Assessment of NRCS Remote Sensing Pilot in Potomac River Basin of Pennsylvania

Final Report

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Executive Summary

An assessment of the Pennsylvania remote sensing pilot project was performed to guide decisions regarding its suitability to generate best management practice (BMP) implementation data that could be reported to the Chesapeake Bay Program (CBP) and credited in the Bay Model. The assessment consisted of three-components: the degree to which practices tracked in the pilot project match BMPs used in the Bay Model, the degree to which methods used in the pilot project met CBP verification requirements, and the accuracy of the remote sensing method as measured with field verification data.

While the pilot project satisfied several of the verification guidance requirements, the remote sensing pilot project was established prior to completion of the verification guidance; and therefore the remote sensing pilot project did not reflect all aspects of the verification guidance document related to visual indicators (VIs) for resource improvement practices (RIs). Field collection was staffed with individuals who each had over 25 years of relevant experience and training; and were supervised by a U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) staff member who is a trained and certified planner. To visually asses the practices included in the project, these individuals based their determinations on practice descriptions and photos located in the NRCS National Conservation Practice Handbook (NHCP) as well as descriptions found in Section IV of the NRCS Field Office Technical Guide (FOTG). The remote sensing pilot was a "Proof of Concept" project and did not include determining if the practices met USDA NRCS Standards and Specifications, despite the use of the FOTG and other sources of practice descriptions.

All but two practices (*heavy use area protection* and *vegetative barrier*) included in the pilot project could be translated directly to CBP BMPs or RIs. Components of soil conservation and water quality plans were tracked independently and not reported with consideration of whether they collectively constituted a soil conservation and water quality plan. For this reason, the number of soil conservation and water quality plans cannot be determined from the data provided.

Results of statistical analyses indicate that remote sensing was most successful in detecting the following practices: *contour orchard and other perennial crops*, *diversion*, *riparian forest buffer*, *prescribed grazing*, *terrace*, and *trails and walkways*. Of these, the greatest success was achieved with *terrace* and *contour orchard and other perennial crops*, both of which are potential components of soil conservation and water quality plans. The following, additional observations are also made, organized based on the number of observations for each practice.

Practices with More than 20 Observations. The following 15 practices had more than 20 observations (superscripts are referenced in the following paragraph):

- 313—Waste Storage Facility [a,f]
- 330—Contour Farming [c,e]
- 331—Contour Orchard and Other Perennial Crops [a,d]
- 340—Cover Crop [a,e]
- 362—Diversion [a,d]
- 382—Fence [a,d]
- 391—Riparian Forest Buffer [a,d]
- 412—Grassed Waterway [a,e]
- 528—Prescribed Grazing [a,d]
- 558—Roof Runoff Structure [a,d]
- 561—Heavy Use Area Protection [a,d]
- 574—Spring Development [a,e]
- 575—Trails and Walkways [b,d]
- 585—Stripcropping [b,d]
- 600—Terrace [a,d]

Twelve of the 15 practices had FARs (False Alarm Rates) less than 15%[a], while three practices, *Stripcropping*, *Trails and Walkways*, and *Contour Farming* had FARs of 17%[b], 18%[b], and 26%[c], respectively. Ten of the practices had HRs (Hit Rates) exceeding 60%[d], four practices had HRs between 40% and 60%[e], and only one practice, *Waste Storage Facilities*, had a lower HR at 27%[f].

Practices with 5-16 Observations. While a larger sampling effort would be preferred, some preliminary observations for the following six (6) practices are made (superscripts are referenced in the following paragraph [superscripts 'i' and 'l' intentionally skipped]):

- 386—Field Border [m]
- 359—Waste Treatment Lagoon [k]
- 472—Access Control [g]
- 601—Vegetative Barrier [g]
- 612—Tree/Shrub Establishment [h]
- 635—Vegetated Treatment Area [j]

The initial findings from the NRCS pilot study indicate that *Access Control* and *Vegetative Barriers* can be reliably detected through remote sensing with a 100% HR and 0% FAR (i.e., all of the projects in the field were identified through remote sensing and there were no false positives).[g] *Tree/Shrub Establishment* also has a 0% FAR, but a 50% HR (i.e., ½ of the projects in the field were identified through remote sensing and there were no false positives).[h] The HR for *Vegetated Treatment Areas* is 7%, indicating that the methods used in the NRCS pilot study to identify the practice through remote sensing were not effective.[j] *Waste Treatment Lagoons* had a 100% HR and 29% FAR, indicating that the remote sensing method used in the NRCS pilot study resulted in identifying all the *Waste Treatment Lagoons* that existed, but also resulted in false positives 29% of the time.[k] *Field Borders* had the highest FAR of all practices at 80%.[m]

Practices with Fewer than Five (<5) Observations. More field verification (i.e., larger n) is needed to determine whether remote sensing is useful for identifying any of the following seven (7) practices:

- 316—Animal Mortality Facility
- 317—Composting Facility
- 332—Contour Buffer Strips
- 380—Windbreak/ Shelterbelt Establishment
- 468—Lined Waterway or Outlet
- 629—Waste Treatment
- 638—Water and Sediment Control Basin

NRSC staff indicated that they anticipate that improved results can be achieved for *stripcropping* and *contour farming* by using a LIDAR (Light Detection and Ranging) layer to see if these practices remain on contour. NRCS also believes that additional criteria can be used to identify manure storages under roof. The low HR for *waste storage facilities* is caused by the preponderance of manure storages under roof, e.g. hog and poultry barns. NRCS is working with its engineering division to identify potential indicators for storages under roof. NRCS estimates that the HR for *waste storages* should improve with additional remote sensing criteria.

Introduction

Pennsylvania Natural Resources Conservation Service (NRCS) of USDA and the Pennsylvania Department of Environmental Protection (DEP) undertook a joint proof of concept pilot project ("Chesapeake Bay Remote Sensing Pilot Project") to determine if remote sensing imagery could be used to identify, inventory, and characterize conservation practices. Tetra Tech (Tt) was contracted to provide an independent analysis and assessment of both the methods and results from this pilot project. The analysis performed by Tt consists of three related components: the degree to which the practices tracked for the pilot project translate directly to CBP BMPs, whether pilot project verification methods followed CBP verification requirements, and a statistical analysis to determine the accuracy of the method.

The following report includes a brief overview of the pilot project, followed by a discussion of the three analytic components. A summary at the end highlights the major observations.

The next phase of this effort would be for the Ag Workgroup to evaluate the results and lessons learned from the pilot project, and determine whether this process and data collection adhere to Bay Model verification standards and could be incorporated into the Bay Model. DEP should also compare these results to those used previously in the Bay Model.

Overview of Pilot Project

The stated purpose of the NRCS pilot project was (Executive Briefing):

In an effort to assist the Commonwealth receive [sic] additional credit for applied agricultural conservation practices, Pennsylvania Natural Resources Conservation Service (NRCS) and the Pennsylvania Department of Environmental Protection (DEP) undertook a joint proof of concept pilot project. The concept tested was to determine if remote sensing imagery could be utilized to identify and inventory conservation practices and if their associated attributes can also be collected using these methods. The secondary benefit of the pilot will be the development of a baseline inventory of conservation practices applied in the Pennsylvania portion of the Potomac River Watershed.

The study was carried out in five counties (Figure 1). DEP provided a list of 28 practices that would be identified in the pilot project. The list of practices was based on BMPs that were able to be detected remotely, as well as the practices which provided the most credit in the Bay Model for achieving the goal of nitrogen, phosphorus, and sediment reduction. Field verification was used to confirm the accuracy of the remotely sensed data collection effort. Field verification methods were established based on a statement of work (SOW) agreed to by NRCS, DEP, and U.S. Environmental Protection Agency (EPA) modelers. This SOW specified that five percent of the farms would be visited in Somerset, Bedford, Fulton and Adams County, while ten percent of the farms were visited in Franklin County.

