CONSERVATION INNOVATION GRANTS
Final Progress Report

Grantee Name:	Michigan Department of Agriculture
Project Title:	Impact Targeting: Applying Conservation Tools to the Worst Erosion Areas for Maximum Sediment/Nutrient Reductions
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Project Activities:
This is the final report to describe work on the Natural Resources Conservation Service (NRCS) funded Conservation Innovation Grant (CIG), *Impact Targeting: applying conservation tools to the worst areas for maximum sediment/nutrient reductions*. The primary project objective was to reduce agricultural sediment/nutrient loadings to the river networks of the Maple, Raisin, and Saginaw River watersheds. The Pigeon-Wiscoggin River watershed was subsequently identified as the focus for the Saginaw-area analysis, as it is the primary watershed served by the Huron Conservation District (a central partner in the CIG project). The Maple River is a Conservation Security Program (CSP) watershed and the River Raisin and Saginaw River are Conservation Reserve Enhancement Program (CREP) watersheds. The project was a collaborative effort between the Michigan Department of Agriculture (MDA), Michigan State University Institute of Water Research (IWR) and the Clinton, Huron, and Lenawee Conservation Districts, with support from the Natural Resources Conservation Service (NRCS) and the Michigan Department of Environment and Natural Resources (DNRE).

One of the initial activities of the project was for IWR to develop a sediment loading model that combined a soil erosion model called RUSLE (Revised Universal Soil Loss Equation – Renard, et al. 1997) and a sediment delivery ratio model called SEDMOD (Spatially Explicit Delivery Model – Fraser, 1995). Through the CIG project this approach was extended to local levels, with high-resolution data and an online information distribution system. This approach was called HIT (High Impact Targeting) and was piloted in the CIG's three study watersheds. A more detailed description of the HIT model is provided in Appendix A.

IWR completed most of the model and online tool development in the project's first year, and training sessions on how to use the model and the HIT Tool were provided to the three Conservation District Technicians working on the project. The tool allowed users to view sediment and erosion data for certain watersheds and their sub-basins, simulate BMP scenarios at watershed scales, prioritize watersheds by BMP cost-benefits, and map high-risk areas down to a field level. At the initial onset of the project the best available elevation data (DEMs – digital elevation models) from USGS was only at a 30-meter resolution; IWR committed to taking the necessary steps to generate finer resolution 10-meter models by building their own DEMs through labor-intensive contour digitizing. The completion of the 10-meter resolution DEMs was completed later on in 2007.

Conservation District Technicians used the HIT Tool in their day-to-day activities and provided feedback to IWR on the tool's usability. Based on technician feedback, IWR re-designed the online tool so that watershed selection was more dynamic and intuitive. A simplified and streamlined user interface was developed and a live and interactive map was created for the interface so users could select specific watersheds geographically.

In May and June 2007, IWR, MDA, and Conservation District (CD) Technicians developed a field evaluation protocol for the HIT model. Essential elements of the HIT Field Evaluation Form included basic site location information; landscape relief description; current and recent weather conditions; presence of BMPs; tillage practices; stream and buffer information; evidence of erosion; and a HIT model evaluation classification. IWR, MDA, and the CD Technicians tested the use of the evaluation form at several field sites in Huron and Lenawee counties in two day-long field trips (June 21, 2007 in Huron County and July 2, 2007 in Lenawee County). The evaluation form was revised based on this field experience and technicians' feedback. Forty sites were evaluated in each watershed. Once the technicians started conducting their field evaluations, IWR analyzed the evaluation data and provided the IWR modeling team with critical information to determine the reasons for identified HIT model errors. To assist the CD Technicians in their local outreach, specifically while performing field evaluations on landowner property, IWR and MDA developed a project flier (see attached).

In the second year of the project, IWR helped the CIG technicians complete and analyze the field evaluations, generated the 10-meter resolution models for the project watersheds, completed a second round of field-evaluations (this time with 10-meter data), made HIT outputs usable in NRCS Toolkit, improved the processing speed of the HIT model, and added new BMP simulations to the on-line tool. IWR also provided the CIG Technicians with the HIT data (including detailed and updated metadata) on digital media. This allowed them to utilize HIT data within their desktop GIS (NRCS Toolkit), and harness the greater processing power (as opposed to that offered by a browser-based mapping application) to display finer and more recent aerial imagery. Access of HIT data in this format allowed the CIG technicians to add their own local GIS data to perform more in depth analyses.

