well as soil structure, organic matter content, and presence of a healthy biotic community. Soil health, therefore, is a more comprehensive representation of the various factors that can affect soil loss. The EP should explore if possible how to incorporate soil health considerations when determining effectiveness values for Conservation Tillage BMPs. For example, a soil with a high functioning soil health system might function better in terms of runoff and erodibility factors than a soil with more residue cover but lower functioning soil health system. The EP should use the USDA-NRCS Soil Health Literature Summary, Matrix of Soil Properties, Matrix Data Dictionary and Summaries and Citations along with other appropriate references and resources in addressing this charge.

Timeline and Deliverables

The Expert Panel project timeline for the development of the panel recommendations is based on the Phase 6.0 model development schedule. This timeline includes the development of a provisional recommendation for this BMP prior to the finalization of a fully documented recommendation report with effectiveness values. Provisional panel recommendations will be used only for initial Phase 6 model development and calibration, and not for future implementation progress reporting by the jurisdictions.

- Early Summer 2015 – Panel stakeholder kickoff meeting
- Summer 2015 – Provisional BMP paper

  Based on their written EPEG charge, the panel will develop a proposed scope of work including BMP structure and type, draft BMP definition(s), and initial elements of the BMP such as associated components and conservation practices, and USDA-NRCS associated conservation practice standard codes. Initially identified literature citations will be included to provide a range of potential effectiveness values that the panel will consider and supplement with further evaluation. The panel will present their provisional BMP paper to the AgWG, WTWG, and WQGIT for informational purposes, and for initial partnership comments on the proposed direction of the panel's evaluation. The paper will not represent a full recommendation report, and the partnership will not be asked for formal approval at this time.

- Prior to October 1, 2015 – In the absence of a Partnership approved panel recommendation report, the CBPO modeling team will request a decision by the Agriculture Workgroup, Watershed Technical Workgroup, and the Water Quality Goal Implementation Team of whether the BMP will be represented using the existing Phase

5.3.2 definitions or the Phase 6.0 panel's provisional paper in the Phase 6 Beta Scenario Builder tool to meet an early October deadline.

- Early October 2015 – All inputs are final and delivered to the WSM by the Scenario Builder team for the final calibration run. Final targets are based on this information.
- Spring 2016 – **Final date** for panel to release full recommendations for approval by the AgWG, WTWG, and WQGIT.
- Early summer 2016 – If approved by the partnership, panel recommendations are final and will replace the interim representation of the BMP in the final version of the Phase 6 modeling tools.

Phase 6.0 BMP Verification Recommendations

The panel will utilize the Partnership approved *Agricultural BMP Verification Guidance*[2], as the basis for developing BMP verification guidance recommendations that are specific to the BMP(s) being evaluated. The panel's verification guidance will provide relevant supplemental details and specific examples to provide the Partnership with recommended potential options for how jurisdictions and partners can verify Conservation Tillage practices in accordance with the Partnership's approved guidance.

[2] http://www.chesapeakebay.net/documents/Appendix%20B%20-Ag%20BMP%20Verification%20Guidance%20Final.pdf

Attachment 1: Outline for Final Expert Panel Reports

- Identity and expertise of Panel members
- Practice name/title
- Detailed definition(s) of the practice
- Recommended nitrogen, phosphorus, and sediment loading or effectiveness estimates
  - Discussion may include alternative modeling approaches if appropriate
- Justification for the selected effectiveness estimates, including
  - List of references used (peer-reviewed, unpublished, etc.)
  - Detailed discussion of how each reference was considered, or if another source was investigated, but not considered.
- Description of how best professional judgment was used, if applicable
- Land uses to which the BMP is applied
- Load sources that the BMP will address and potential interactions with other practices
- Description of pre-BMP and post-BMP circumstances, including the baseline conditions for individual practices
- Conditions under which the BMP works:
  - Should include conditions where the BMP will not work, or will be less effective. An example is large storms that overwhelm the design.
  - Any variations in BMP effectiveness across the watershed due to climate, hydrogeomorphic region, or other measureable factors.
- Temporal performance of the BMP including lag times between establishment and full functioning (if applicable)
- Unit of measure (e.g., feet, acres)
- Locations within the Chesapeake Bay watershed where this practice is applicable
- Useful life; effectiveness of practice over time
- Cumulative or annual practice
- Description of how the BMP will be tracked, reported, and verified:
  - Include a clear indication that this BMP will be used and reported by jurisdictions
- Suggestion for a review timeline; when will additional information be available that may warrant a re-evaluation of the estimate
- Outstanding issues that need to be resolved in the future and a list of ongoing studies, if any
- Documentation of any dissenting opinion(s) if consensus cannot be reached
- Operation and Maintenance requirements and how neglect alters performance