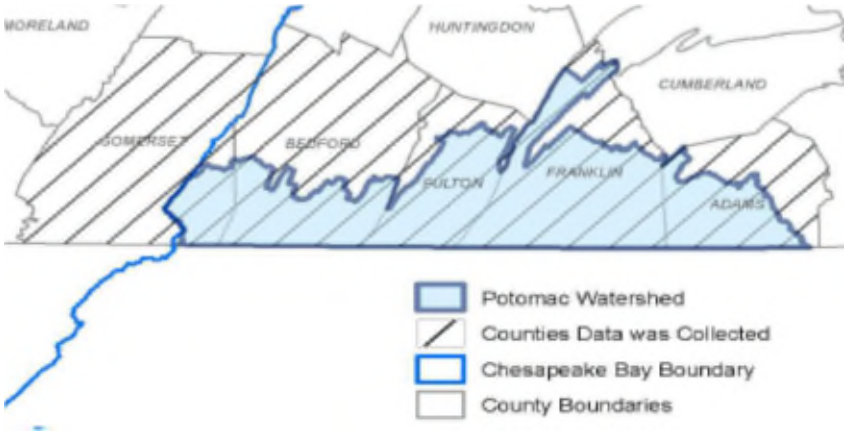

Figure 1. Pilot project area (Kraft et al. 2016)

Crosswalk of Practices Tracked versus CBP BMPs

The relationship between the 28 practices included in the pilot survey and those reported to the Bay Model is summarized in Table 1. Both CBP BMPs and RIs are shown, along with potentially corresponding NRCS practices from the pilot project. The heavy use area protection (561) and vegetative barrier (601) practices are absent because only those NRCS practices for which corresponding CBP BMPs or RIs could be identified are included in Table 1. Note that the soil conservation and water quality plans BMP can consist of multiple NRCS practices. The degree to which these individual component practices were found in combinations sufficient to warrant credit as soil conservation and water quality plan BMPs was not reported; however, NRCS staff[1] have indicated this analysis could be accomplished through query of the results data base.

[1] Joseph Kraft. December 12, 2016. Personal communication.

Table 1. Crosswalk between NRCS practices and Bay Model practices

CBP BMP	CBP Resource Improvement (RI) Practice	Potential Corresponding NRCS Practices
Animal Mortality Facility (MortalityComp)	RI-2: Animal Compost Structure	Animal Mortality Facility (316), Composting Facility (317)
Animal Trails and Walkways, Barnyard Runoff Control (BarnRunoffCont)		Trails and Walkways (575)
Cover Crops - various types, (CoverCropXX)		Cover Crop (340)
Forest Buffers (ForestBuffers)	RI-9, 10: Forest Nutrient Exclusion Area or Buffer on Watercourse Resource Improvement Practice, Forest Nutrient Exclusion Area on Watercourse (RI9), Forest Buffer on Watercourse (RI10)	Riparian Forest Buffer (391)
Grass Buffers/Vegetated Open Channel - Agriculture (GrassBuffers), Vegetated Open Channels - A/B soils, no underdrain (VegOpChanNoUDAB), Vegetated Open Channels - C/D soils, no underdrain (VegOpChanNoUDCD)	RI-7, 8: Grass Nutrient Exclusion Area or Buffer on Watercourse Resource Improvement Practice	Grassed Waterway (412), Vegetated Treatment Area (635)
Precision Intensive Rotational Grazing (PrecRotGrazing), Prescribed Grazing	RI-15: Rotational Grazing Resource Improvement Practice	Prescribed Grazing (528)
Roof Runoff Structure (BarnRunoffCont)	RI-16: Barnyard Clean Water Diversion	Roof Runoff Structure (558)
Soil Conservation and Water Quality Plans (ConPlan)		Contour Buffer Strips (332), Contour Farming (330), Contour Orchard and Other Perennial Crops (331), Diversion (362), Grassed Waterway (412), Lined Waterway or Outlet (468), Stripcropping (585), Terrace (600), Water and Sediment Control Basin (638)
Spring Development (OSWnoFence)	RI-18: Watering Trough Resource Improvement Practice	Spring Development (574)
Stream Access Control with Fencing (PastFence), Exclusion Fence with Forest or Grass Buffer or Narrow Buffer	RI-4a, 4b, 5, 6: Watercourse Access Control Resource Improvement Practice, (RI-4a) Watercourse Access Control-Narrow Grass, (RI-4b) Watercourse Access Control-Narrow Trees, (RI-5) Watercourse Access Control-Grass, (RI-6) Watercourse Access Control-Trees	Access Control (472), Fence (382)
Tree Planting (TreePlant)		Tree/Shrub Establishment (612)

CBP BMP	CBP Resource Improvement (RI) Practice	Potential Corresponding NRCS Practices
Waste Storage Facility for various animal types, Waste Treatment for various animal types, Waste Treatment Lagoon for livestock, Animal Waste Management System (AWMS)	Dry Waste Storage Structure (RI)	Waste Storage Facility (313), Waste Treatment (629), Waste Treatment Lagoon (359)

Assessment of Pilot Project Methodology

The CBP has specified verification methods that can be used to confirm the presence and functionality of BMPs that are reported for credit in the Bay Model. The methods used for the remote sensing pilot project were compared with the procedures specified in the CBP verification guidance (*Strengthening Verification of Best Management Practices Implemented in the Chesapeake Bay Watershed: A Basinwide Framework*, October 2014). Appendix B of the verification guidance addresses agricultural BMPs and Appendix H has guidance for RI practices. It is noted that the verification guidance was finalized after the SOW for the remote sensing pilot project was completed earlier in 2014; therefore, the remote sensing pilot project SOW may not reflect all aspects of the verification guidance document. NRCS considers the remote sensing pilot project to be a "Proof of Concept" for BMP identification on farms.

Agricultural BMP Verification Guidance

A wide range of verification methods are described in the verification guidance, including farm inventories, office or farm records, transect surveys, agency-sponsored surveys, and remote sensing. The suitability of each of these methods for verification varies by BMP category (Visual Assessment BMPs - Single Year, Visual Assessment BMPs - Multi-Year, and Non-Visual Assessment BMPs), BMP implementation mechanism (Non-Cost-Shared BMPs, Cost-Shared BMPs, Regulatory Programs, and Permit-Issuing Programs), and specific aspect of BMP assessment (detection, meeting USDA/state design specifications, meeting federal/state operation and maintenance specifications, RI practice assessment, installation date, and expiration date), all of which is summarized in a series of tables in the verification guidance. The two methods used in the NRCS pilot survey are remote sensing and farm inventories.

Table 2 summarizes by BMP implementation mechanism both the coverage and staff requirements for initial and follow-up verification. Non-cost-shared practices include both practices that fully meet NRCS practice standards and address CBP BMP definitions, and RIs which are non-cost shared practices that do not fully address all NRCS practice standards but do comply with appropriate CBP BMP definitions. Appendix H of the verification guidance provides specific VIs for verifying RIs. In all cases, initial verification of NRCS practices is to be performed by trained and certified technical agency field staff or engineers. However, any trained and/or certified technical field staff person that has the required knowledge and skills to determine if the practice meets the applicable RI definition and VIs may conduct the RI practice review. The NRCS pilot project attempted to locate all practices regardless of BMP implementation mechanism.

Attachments A-1 and A-2 summarize the applicable assessment methods for CBP BMPs and RIs, respectively. Remote sensing and farm inventories are the two methods used in the NRCS pilot project, the former as the verification method to be tested and the latter as the method for ground-truthing the results from remote sensing. Attachment A-1 and Attachment A-2 include only the remote sensing and farm inventory methods that best match the methods used in the NRCS pilot project.

Remote sensing is defined in the verification guidance as "statistically designed and recognized remote sensing surveys with supporting field-level scale ground-truthing verification." Verification expectations are for a "non-annual frequency of statistical remote sensing surveys implemented by trained and certified agency [or NGO] personnel, for all or a sufficient statistical percentage of operations during BMP life span." There are two remote sensing methods in the verification guidance, the only substantive difference being that one is performed by agency personnel and the other by NGO personnel. Available information indicates that agency personnel were used in the pilot project.