The main focus of the second and third years of the project was outreach and education. CD Technicians held numerous hands-on sessions to introduce the HIT Tool to potential users such as other conservation technicians, watershed groups, drain commissioners, road commissions, and agricultural producers. The CD Technicians solicited feedback from these potential users and communicated that feedback to IWR so that further refinements, when possible, could be made to the HIT Tool. Overall, through meetings, one-on-one sessions, display booths, and specific HIT Tool training sessions, the CD Technicians reached more than 2,500 people with information about HIT, Farm Bill programs, and other conservation programs available in their respective watersheds.

In the third and final year of the project, in addition to continuing their outreach and education activities, the CD Technicians performed an evaluation of the HIT model using stream monitoring data, with assistance from IWR, MDA, and DNRE. In the initial project proposal, DNRE staff was to conduct the stream monitoring sampling, but when the time came DNRE did not have adequate staff to dedicate to the CIG project. Instead they provided oversight and their laboratory was used to analyze the samples. CD Technicians were trained and provided with the necessary equipment to conduct the sampling. Samples were taken at small catchment basins that were physically similar (in terms of acreage, land cover classes, soil types, and proximity), but dissimilar in the presence of BMPs or sediment loading. The pairs were compared for Total Suspended Solids (TSS), and samples were obtained during or immediately following storm events. Results were provided to IWR for statistical analysis.

Results:
This Conservation Innovation Grant project has developed a powerful and user-friendly on-line decision support system to aid in the reduction of sediment loading to Great Lakes tributaries. The HIT tool and its component sediment models have been refined throughout this CIG project to provide conservationists with the data and analysis functions they need to optimally target sediment-reducing BMPs. The CIG technicians in the Clinton and Huron conservation districts have used it in this way to aid in the development of Watershed Management Plans for the Clean Water Act (section 319). The Lenawee CIG technician has utilized HIT to target conservation efforts; but has also demonstrated its applicability for broader audiences, including real estate agents estimating land value. The tool has been well-received by audiences at the numerous workshops and presentations described above, and a growing list of users have asked to be notified when the Great Lakes Basin-wide version of HIT becomes available.

The development of the HIT tool itself was a positive result of the CIG project, but the extensive field evaluations carried out by IWR and the CIG technicians were a necessary and more important project outcome. The utility of the HIT tool would be diminished if we could not confirm its predictions with a degree of confidence.

A total of 120 sites were first identified to evaluate the 30-meter HIT models. Later, additional sites were selected to evaluate the 10-meter HIT models. Each CIG technician identified 40 sites in his/her watershed: 20 sites flagged by HIT as high-risk for sediment yields and 20 sites <u>not</u> flagged by HIT, but which could be yielding significant sediment loadings (e.g., an agricultural site close to a stream or ditch). We chose this sampling design to not only evaluate HIT's ability to identify sediment contributing locations, but to also make sure that HIT did not incorrectly flag locations (false positives). Overall, HIT accurately characterized the landscape 70% of the time. More detailed field evaluation results are provided in Appendix B.

The stream monitoring results from the sampling efforts of the CD technicians resulted in no or little correlation between the HIT estimates and Total Suspended Solids (TSS) results. Due to budget limitations for this activity, each site could only be sampled once or twice during five different storm events; considering the small sample size, a broader analysis might show more positive results. Overall, the results show that caution should be exercised when using HIT to prioritize sub-basins, but field-level analyses can rely on HIT to accurately identify high-risk areas at a roughly 70% rate.

Overall, key lessons learned from the CIG project, as presented at the Soil and Water Conservation Society's 2009 Annual Meeting held in Dearborn, MI, include:

- Conservation Districts and government agencies are the ideal users of HIT.
- The model benefits significantly from finer local inputs.
- On-the-ground partnerships with local groups are critical.
- The model does well at identifying specific locations/fields at risk for sediment loading.
- Model estimates of sediment loading at watershed scales are for relative comparisons, not precision.