Additional Guidelines

- Identify ancillary benefits and unintended consequences
- Include negative results
  - Where studies with negative pollution reduction data are found (i.e. the BMP acted as a source of pollutants), they should be considered the same as all other data.
- Include results where the practice relocated pollutants to a different location. Examples include where a practice eliminates a pollutant from surface transport but

moves the pollutant into groundwater, or where the practice will move manure from the farm credited for the practice to another farm more in need of nutrients.

In addition, the Expert Panel will follow the "data applicability" guidelines outlined Table 1 of the Water Quality Goal Implementation Team *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*.

Attachment 2: RUSLE2 runs demonstrating potentially missed benefits based on the Phase 5.3.2 model definitions

RUSLE2 Worksheet Erosion Calculation Record

Background:
With the advent of the RUSLE2 erosion prediction model in the early 2000's, it became possible to more precisely model the effect of soil disturbance from specific tillage systems on soil erosion, soil health, and runoff. Instead of residue levels defining the tillage system, RUSLE2 accurately models tillage system soil disturbance and crop biomass production to define predicted residue levels on a daily time sensitive basis. Thus NRCS has moved away from using only measured residue levels in the field as a sole indication of soil disturbance through tillage. RUSLE2 outputs can compare tillage systems due to their modeled soil disturbance characteristics through a Soil Tillage Intensity Rating (STIR) output. Furthermore, predicted soil surface residue levels are available as outputs at any given time during the management sequence. Other relevant outputs in addition to STIR and residue levels include soil loss, Soil Conditioning Index (SCI), fuel use for the management system, soil detachment level, sediment delivery, and inches of runoff from a hill slope profile.

NRCS maintains two Conservation Practice Standards for Residue and Tillage Management: CPS 329 Residue and Tillage Management –No Till/Strip Till/Direct Seed and CPS 345 Residue and Tillage Management-Mulch Till. Both practice standards require modeling with RUSLE2. CPS 329 has a requirement to be less than full width tillage. Generally anything greater than 40% surface disturbance results in "surface soil splash" and would fall into a full width tillage category. CPS 329 has a maximum allowable STIR of 30 (in most cases the less than full width tillage definition limits the STIR to much less than 30). To meet either standard, relevant soil loss levels and/or soil health objectives must be benchmarked and met.

NRCS uses a Conservation Measurement Tool (CMT) to measure existing levels of conservation stewardship as a requirement for participation in the Conservation Stewardship Program (CSP). Meeting a stewardship threshold is required to enter the program with higher levels of measured stewardship rewarded accordingly. Within the CMT, tillage disturbance is measured through characterization of a producer's tillage system into one of 6 categories. The categories proceed from category (a) through category (f) with the highest levels of disturbance described in (a) and the lowest in (f). The point made through this illustration is that the tillage systems are specified in terms of relative disturbance in addition to providing target residue levels.

a) full width tillage, deeper than 4 inches that involves soil inversion and lifting (such as plows or deep disking). This does not include fertilizer injectors.

b) full width tillage, deeper than 4 inches that involves soil fracturing and lifting (such as sub-soilers, rippers or paraplows).

c) full width tillage performed after harvest and leaves more than 30% residue cover. Does not include seedbed preparation immediately prior to planting of a cover crop.

d) conservation tillage (includes mulch tillage) and maintain greater than 30% residue cover after planting. Residue cover includes crop residues, cover crops, composts or other natural mulch materials; it does not include plastic.

e) no till system that maintains greater than 50% residue cover after planting. Residue cover includes crop residues, cover crops, composts or other natural mulch materials; it does not include plastic.

f) no till system that maintains greater than 75% residue cover after planting. Residue cover includes crop residues, cover crops, composts or other natural mulch materials; it does not include plastic. For systems using perennials with no tillage after year of establishment, include the number of years of perennials. For vineyards, orchards or other permanent crops, enter 1 here.