Table 2. Initial and follow-up BMP verification coverage and expertise

BMP Implementation Mechanism	Initial Verification Method	Follow-Up Verification Method
Non-cost-shared Cost-shared Regulatory program	100% of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers with supporting documentation that it meets the governmental and/or CBP practice standards. Any trained and/or certified technical field staff person that has the required knowledge and skills to determine if the practice meets the applicable RI definition and VIs may conduct the review for non-cost-shared RIs. Visual assessment for single year BMPs, such as tillage practices, can be statistically sub-sampled utilizing scientifically accepted procedures.	(a) Default: random, follow-up assessments are recommended to be conducted on 10% of those multi-year BMPs which are known to collectively account for greater than 5% of a jurisdiction's agricultural sector nutrient and/or sediment load reductions as estimated in the most recent progress scenario (5% for lower priority BMPs) (b) Alternative strategy for follow up sub-sampling of non-cost shared BMPs.
Permit-issuing program	100% of the initial identification of annual or multi-year structural BMPs and plan implementation by trained and certified technical field staff or engineers with supporting documentation that it meets the governmental and/or CBP practice standards. Not applicable to RIs. Visual assessment for single year BMPs, such as tillage practices, can be statistically sub-sampled utilizing scientifically accepted procedures.	(a) Default: random, follow-up inspections are recommended to be conducted on 20% of those permitted multi-year BMPs (b) Alternative strategy for follow up sub-sampling of non-cost shared BMPs.

There are eight farm inventory methods in the verification guidance, but only two of them apply to the pilot project. The two inventory methods featured in Attachments A-1 and A-2 are those performed by trained and certified federal, state, and/or county agency personnel or by trained and certified NGO personnel. Available information indicates that the personnel used for the pilot project were somewhat of a hybrid because all five were retired agency experts.

Ten of the BMPs in Attachment A-1 are categorized as Visual Assessment BMP – Multi-Year practices. Cover crop is categorized as Visual Assessment BMP – Single-Year, while Soil Conservation and Water Quality Plan is classified as Non-Visual Assessment BMP.

All RIs listed in Attachment A-2 are categorized as Visual Assessment BMP - Multi-Year Practices. These are practices can be visually assessed and have a protracted physical presence on the landscape, i.e., of more than one year when properly maintained and operated.

Attachment A-3 shows details contained on the VI checklists for the CBP RIs applicable to the NRCS remote sensing pilot project. For practices not considered to be RIs, practices were visually inspected and compared to photos and descriptions in the NHCP as well as practice descriptions in Section IV of the NRCS FOTG. The practices identified in the NRCS FOTG can correspond to CBP BMP definitions.

Remote Sensing Methodology

Two groups of data collectors were used for the Pilot Project (Executive Briefing). The activities of the two groups were coordinated by PA NRCS State Office GIS staff under the supervision of the State Soil Scientist who is a trained and certified planner. One group of data collectors was contracted to work out of the PA NRCS State Office and consisted of three former PA NRCS staff with extensive GIS and conservation practice expertise. The State Office GIS and the three PA data collectors participated in a one-week online GIS image interpretation refresher course from the University of Michigan before beginning data collection. They also brought knowledge and expertise of the NHCP, as well as the practice descriptions, standards, and specifications found in Section IV of the NRCS FOTG.

A second group of data collectors consisting of ten staff from the NRCS East Remote Sensing Lab (ERSL) in Greensboro, North Carolina was also used. The ERSL staff had specialized skills in photo interpretation and knowledge of standard quality control measures that were used as part of their normal operating procedures that are associated with the National Resource Inventory (NRI) which has included collecting conservation practices remotely since 1997. NRCS staff[2] indicated that the lab staff were trained on all aspects of NRI data collection to ensure the integrity of the survey. This training was directly transferable to the Pennsylvania remote sensing pilot project as there is commonality in the conservation practices in the NRI and the pilot project. Lab staff were given the conservation practice standard overview fact sheets as reference and were provided over-viewing training by Pennsylvnia NRCS staff. During the initial days of remote sensing data collection, the East National Technology Support Center staff as well as lab technical specialist were consulted for questions and practice confirmation. Staff used multiple images years, LIDAR imagery, digital raster graphics (DRG), soil surveys and when possible, street view for confirmation of practices. A final check included access to conservation plans,

[2] Denise Coleman. December 12, 2016. Personal communication.

where available. Throughout the process, NRCS staff collaborated with DEP staff to ensure the data collected met the Pennsylvania remote sensing pilot project objectives.

Methods for the following were developed through a collaborative approach between Pennsylvania NRCS, DEP, the Chesapeake Bay Program, USDA NRCS East Remote Sensing Lab, and a USDA NRCS contractor located in Fort Collins:

- BMP identification
- Attribute identification
- Geospatial database development
- Data collection

As noted above, DEP provided a list of 28 BMPs that would be identified in the pilot project. Members of the team used the existing NRCS Conservation Practice and Bay BMP "Cross-Walk" to correlate between the BMPs identified in the Bay Model and the conservation practices identified in the NRCS Electronic FOTG. The attributes for each of the practices were identified, including the Bay Model reporting units and additional data (e.g., riparian buffer width) where needed.

A USDA NRCS Contractor with expertise in geospatial database development assisted with the development of the database. The database captured all critical practice data and attributes requested by DEP, including the practice code, practice name, unit of measure (acres, count, or linear feet), and about thirty additional fields to address practice attributes. Drop-down menus were developed to facilitate data entry.

A grid approach was adopted to collect the remote sensing data, dividing the project area into approximately seven acres per grid. Data collectors were assigned a "working area" that contained a number of grid cells. Each cell was individually reviewed and if conservation BMPs were present, they were digitized and attribute data were entered into the geospatial database. Practices observed through remote sensing technology were entered into the geospatial database through a Geographic Information System (GIS). A total of 5,790 farms were inventoried in the five counties.

Other sources of geospatial data commonly used by the data collectors to aid in the remote sensing process may have included one or more of the following:

- National Agriculture Imagery Program (NAIP), 1 meter resolution
- Digital Globe Imagery, 0.5 meter resolution
- Google Earth
- Google Street
- USDA-NRCS Toolkit Data
- FSA Cover Crop Reports
- Normalized Difference Vegetation Index (NDVI) on dormant LandSat Imagery

Field Verification Methodology

Participants agreed that field verification to confirm the accuracy of the remotely sensed data collection effort would consist of the standard USDA NRCS 5% quality assurance/quality control sample (Executive Briefing). Five percent of farms were field verified for four counties (Adams, Fulton, Bedford, and Somerset), while a ten percent sample was used in Franklin County due to the high density of agricultural operations there. Statistics from the 2012 Census of Agriculture were used to determine the total number of farm operations and sample size for each county.

A random point cloud was developed for each county using ArcMap's random point generator. Those farms upon which a point fell were selected for field verification. Field verification was limited to farms within the Potomac River Basin portion of the pilot project counties (light blue-shaded area in Figure 1). A total of 201 farms were selected for on-the-ground spot checks.

The staff conducting on-site field verification included two of the three former PA NRCS staff that conducted the remote sensing (both soil scientists), one former Conservation District Manager, and two retired NRCS District Conservationists who had extensive knowledge of conservation practices. These professionals were selected for the following reasons: knowledge of the type of conservation practices existing on the landscape; communication experience with the farm community; and knowledge of geospatial data.

Field verification procedures and protocols were developed at the NRCS state office. Staff performing field verification received in-field training on the procedures and protocols and were supervised by an NRCS staff member who is a trained and certified planner. See supporting document **Supporting Information 1-Letter Documenting Field Staff Supervision** for a letter certifying NRCS staff supervision. Field verification consisted of a full farm inventory with verification of remotely sensed practices, identification of practices not captured via remote sensing, and flagging of remotely sensed practices that did not exist on the ground.