Potential of Transferability of Results:
One of the stated goals of the CIG project proposal was to generate a model that could be expanded to other Great Lakes Basin states. While HIT's estimates of sediment loading are not as precise as models that require more data input, HIT's comparatively small number of inputs makes it readily transferable to other watersheds. IWR has utilized the knowledge gained from the experience of the CIG project and from the Conservation District partnerships in particular, to expand the HIT System around the Great Lakes Basin. This expansion includes projects in the Lower Grand and Thornapple watersheds, and the development of HIT 2.0, a beta version of a new on-line HIT tool.

HIT 2.0 will provide erosion and sediment loading data for the entire Great Lakes Basin in an advanced and sophisticated mapping interface. Although the HIT 2.0 watershed models were developed with coarser STATSGO soil surveys, 30-meter DEMs, and state-wide assumptions regarding crop-type and tillage acreages, the hope is that as Conservation Districts around the Great Lakes Basin begin to work with these models, it will create support for the development of finer models in certain locations. With HIT 2.0, users will be able to compare multiple 8-digit watersheds, 6-digit watershed, and even 4-digit watersheds. They will also be able to compare 10-digit and 12-digit watersheds located anywhere in the Great Lakes Basin, not just those within a particular 8-digit watershed. To facilitate these comparisons, HIT 2.0 includes intuitive query tools to help users locate watersheds of interest. Users will also have the ability to download HIT models, with fully-documented and standards compliant metadata, for use in their own desktop GIS. HIT 2.0 will become available in 2010.

Conclusion:

The issue of the Great Lakes restoration is arguably receiving more attention now than at any time before. As evidenced by the Obama Administration's one half billion dollar commitment through the Great Lakes Restoration Initiative, the federal government has demonstrated that it is ready to take aggressive action in preserving the quality and quantity of Great Lakes waters. Efforts must be targeted at the areas that will yield the most benefit; this CIG project offers a model of technology and partnership to facilitate such targeting. Through the use of the HIT system, decision makers can prioritize BMP placements down to the field level. With a partnership linking academic technical expertise, state and federal management, and local implementation, the team working on this particular CIG project has bridged the gap between science and practice, and has demonstrated a means for protecting the Great Lakes in an effective and cost-efficient manner.

Appendix A

High Impact Targeting (HIT):

Web-accessible System to Target
Highest Risk Sediment Loading Areas

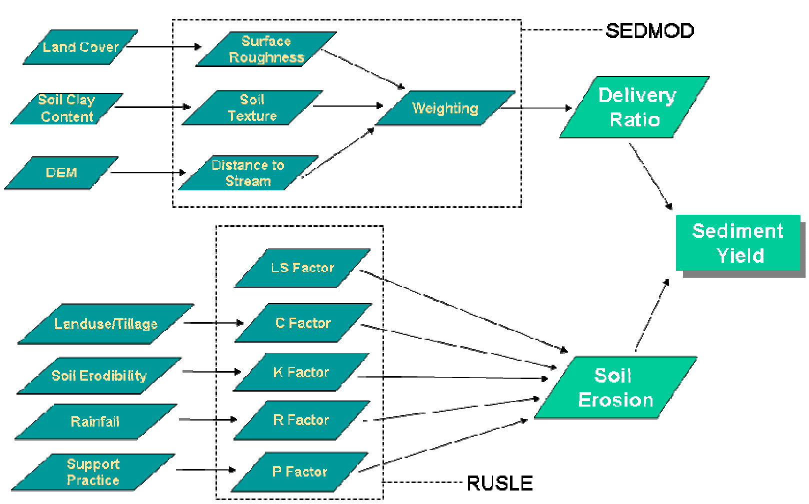
Overview

Sediment loadings continue to pose a major threat to water quality throughout the nation's waterways, and in particular the Great Lakes region. In addition to water quality concerns, sedimentation interferes with navigation on waterways, and costs millions of taxpayer dollars per year in dredging.