Discussion:
Two RUSLE2 runs are provided below. The first run provides 7 tillage system alternatives for corn grain (high residue crop). The second run provides 7 similar alternatives for corn silage (low residue). Alternatives start with high disturbance inversion primary tillage (conventional) and proceed incrementally to lower disturbance systems. Residue levels do play an important role in reducing soil loss and runoff as evidenced from the runoff outputs. However in low residue systems there seems to be a benefit potentially missed at residue levels below the 30% residue benchmark defined as a Conservation Tillage (CT) land use. There may be benefits that deserve some credit in low residue systems where there is very low disturbance from tillage and only moderate residue levels as a BMP. Likewise in the high residue crop system there seems to be the potential for benefits missed in a low till, very high surface residue system compared to a moderate residue, moderate disturbance system as BMPs.

Possible Challenges:
1) Is there a need or opportunity to redefine the CT land use to something other than residue levels?

2) Is there a need or opportunity to apply additional BMPs levels?

3) Is there a need or opportunity to define BMPs in terms of tillage system used (either as a system narrative or STIR value) in addition to residue levels?

Info:

Inputs:

Owner name	*Location*	*--*
****Owner name****	**USA\New York\Chenango County**	

Location	*Soil*	*T value*	*Slope length (horiz)*	*Avg. slope steepness, %*
USA\New York\Chenango County	Chenango County, New York\BaC Bath channery silt loam, 8 to 15 percent slopes\Bath Channery silt loam 90%	3.0	100	9.0

High Residue-Corn Grain- Outputs

Description	*STIR*	*Residue cover after plant %*	*SCI*	*Soil detachment, t/ac/yr*	*Cons. plan. soil loss, t/ac/yr*	*Sed. delivery, t/ac/yr*	*Net Event Runoff in/yr*
Corn Grain High Residue, Full width, inversion, two pass secondary.	117	3.7	.024	4.1	4	4.1	5.1
Corn Grain, full width, non-inversion, 8 in. deep, one pass secondary at 6 in deep, second pass secondary at 2 in deep.	117	30	.14	2.4	2.5	2.4	4.6
Corn Grain, one pass full width, shallow, 4 in. deep	29.9	74	.55	1.9	1.8	1.9	4.7
Corn Grain, one pass deep zone builder, and then plant in zone. Less than 40% surface disturbance.	15.7	77	.63	1.5	1.5	1.5	5.0
Corn Grain, one pass with strip till planter, shallow, 2 in. depth, less than 30% surface disturbance.	5.63	85	.79	0.21	.4	0.21	4.2
Corn Grain, one pass full width, vertical till, shallow, 2 in depth.	5.41	83	.81	0.21	.2	0.21	3.6
Corn Grain, one pass direct seed with No-Till planter	4.00	86	.83	0.21	.2	0.21	3.9

Low Residue-Corn Silage- Outputs

Description	*STIR*	*Residue Cover after plant %*	*SCI*	*Soil detachment, t/ac/yr*	*Cons. plan. soil loss, t/ac/yr*	*Sed. delivery, t/ac/yr*	*Net Event Runoff in/yr*
Corn silage, full width primary inversion, two pass secondary.	117	<1	-.59	6.95	6.95	6.95	6.3
Corn silage, low residue, full width, non-inversion primary 8 in depth, one pass secondary, 4 in. depth	68.7	9.4	-.31	5.84	5.84	5.84	6.0
Corn Silage, one pass non-inversion, full width shallow tillage, 4 in depth.	29.7	24	-.12	5.39	5.39	5.39	6.0
Corn Silage, one pass deep zone builder then plant in zones. 40% or less surface disturbance.	15.6	26	.012	4.42	4.42	4.42	6.5
Corn Silage, one pass zone till with strip till planter, 2 in depth, 30% surface disturbance.	5.48	30	.16	3.08	3.08	3.08	6.1
Corn Silage, one pass full width vertical tillage tool, 2 in depth.	5.26	32	.22	2.38	2.38	2.38	5.6
One pass direct seed with no-till planter.	3.85	31	.23	2.41	2.41	2.41	5.8

RUSLE2 Users Guide http://fargo.nserl.purdue.edu/rusle2_dataweb/userguide/RUSLE2_User_Ref_Guide_2008.pdf

PA STIR Fact Sheet http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1119754.pdf