While it was stated in the Executive Briefing that procedures and protocols were developed at the NRCS state office, the field verification methods used were based on NRCS institutional documents, the NHCP and Section IV of the FOTG, which provide photos, descriptions, standards and specifications for each of the 28 practices. Having these documents as a field reference and adhering to the specifications outlined in these documents throughout their career, these field collectors documented the presence of conservation practices. As stated previously, while Section IV of the FOTG outlines standards and specifications, the purpose of the remote sensing pilot project was only to assess the absence or presence of a practice, not determine whether the practice met FOTG standards and specifications. The applied date of the practice was determined using toolkit data where available. Imagery was used to determine the year in which the practice was implemented if that information was not contain in the toolkit data set. Five retired experts (1 District Manager, 2 District Conservationists, and 2 Soil Scientists) were given a map and a list of practices remotely collected at the 5% of operations to be field-verified. They recorded whether the remotely collected practice was there or not and also performed a walk-through to identify any additional practices that were on the operation but were not remotely collected. Remotely collected practices that could not be confirmed fell into the "Delete" category and additional practices found in the field but not remotely collected fell into

the “Field Collect” category. There was no assessment of compliance with standards and specifications, just visual observation. Field verification information was entered into the geospatial database, and any conservation practices in the “Field Collect” category were geospatially identified and described with collected attribute data. Further information that describes the training, staffing, and materials used are available in the following NRCS-provided materials:

- Supporting Information 2-Training, Biosketches, & Lessons Learned
- Supporting Information 3-Sample Remote Sensing & Field Maps
- Supporting Information 4-Conservation Practice Standard Overview Sheets
- Supporting Information 5-Conservation Practices Remote Sensing Visual

Comparison of CBP Verification and Pilot Project Methodologies

As discussed above, the suitability of an assessment method for verification varies by BMP category, BMP implementation mechanism, and specific aspect of BMP assessment. The pilot project remote sensing effort was designed to gather information on 28 NRCS practices regardless of BMP implementation mechanism. The BMP categories addressed are found in Tables 3 and 4 and include Visual Assessment BMP – Multi-Year, Visual Assessment BMP – Single-Year, and Non-Visual Assessment BMP.

Remote Sensing

The pilot project remote sensing effort met the requirements for sampling percentages (100%, 20%, 10%) listed in Table 2 because it attempted to detect all BMPs. Available information indicates that the pilot project remote sensing effort satisfies the technical requirements specified in the verification guidance. A census approach as used and field-level ground-truthing was performed. Because this was a one-time pilot project there is no frequency to assess. Remote sensing was conducted by trained agency personnel who were supervised by an NRCS staff member that is a trained and certified planner as required. Selection of farms for field verification was based on a satisfactory random-selection method although it is noted later that data utility was limited due to insufficient sample sizes for some practices.

The verification guidance states that remote sensing is “Potentially Eligible” for BMP detection of Visual Assessment BMP – Multi-Year and Visual Assessment BMP – Single-Year practices, but “Not Eligible” for BMP detection of Non-Visual Assessment BMP practices. Further, regardless of BMP category encountered in this project, remote sensing is “Not Eligible” for determining whether BMPs meet USDA or state design specifications or whether BMPs meet federal or state O&M specifications. The measure of success in BMP detection is described under *Calculation of Measures of Remote Sensing Accuracy and Completeness*. The test of whether BMPs detected by remote sensing actually met these design or O&M specifications in the pilot project would be the determinations made via field verification. This pilot “Proof of Concept” project did not include determining if practices met USDA NRCS Standards and Specifications. As such, field verification did not include such an assessment so the degree to which remotely-sensed BMPs met these design or O&M specifications in the pilot project is unknown. This same concern applies to the RIs for which VI checklists would be required to determine if remotely-sensed practices met VI requirements. As stated earlier, the verification guidance was finalized after the SOW for the remote sensing pilot project was completed in

2014; therefore, the remote sensing pilot project SOW may not reflect all aspects of the verification guidance document.

Field Verification

The field verification component of the pilot project was used to assess remote sensing performance, not as an independent on-site farm inventory designed to cover the entire study area. For this reason, the percentage of farms visited (5% for Adams, Bedford, Fulton, and Somerset Counties; 10% for Franklin County) is not directly comparable to the percentages specified in Table 2.

Available information indicates that the staff employed to perform the field verification met the requirement of being "trained technical field staff or engineers." All were trained and all had knowledge of the type of conservation practices included in the pilot project.

The verification guidance states that, regardless of BMP category encountered in this project, on-site farm inventory is "Eligible" for BMP detection and for determining whether BMPs meet USDA or state design specifications. On-site farm inventory is "Eligible" for determining whether BMPs meet federal or state O&M specifications for both Visual Assessment BMP – Multi-Year and Visual Assessment BMP – Single-Year practices, but only "Potentially Eligible" of same for Non-Visual Assessment BMP practices. This method is "Eligible" for assessing RIs that are Visual Assessment BMP – Multi-Year, but "Non Applicable" for assessing RIs that are Visual Assessment BMP – Single-Year or Visual Assessment BMP – Single-Year practices. As noted above, however, all RIs are Visual Assessment BMP – Multi-Year practices.

As noted above, however, field verification did not include an assessment of whether practices met USDA or state design specifications, federal or state O&M specifications, or completion of a VI checklist for RIs. For this reason, the degree to which BMPs assessed through on-site farm inventory met these design or O&M considerations is unknown. This pilot "Proof of Concept" project did not include determining if practice met USDA NRCS Standards and Specifications. The presence or absence of a practice was recorded, but whether the practice could be counted as a BMP or RI practice for Bay Model credit was not documented. As stated earlier, the verification guidance was finalized after the SOW for the remote sensing pilot project was completed in 2014; therefore, the remote sensing pilot project SOW may not reflect all aspects of the verification guidance document.

Calculation of Measures of Remote Sensing Accuracy and Completeness

Method

Pilot project data were released to DEP and Tt in aggregate form, consistent with the requirements of the Privacy Act of 1974, as amended, (5 USC 552), Section 1244 of the Food Security Act of 1985, as amended (16 USC 3844), and Section 1619 of the Food, Conservation and Energy Act of 2008 (7 USC 8791). Field verification data from the pilot project was used to generate statistics regarding the accuracy and completeness of the remote sensing method. Field verification was performed on a farm basis (5% for Adams, Bedford, Fulton, and Somerset Counties; 10% for Franklin County), but statistics will be generated on a BMP basis. Overall,

7.27 percent of farms in the Potomac Basin (201 of 2,766) were included in field verification. Results from the field verification were used to characterize the accuracy of remote sensing for each BMP tracked in the pilot survey. Possible outcomes for remote sensing are summarized in Figure 2 and Table 3.

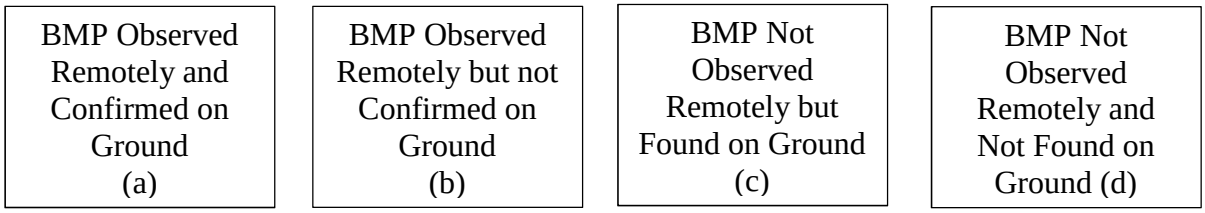

Figure 2. Possible outcomes for remote sensing

Table 3. Data elements used in measures of remote sensing accuracy and completeness

Remote Sensing Result	Field Observed		
	Yes	**No**	**Marginal Total**
Yes	a	b	a+b
No	c	d	c+d
Marginal Total	a+c	b+d	a+b+c+d=n

Three measures (Schaefer 1990) were used to characterize the accuracy and completeness of the remote sensing method as applied in the Potomac River Basin portion of Pennsylvania.

- Critical Success Index (CSI)
- Hit Rate (HR)
- False Alarm Ratio (FAR)

All three measures can be calculated using the data illustrated in Table 3. Note that "d" is unknown and not used in any of the three measures applied for this report.