With a new system developed by the MSU Institute of Water Research (IWR) high-risk sediment loading areas may now be targeted down to the field level. The new web-accessible system, High Impact Targeting (HIT), estimates sediment loadings to Great Lakes Basin rivers and streams based on estimates of erosion and sediment transport from agricultural lands. HIT utilizes sophisticated geospatial models to estimate sediment loadings with a high degree of resolution. The Institute's approach can be used from a watershed-level scale on down to the field level for precise identification of high-risk areas.

IWR's approach integrates three spatially-explicit components. First, an estimate of the percentage of eroded soil that ends up in nearby streams is obtained from the Spatially-Explicit Delivery Model (SEDMOD). Second, the actual annual volume (in tons/acre/year) of eroded soil is obtained from the Revised Universal Soil Loss Equation (RUSLE). Third, the annual volume of sediment transported to nearby streams is obtained by combining the results of SEDMOD and RUSLE.

Integrated Erosion and Sediment Delivery Model Flow Chart



Appendix B
Field Evaluation Results

Each site was classified by the CIG technicians into one of six categories:

1. Flagged at-risk; signs of erosion and sediment loading visible.
2. Flagged at-risk; no signs of erosion or sediment loading, but landscape conditions conducive to sediment loading (ag land, relief, close to stream), or BMP installed (indicating historical erosion).
3. Flagged at-risk; no signs of erosion or sediment loading, and landscape conditions not conducive to sediment loading (not ag land, no relief, buffers in place, far from stream).
4. Not flagged at-risk; no signs of erosion or sediment loading, and landscape conditions not conducive to sediment loading (not ag land, no relief, buffers in place, far from stream).
5. Not flagged at-risk; no signs of erosion or sediment loading, but landscape conditions conducive to sediment loading (ag land, relief, close to stream).
6. Not flagged at-risk; signs of erosion and sediment loading visible.

Classifications 1, 2, and 4 were considered accurate characterizations of the landscape ("hits"), while 3, 5, and 6 were considered inaccurate ("misses"). In terms of model performance, a classification of 1 would be ideal and 6 would be a worst-case scenario (false negative). However, due to the ephemeral nature of gully erosion it was often difficult for technicians to find enough evidence at a site to warrant a classification of 1; therefore classifications of 2 and 4 were more common.

Here are the classification results for the 30-meter evaluations, as % of sites in each class:

Classifications:	**1**	**2**	**3**	**4**	**5**	**6**	**% HITs (1 + 2 + 4)**	**% Miss (3 + 5 + 6)**
Maple	7.5%	25	17.5	45	0	5	**77.5**	**22.5**
Pigeon-Wiscoggin	19.5%	56.1	0	2.4	7.3	14.6	**78**	**22**
Raisin	25%	25	0	5	17.5	27.5	**55**	**45**
Average	**17.3%**	**35.4**	**5.8**	**17.5**	**8.3**	**15.7**	***70.2***	***29.8***

Here are the classification results for the 10-meter evaluations, as % of sites in each class:

Classifications:	**1**	**2**	**3**	**4**	**5**	**6**	**% HITs (1 + 2 + 4)**	**% Miss (3 + 5 + 6)**
Maple	5.1%	38.5	5.1	35.9	7.7	7.7	**79.5**	**20.5**
Pigeon-Wiscoggin	37.5%	25	0	7.5	27.5	2.5	**70**	**30**
Raisin	12.5%	32.5	2.5	5	37.5	10	**50**	**50**
Average	**18.4%**	**32**	**2.5**	**16.1**	**24.2**	**6.7**	***66.5***	***33.5***

Surprisingly, the overall accuracy rate went down with the finer resolution models. Despite the fact that the rate of best-case scenarios (classification 1) increased (17.3% to 18.4%) and the worst-case scenarios (classification 6) decreased (15.7% to 6.7%), sites not flagged as at-risk, but considered conducive to sediment loading (classification 5), jumped from 8.3% to 24.2%. This unexpected decrease in accuracy could be attributed to two primary causes: 1. a change in the sample design, 2. changes to the HIT model itself.