Critical Success Index (CSI)

The CSI is a measure of the accuracy of the remote sensing method as the percentage of observations that are confirmed on the ground, i.e., BMP presence was correctly determined. The range for the CSI is 0 to 1, with a value of 1 indicating perfect remote sensing. The CSI is a frequently used measure because, unlike the FAR, it takes into account both false positives and missed events, and is therefore a more balanced score. The CSI is calculated as:

$$CSI = a/n \quad (1)$$

Hit Rate (HR)

HR ranges from 0 to a perfect score of 1. Because the formula contains reference to "c" (misses) and not to "b" (false positives), the hit rate is sensitive to missed BMPs and not falsely found BMPs.

$$H = a/(a + c) \quad (2)$$

False Alarm Ratio (FAR)

FAR is the fraction of remotely sensed BMPs that were not confirmed via field verification. The number of missed BMPs is not considered in the FAR. For this reason, H and FAR should both be considered for a better understanding of the performance of the remote sensing.[3]

$$FAR = b/(a + b) \quad (3)$$

Results

Table 4 shows the values of a, b, c, and sample size (n=a+b+c) for each BMP included in the remote sensing pilot project.

Table 4. Field verification values for calculation of measures

Practice Code	BMP Observed Remotely and Confirmed on Ground (a)	BMP Observed Remotely but not Confirmed on Ground (b)	BMP Not Observed Remotely but Found on Ground (c)	Total Field Verification Sample Size (n)
313	17	1	46	64
316	0	0	1	1
317	0	0	1	1
330	63	22	52	137
331	30	0	3	33
332	2	0	0	2
340	264	40	198	502
359	5	2	0	7
362	42	2	8	52
380	1	0	0	1
382	82	8	42	132
386	2	8	0	10
391	163	12	29	204
412	101	9	131	241
468	2	0	0	2
472	11	0	0	11
528	62	3	17	82
558	20	1	13	34
561	35	4	20	59
574	9	1	11	21
575	32	7	4	43
585	110	22	40	172

[3] The post agreement (PAG) is computed as 1-FAR and is the fraction of remotely sensed BMPs which are correct. Given PAG's complementary nature to FAR, only FAR is used in these analyses.

Practice Code	BMP Observed Remotely and Confirmed on Ground (a)	BMP Observed Remotely but not Confirmed on Ground (b)	BMP Not Observed Remotely but Found on Ground (c)	Total Field Verification Sample Size (n)
600	27	0	0	27
601	5	0	0	5
612	8	0	8	16
629	0	0	0	0
635	1	0	14	15
638	0	0	4	4

Confidence Interval for a Binomial Distribution

CSI values for field verification can be represented by a binomial distribution. In a binomial distribution there are two mutually exclusive options, e.g., Yes or No, Correct or Incorrect. The following equation may be used to estimate the confidence interval of the proportion of Yes values (p) (https://onlinecourses.science.psu.edu/stat414/node/264):

$$p \pm Z_{1-\propto/2}\sqrt{\left(\frac{p(1-p)}{n}\right)\cdot\left(\frac{N-n}{N-1}\right)} \quad (4)$$

where

p = proportion of "yes" responses
N = total number of population units in sample population
n = number of samples
$Z_{1-\alpha/2}$ = value corresponding to cumulative area of 1-α/2 using the normal distribution (e.g., 1.645 for 90% confidence level, 1.96 for 95% confidence level)

The second term under the square root operator accounts for finite populations (N). When N is large, this term can be set to unity, but is maintained in these analyses.

There are two outcomes from the field verification:

- BMP presence correctly determined via remote sensing (a)
- BMP presence incorrectly determined via remote sensing (b+c)

In this case, an incorrect identification includes both false positives and misses. The proportion of correct or "yes" responses (p in the binomial equation) and number of samples can be represented mathematically by:

$$Correct\ Proportion = p = \frac{a}{a+b+c} = \frac{a}{n} = CSI \quad (5)$$

The value of N is unknown. When N is unknown it takes experience and knowledge of the equation's use in other setting to determine whether the result is positive. For the purposes of

Equation 4, N for each BMP ($N_{BMP\text{-}PRB}$) is estimated as the total number of BMPs remotely detected in all five counties ($N_{RemoteCollected}$) times the fraction of farms in the five counties that are in the Potomac River Basin ($f_{BMP\text{-}PRB}$) times the ratio of n to the number of remotely sensed BMPs there were ground verified as shown using the following equation:

$$N_{BMP-PRB} = N_{RemoteCollected} \times f_{BMP-PRB} \times \frac{n}{a+b} \quad (6)$$

In essence, the Equation 6 scales up $N_{RemoteCollected}$ to account for the BMPs found in the field but not remotely. The value of $f_{BMP\text{-}PRB}$ was estimated as 0.48 based on the data provided by the NRCS (Table 5). Calculated $N_{BMP\text{-}PRB}$ values for each BMP are show in Table 6.
Using the above values for a, b, c, n, and $N_{BMP\text{-}PRB}$ (for N), values for all three measures, including 90 percent confidence intervals for CSI were collected and summarized in Table 7.

Table 5. Farms within Potomac River Basin

County	Farms in County	Percent of Farms in Potomac River Basin	Farms in Potomac River Basin
Somerset	1,140	11	126
Bedford	1,210	30	358
Fulton	656	67	441
Franklin	1,596	79	1,263
Adams	1,188	49	578
TOTAL	**5,790**	**48**	**2,766**

The following observations are made with respect to Table 7.

Practices with More than 20 Observations. The following 15 practices had more than 20 observations (superscripts are referenced in the following paragraph):

- 313—Waste Storage Facility [a,f]
- 330—Contour Farming [c,e]
- 331—Contour Orchard and Other Perennial Crops [a,d]
- 340—Cover Crop [a,e]
- 362—Diversion [a,d]
- 382—Fence [a,d]
- 391—Riparian Forest Buffer [a,d]
- 412—Grassed Waterway [a,e]
- 528—Prescribed Grazing [a,d]
- 558—Roof Runoff Structure [a,d]
- 561—Heavy Use Area Protection [a,d]
- 574—Spring Development [a,e]
- 575—Trails and Walkways [b,d]
- 585—Stripcropping [b,d]
- 600—Terrace [a,d]

Twelve of the 15 practices had FARs less than 15%[a], while three practices, *Stripcropping*, *Trails and Walkways*, and *Contour Farming* had FARs of 17%[b], 18%[b], and 26%[c], respectively. Ten of the practices had HRs exceeding 60%[d], four practices had HRs between 40% and 60%[e], and only one practice, *Waste Storage Facilities*, had a lower HR at 27%[f].

Table 6. Population estimates for Potomac River Basin

Practice Code	Practice Name	Population Estimate ($N_{BMP-PRB}$)
313	Waste Storage Facility	370
316	Animal Mortality Facility	CBD
317	Composting Facility	CBD
330	Contour Farming	675
331	Contour Orchard and Other Perennial Crops	91
332	Contour Buffer Strips	20
340	Cover Crop	2849
359	Waste Treatment Lagoon	28
362	Diversion	151
380	Windbreak/Shelterbelt Establishment	15
382	Fence	660
386	Field Border	22
391	Riparian Forest Buffer	1070
412	Grassed Waterway	1584
468	Lined Waterway or Outlet	16
472	Access Control	131
528	Prescribed Grazing	747
558	Roof Runoff Structure	152
561	Heavy Use Area Protection	295
574	Spring Development	216
575	Trails and Walkways	211
585	Stripcropping	1371
600	Terrace	81
601	Vegetative Barrier	25
612	Tree/Shrub Establishment	231
629	Waste Treatment	CBD
635	Vegetated Treatment Area	101
638	Water and Sediment Control Basin	CBD
CBD = Cannot be determined due to division by zero.		

Table 7. Measures of remote sensing accuracy and completeness

Practice Code	Practice Name	n	Critical Success Index (CSI)				Hit Rate (HR)	False Alarm Ratio (FAR)	Group
			p	α	Half-Width CI	CSI Range at 90% Confidence Level			
313	Waste Storage Facility	64	0.27	0.1	0.08	18-35%	0.27	0.06	1
316	Animal Mortality Facility	1	0.00	0.1	CBD	CBD	0.00	CBD	NA
317	Composting Facility	1	0.00	0.1	CBD	CBD	0.00	CBD	NA
330	Contour Farming	137	0.46	0.1	0.06	40-52%	0.55	0.26	2
331	Contour Orchard and Other Perennial Crops	33	0.91	0.1	0.07	84-98%	0.91	0.00	4
332	Contour Buffer Strips	2	0.99[1]	0.1	0.11	88-100%	1.00	0.00	4
340	Cover Crop	502	0.53	0.1	0.03	49-56%	0.57	0.13	5
359	Waste Treatment Lagoon	7	0.71	0.1	0.25	47-96%	1.00	0.29	3
362	Diversion	52	0.81	0.1	0.07	73-88%	0.84	0.05	3
380	Windbreak/ Shelterbelt Establishment	1	0.99[1]	0.1	0.16	83-100%	1.00	0.00	4
382	Fence	132	0.62	0.1	0.06	56-68%	0.66	0.09	5
386	Field Border	10	0.20	0.1	0.16	4-36%	1.00	0.80	6
391	Riparian Forest Buffer	204	0.80	0.1	0.04	76-84%	0.85	0.07	3
412	Grassed Waterway	241	0.42	0.1	0.05	37-47%	0.44	0.08	5
468	Lined Waterway or Outlet	2	0.99[1]	0.1	0.11	88-100%	1.00	0.00	4
472	Access Control	11	0.99[1]	0.1	0.05	94-100%	1.00	0.00	4
528	Prescribed Grazing	82	0.76	0.1	0.07	68-83%	0.78	0.05	3
558	Roof Runoff Structure	34	0.59	0.1	0.12	47-71%	0.61	0.05	5
561	Heavy Use Area Protection	59	0.59	0.1	0.09	50-69%	0.64	0.10	5
574	Spring Development	21	0.43	0.1	0.17	26-60%	0.45	0.10	5
575	Trails and Walkways	43	0.74	0.1	0.1	65-84%	0.89	0.18	3
585	Stripcropping	172	0.64	0.1	0.06	58-70%	0.73	0.17	3
600	Terrace	27	0.99[1]	0.1	0.03	96-100%	1.00	0.00	4
601	Vegetative Barrier	5	0.99[1]	0.1	0.07	92-100%	1.00	0.00	4
612	Tree/Shrub Establishment	16	0.50	0.1	0.2	30-70%	0.50	0.00	5
629	Waste Treatment	0	CBD	0.1	CBD	CBD	CBD	CBD	NA
635	Vegetated Treatment Area	15	0.07	0.1	0.1	0-16%	0.07	0.00	1
638	Water and Sediment Control Basin	4	0.00	0.1	CBD	CBD	0.00	CBD	NA

[1]Value was 1. Assumed 0.99 for calculation of confidence interval.
CBD = Cannot be determined due to division by zero. NA = Not applicable.
Note, that cover crops were initially included into the project however it was discontinued since Capital RC&D was conducting a CTIC survey to assess the presence of cover crops.

Practices with 5-16 Observations. While a larger sampling effort would be preferred, some preliminary observations for the following six (6) practices are made (superscripts are referenced in the following paragraph [superscripts 'i' and 'l' intentionally skipped]):

- 386—Field Border [m]
- 359—Waste Treatment Lagoon [k]
- 472—Access Control [g]
- 601—Vegetative Barrier [g]
- 612—Tree/Shrub Establishment [h]
- 635—Vegetated Treatment Area [j]

The initial findings from the NRCS pilot study indicate that *Access Control* and *Vegetative Barriers* can be reliably detected through remote sensing with a 100% HR and 0% FAR (i.e., all of the projects in the field were identified through remote sensing and there were no false positives).[g] *Tree/Shrub Establishment* also has a 0% FAR, but a HR of 50% (i.e., ½ of the projects in the field were identified through remote sensing and there were no false positives).[h] The HR for *Vegetated Treatment Areas* is 7%, indicating that the methods used in the NRCS pilot study to identify the practice through remote sensing were not effective.[j] *Waste Treatment Lagoons* had a 100% HR and 29% FAR, indicating that the remote sensing method used in the NRCS pilot study resulted in identifying all the *Waste Treatment Lagoons* that existed, but also resulted in false positives 29% of the time.[k] *Field Borders* had the highest FAR of all practices at 80%.[m]

Practices with Fewer than Five (<5) Observations. More field verification (i.e., larger n) is needed to determine whether remote sensing is useful for identifying any of the following seven (7) practices:

- 316—Animal Mortality Facility
- 317—Composting Facility
- 332—Contour Buffer Strips
- 380—Windbreak/ Shelterbelt Establishment
- 468—Lined Waterway or Outlet
- 629—Waste Treatment
- 638—Water and Sediment Control Basin

Interpretation of the data for CSI, HR, and FAR in Table 7 can also be aided by cluster analysis, a statistical procedure that groups a set of objects (BMPs in this case) in such a way that objects in the same group (or cluster) are more similar (based on CSI, HR, and FAR scores) to each other than to those in other groups. The user can specify the number of groups, and in this case six groups resulted in the best result for this report. The rightmost column of Table 7 shows the results of cluster analysis assuming six groups. It can be seen that only one BMP is in each of groups 2 (*Contour Farming*) and 6 (*Field Border*), and two BMPs (*Waste Storage Facility* and *Vegetated Treatment Area*) are in group 1.

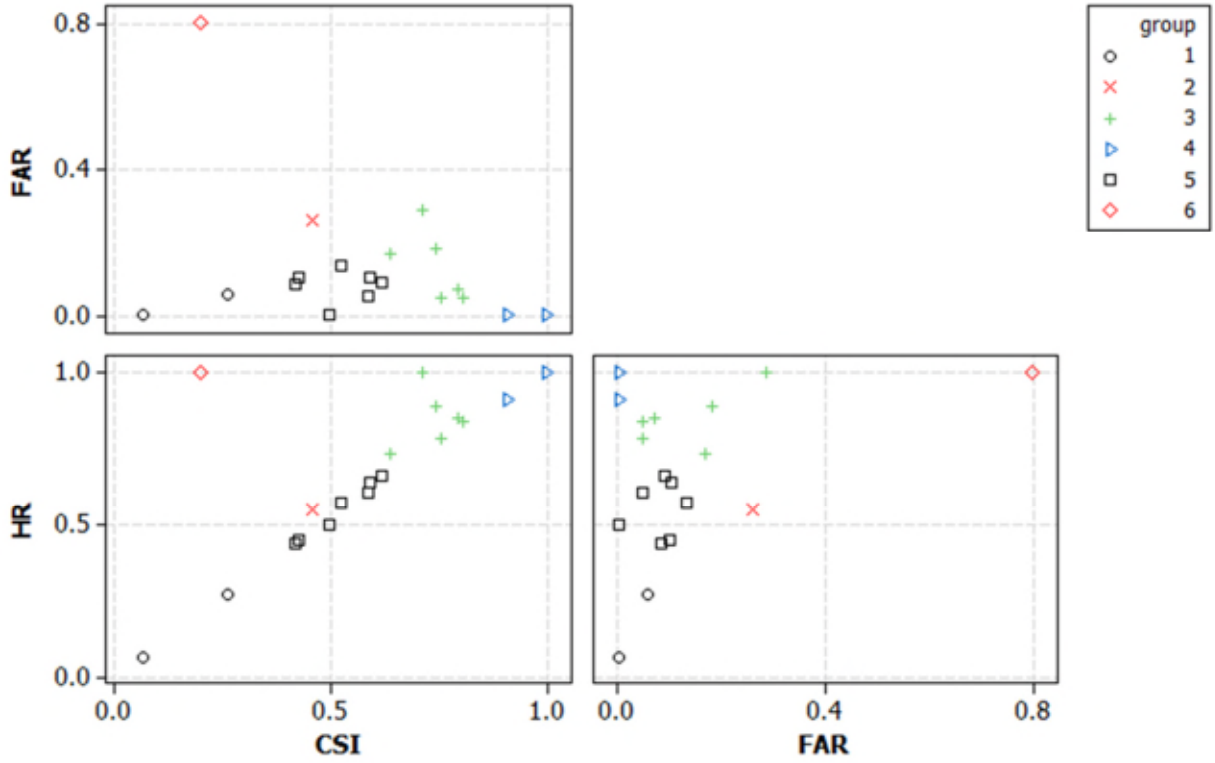

Figure 3. Cluster analysis results

The results presented in Table 7 and Figure 3 demonstrate a range in the success of detecting practices via remote sensing. Ignoring cases where sample size (n) is below 20, six practices had a CSI range that bracketed 80 percent or greater: *contour orchard and other perennial crops* (84-98%), *diversion* (73-88%), *riparian forest buffer* (76-84%), *prescribed grazing* (68-83%), *terrace* (96-100%), and *trails and walkways* (65-84%). With the exception of *stripcropping* (58-70%), these six practices represent all of the practices in Groups 3 and 4 with 20 or more observations. The clustering of Group 3 and 4 members can be seen in Figure 3. The HR for these six practices ranged from 78% (*prescribed grazing*) to 100% (*terrace*), and the FAR ranged from 0% (*contour orchard and other perennial crops*, *terrace*) to 18% (*trails and walkways*).

The lowest CSI values for practices with n≥20 were found for *waste storage facilities* (18-35%) and *grassed waterway* (37-47%), which are members of Group 1 and Group 5, respectively. The low CSI for *waste storage facility* can be largely explained by the fact that swine operations, for example, can have under-floor storage of manure which is not visible remotely. This could account for the low HR of 27% for waste storage facilities. The highest FAR value for practices with n≥20 was for *contour farming* (26%).

Summary

Pennsylvania NRCS of USDA and DEP undertook a joint proof of concept remote sensing pilot project to determine if remote sensing imagery could be used to identify, inventory, and characterize conservation practices. While the pilot project satisfied several of the verification

guidance requirements, the remote sensing pilot project was established prior to completion of the verification guidance; therefore, the remote sensing pilot project did not reflect all aspects of the verification guidance document related to VIs for RIs. Field collection was staffed with individuals who each had over 25 years of relevant experience and training; and were supervised by an NRCS staff member who is a trained and certified planner. To visually asses these practices, these individuals based their determinations on practice descriptions and photos located in the NRCS NHCP as well as descriptions found in Section IV of the NRCS FOTG. The remote sensing pilot was a "Proof of Concept" project and did not include determining if the practices met USDA NRCS Standards and Specifications, despite the use of the FOTG and other sources of practice descriptions.

All but two practices (*heavy use area protection* and *vegetative barrier*) included in the pilot project could be translated directly to CBP BMPs or RIs. Components of soil conservation and water quality plans were tracked independently and not tracked with consideration of whether they collectively constituted a soil conservation and water quality plan. For this reason, the number of soil conservation and water quality plans cannot be determined from the data provided.

Results of statistical analyses indicate that remote sensing was most successful in detecting the following practices: *contour orchard and other perennial crops*, *diversion*, *riparian forest buffer*, *prescribed grazing*, *terrace*, and *trails and walkways*. Of these, the greatest success was achieved with *terrace* and *contour orchard and other perennial crops*, both of which are potential components of soil conservation and water quality plans.

NRSC staff[4] indicated that they anticipate that improved results can be achieved for *stripcropping* and *contour farming* by using a LIDAR layer to see if these practices remain on contour. NRCS also believes that additional criteria can be used to identify *manure storages* under roof. The low HR for *waste storage facility* is due to the preponderance of manure storages under roof, e.g. hog and poultry barns. NRCS is working with its engineering division to identify potential indicators for storages under roof. NRCS estimates that the HR for *waste storages* should improve with additional remote sensing criteria.

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Schaefer, J.T. 1990. The critical success index as an indicator of warning skill. *Weather and Forecasting*. 5:570-575. http://www.nssl.noaa.gov/users/brooks/public_html/feda/papers/schaefer1990.pdf (Accessed November 1, 2016).

[4] Denise Coleman. December 12, 2016. Personal communication.

Attachments

Attachment A-1. BMP category and assessment methods for CBP BMPs

CBP BMP	BMP Category	Assessment Method
• Animal Mortality Facility (MortalityComp) • Animal Trails and Walkways, Barnyard Runoff Control (BarnRunoffCont) • Forest Buffers (ForestBuffers) • Grass Buffers/Vegetated Open Channel - Agriculture (GrassBuffers), Vegetated Open Channels - A/B soils, no underdrain (VegOpChanNoUDAB), Vegetated Open Channels - C/D soils, no underdrain (VegOpChanNoUDCD) • Precision Intensive Rotational Grazing (PrecRotGrazing), Prescribed Grazing • Roof Runoff Structure (BarnRunoffCont) • Spring Development (OSWnoFence) • Stream Access Control with Fencing (PastFence), Exclusion Fence with Forest or Grass Buffer or Narrow Buffer • Tree Planting (TreePlant) • Waste Storage Facility for various animal types, Waste Treatment for various animal types, Waste Treatment Lagoon for livestock, Animal Waste Management System (AWMS)	Visual Assessment BMP – Multi-Year	<u>Remote Sensing</u> is "Potentially Eligible" • "Not Eligible" for federal c/s, state c/s, and NGO c/s BMPs • "Potentially Eligible" for privately-funded and previously cost-shared BMPs with expired contracts • "Potentially Eligible" for BMP detection, • "Not Eligible" for determining whether BMPs meet USDA or state design specifications • "Not Eligible" for determining whether BMPs meet federal or state O&M specifications • "Potentially Eligible" to assess RIs • "Potentially Eligible" to determine BMP installation and expiration dates <u>On-Site Farm Inventory</u> by trained and certified federal, state, and/or county agency personnel is "Eligible" • "Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Eligible" for BMP detection • "Eligible" for determining whether BMPs meet USDA or state design specifications • "Eligible" for determining whether BMPs meet federal or state O&M specifications • "Eligible" for assessing RIs • "Eligible" to determine BMP installation and expiration dates <u>On-Site Farm Inventory</u> by trained and certified NGO personnel is "Eligible" • "Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Eligible" for BMP detection • "Eligible" for determining whether BMPs meet USDA or state design specifications • "Eligible" for determining whether BMPs meet federal or state O&M specifications • "Eligible" for assessing RIs • **"**Eligible" to determine BMP installation and expiration dates

CBP BMP	BMP Category	Assessment Method
• Cover Crops - various types, (CoverCropXX)	Visual Assessment BMP – Single Year	Remote Sensing is "Potentially Eligible" • "Not Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Potentially Eligible" for BMP detection • "Not Eligible" for determining whether BMPs meet USDA or state design specifications • "Not Eligible" for determining whether BMPs meet federal or state O&M specifications • "Non Applicable" for assessing RIs • "Potentially Eligible" to determine BMP installation and expiration dates On-Site Farm Inventory by trained and certified federal, state, and/or county agency personnel is "Eligible" • "Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Eligible" for BMP detection • "Eligible" for determining whether BMPs meet USDA or state design specifications • "Eligible" for determining whether BMPs meet federal or state O&M specifications • "Non Applicable" for assessing RIs • "Eligible" to determine BMP installation and expiration dates On-Site Farm Inventory by trained and certified NGO personnel is "Eligible" • "Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Eligible" for BMP detection • "Eligible" for determining whether BMPs meet USDA or state design specifications • "Eligible" for determining whether BMPs meet federal or state O&M specifications • "Non Applicable" for assessing RIs • "Eligible" to determine BMP installation and expiration dates
• Soil Conservation and Water Quality Plans (ConPlan)	Non-Visual Assessment BMP	Remote Sensing is "Not Eligible" for non-visual assessment of BMPs and "Non-Applicable" to non-visual assessment of RIs On-Site Farm Inventory by trained and certified federal, state, and/or county agency personnel is "Eligible"

CBP BMP	BMP Category	Assessment Method
		• "Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Eligible" for BMP detection • "Eligible" for determining whether BMPs meet USDA or state design specifications • "Potentially Eligible" for determining whether BMPs meet federal or state O&M specifications • "Non Applicable" for assessing RIs • "Potentially Eligible" to determine BMP installation and expiration dates <u>On-Site Farm Inventory</u> by trained and certified NGO personnel is "Eligible" • "Eligible" for federal c/s, state c/s, NGO c/s BMPs, privately-funded, and previously cost-shared BMPs with expired contracts • "Eligible" for BMP detection • "Eligible" for determining whether BMPs meet USDA or state design specifications • "Potentially Eligible" for determining whether BMPs meet federal or state O&M specifications • "Non Applicable" for assessing RIs • "Potentially Eligible" to determine BMP installation and expiration dates

Attachment A-2. BMP category and assessment methods for CBP RIs

CBP RI Practice	BMP Category	Assessment Method
• RI-1: Dry Waste Storage Structure • RI-2: Animal Compost Structure • RI-4a, 4b, 5, 6: Watercourse Access Control Resource Improvement Practice, (RI-4a) Watercourse Access Control-Narrow Grass, (RI-4b) Watercourse Access Control-Narrow Trees, (RI-5) Watercourse Access Control-Grass, (RI-6) Watercourse Access Control-Trees • RI-7, 8: Grass Nutrient Exclusion Area or Buffer on Watercourse Resource Improvement Practice • RI-9, 10: Forest Nutrient Exclusion Area or Buffer on Watercourse Resource Improvement Practice, Forest Nutrient Exclusion Area on Watercourse (RI9), Forest Buffer on Watercourse (RI10) • RI-15: Rotational Grazing Resource Improvement Practice • RI-16: Barnyard Clean Water Diversion • RI-18: Watering Trough Resource Improvement Practice	Visual Assessment BMP – Multi-Year	<u>Remote Sensing</u> is "Potentially Eligible" • All Ris are eligible if RI Vis can be identified by approved methodology and remote sensing signatures • Documentation Necessary: Inventory entity provides VI checklist, photo description, and location documentation to certifying entity <u>On-Site Farm Inventory</u> by trained and certified federal, state, and/or county agency personnel is "Eligible" • All Ris are eligible if they meet RI Vis • Documentation Necessary: VI checklist, photo description, and location documentation <u>On-Site Farm Inventory</u> by trained and certified NGO personnel is "Eligible" • All Ris are eligible if they meet RI Vis • Documentation Necessary: VI checklist, photo description, and location documentation

Attachment A-3. Visual indicator checklists for CBP RIs

CBP RI Practice	Assessment Method (All RIs fall under Visual Assessment BMP - Multi-Year)
RI-2: Animal Compost Structure	Requires visual observation for the following: • Facility operates without polluting waters. • Facility meets pollution control requirements of state & local agencies and regulations. • The appropriate carbon source to animal carcass volume was utilized resulting in appropriate biological decomposition. Requires estimate by paces that: • Facility is located ≥100' from wells unless there is a waiver. • Facility is 100' from top of bank of any stream or per state, county, or local regulation. Requires owner interview to confirm resulting product is utilized according to state and local regulations. Requires the following recorded values on checklist: • Number of systems • Animal type and animal units
RI-9, 10: Forest Nutrient Exclusion Area or Buffer on Watercourse Resource Improvement Practice, Forest Nutrient Exclusion Area on Watercourse (RI9), Forest Buffer on Watercourse (RI10)	Requires visual observation for the following: • Dominant vegetation (>50% canopy cover) consists of existing, natural regenerated, or planted trees and/or shrubs. • Overland/sheet flow through buffer is maximized (no concentrated flow). • Structural measures are present where vegetation practice is insufficient to control erosion. Requires estimate by paces that: • Perpendicular distance from top-of-bank of stream, ditch, or tidal area ≥10' minimum average for width of buffer. Requires the following recorded values on checklist: • Length in feet • Width in feet
RI-7, 8: Grass Nutrient Exclusion Area or Buffer on Watercourse Resource Improvement Practice	Requires visual observation for the following: • Overland flow through buffer is maintained as sheet flow. • All excessive sheet-rill and concentrated flow are controlled in areas immediately adjacent & up-gradient of buffer, before entering. • No livestock are present nor have access. Owner interview also required for this. • Plant species are native (preferred), or introduced and non-invasive, with stiff stems and high stem density. • Plants are compatible in growth rate, tolerant of flooding/saturation and shade. • Minimum of 75% perennial grass cover is present. Requires estimate by paces that: • Horizontal buffer width ≥10' measured perpendicular to top-of-bank intermittent stream, ditch, or tidal area • Width is ≥35' if receiving dissolved contaminants (e.g., nutrients, pesticides). Visual observation also required for this.

CBP RI Practice	Assessment Method (All RIs fall under Visual Assessment BMP - Multi-Year)
	Requires the following recorded values on checklist: • Length in feet • Width in feet
RI-15: Rotational Grazing Resource Improvement Practice	Requires visual observation for the following: • 75% perennial grass cover is maintained in all grazing areas through the appropriate use of fencing as needed. • Livestock have limited (restricted) access to streams, seeps, ponds, and other surface waters in compliance with state regulations. • Livestock have close access to clean water, which meets their average daily water requirements. • Grazing system (watering, feeding, and HUAs) minimizes erosion and protects sensitive areas. • Owner has a grazing objective for all grazing units and manages the grass height. Visually observe grass height and interview owner as well for this. Requires owner interview to confirm that nutrient management is applied in accordance with state regulations and that the landowner has a plan for movement of animals to maintain appropriate forage cover.
RI-16: Barnyard Clean Water Diversion	Requires visual observation for the following: • Surface outlet is stable; downspouts have elbow and dissipation device directed away from buildings, as appropriate. • Gutter-less system has stone-filled, collection trench under entire roof drip line; width ≥24", depth ≥24". Owner interview also required for this. • Drip line stone extends along sides of and over pipe. • Gutter is K-style, half-round, or box-type on good-condition vertical fascia board, free floating on supports, and ≥5" top width. Roof rafter ends are sound. • Downspout avoids mix with waste. • The system is sound and functioning. • Downspouts are securely fastened at top and bottom, with intermediate supports ≤10', installed appropriately. • Gutter and downspout are protected from livestock. Otherwise made of steel pipe, Sch40, or similar. • Clean surface runoff is directed away from barnyard area.
RI-18: Watering Trough Resource Improvement Practice	Requires visual observation for the following: • Area around trough does not create a resource concern. • Automatic water level control is functioning without overtopping. • Overflow is piped to acceptable outlet. • Backflow prevention is installed and working, where connected to wells or domestic or municipal water systems and meets state and local regulations. Requires owner interview to confirm that there is an adequate water supply.
RI-4a, 4b, 5, 6: Watercourse Access Control Resource	Requires visual observation for the following: • Exclusion method controls the intended animals. Owner interview also required for this.

CBP RI Practice	Assessment Method (All RIs fall under Visual Assessment BMP - Multi-Year)
Improvement Practice, (RI-4a) Watercourse Access Control-Narrow Grass, (RI-4b) Watercourse Access Control-Narrow Trees, (RI-5) Watercourse Access Control-Grass, (RI-6) Watercourse Access Control-Trees	• Livestock concentration and grazing are minimized in riparian (wetland, stream) areas. • Areas around fence are stabilized. • Vegetation in buffer between the barrier and surface water are of a density to help reduce sediment, organic material, nutrients, pesticides, and other pollutants in surface runoff. • Exclusion method is determined to be critical to confinement/exclusion from environmental area. Requires the following recorded values on checklist: • Length in feet • Width in feet
RI-1: Dry Waste Storage Structure	Requires visual observation for the following: • Facility operates without polluting waters. • Offsite runoff is excluded or accounted for in storage. • Storage of stackable manure must meet all state and local regulations. All runoff is controlled and non-polluting. Owner interview also required for this. • No safety concerns present. • Slab on grade, or may be other stabilized impervious surface. • Retaining wall if used is straight, not in imminent danger of failure. Requires estimate by paces that: • Facility is located ≥100’ from wells unless there is a waiver. • Facility is 100’ from top of bank of any stream or per state, county, or local regulation. Requires owner interview to confirm volume per sizing sheet for NRCS Spec or to describe management methodology used by farmer. Requires the following recorded values on checklist: • Number of systems • Animal type and animal units