To gain a more complete understanding of flood risk, the Iowa Department of Natural Resources (Iowa DNR) is embarking on a new program to create a statewide seamless layer of updated, two-dimensional (2D) flood hazard data.

During the flooding of 2008, the State of Iowa became aware of the need to update flood risk data for emergency response and flood preparation for communities. Nearly a third of the counties in the state were without Flood Insurance Rate Maps (FIRMs) while nearly half were working with data that was 20 - 30 years old. Not only was this data out of date due to development and other changes in the land, but different engineering methodology was also used to determine flood risk for various parts of the state. The information was also difficult to use as quite a bit was paper mapping which did not have imagery or any accurate way to spatially reference flood risk making floodplain regulation challenging.

The Iowa DNR responded to this need by applying for a Housing and Urban Development (HUD) grant and started responding to the lack of flood risk data by starting a Statewide Floodplain Mapping Program in 2010. Ten years later the main goal of this program, to provide digital flood risk data based on LiDAR to all communities in the state, is nearly complete. However, providing accurate, up-to-date flood risk awareness requires periodic updates as development occurs and the landscape changes across the state.

Mapping methodologies also change over time and the mapping approach in coming years will be Future of Flood Risk Data (FFRD). FFRD will seek to shift flood hazard data from binary to graduated (probabilistic) risk analysis. This will help to better understand flood hazards and to improve planning for mitigation. Graduated risk means utilizing a greater range of event recurrence and/or storm variability in order to better define flood hazards and associated risk, as opposed to simply evaluating based on the 1% (100 year) risk and a handful of other recurrence intervals. Graduated risk will better inform residents of risk and will open up new tools and methods for floodplain management and mitigation.

Development of base two-dimensional hydraulic modeling, known as 2D Base Level Engineering (2D BLE), will provide the foundational data that will be used for future FIRMs and probabilistic analysis for graduated risk assessment. The inter-usability of 2D BLE data and data bundling allows for future alternate model version adaptability for varied end users including state, federal, local and private entities which can be reused instead of starting from scratch for every project. This aligns with emerging FEMA/Regional direction and flood risk data development initiatives in neighboring states such as Missouri, South Dakota, and Kansas. Instead of providing modeling related to flood insurance requirements only, this data will deliver both predictive capabilities that can be used for mitigation planning and can be used to regulate if a community so chooses.

2D BLE is a major improvement over one dimensional HEC-RAS hydraulic modeling used for currently effective mapping although some portions of the inputs remain similar. The major difference is that 1D methodologies are tied to a stream with a digitized profile baseline to determine risk. The derived water surface elevation represents one-way movement of water down that profile baseline tied to and interpolated between cross sections drawn by engineers using various approaches. The profile baseline is restricted to a drainage area of greater than 1 square mile and a defined stream channel to collect water. The models show fluvial flooding - what happens when the water from a flooding event reaches the profile baseline (stream). This makes modeling for lakes not easily achievable and requires extra effort to model accurately.

2D models utilize a “mesh” of cells and shows pluvial flooding that can occur outside of streams because it covers the whole ground surface (from LIDAR) in all portions of a modeled area, not just along significant streams. Hydrology is combined with hydraulics, and precipitation is applied to the mesh. Water flow is calculated in two directions (downstream and laterally), producing a greater analysis of how drainage occurs across a landscape. There are no inputs to the mesh other than the LiDAR derived digital elevation model (DEM) necessary. However, refinements will be made to the mesh including surveyed cross section data, breaklines and other information that can be used to inform the mesh while modeling in areas needing more detail, like urbanized areas.

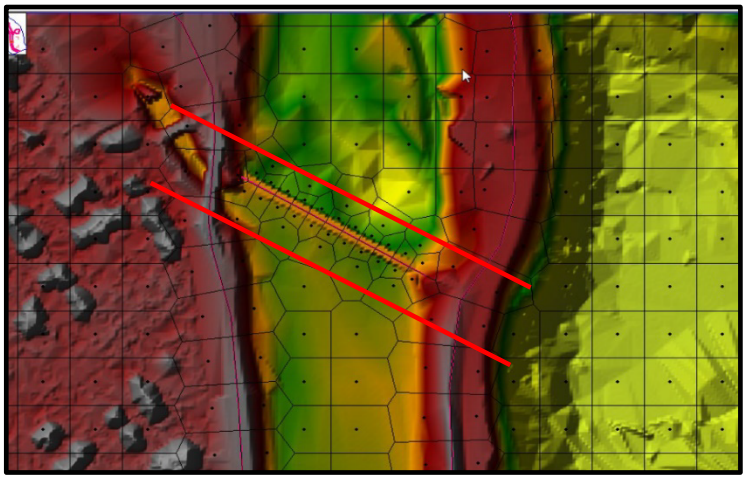

Figure 1. The mesh created to do modeling can be refined around areas of development or structures that affect water flow. Cross Sections (red) can be added to the overall modeling process to inform the model and make mapping results more accurate.

Source: HEC-RAS_6.0 2DModelingUsersManual

The current effective 1D mapping has been questioned because it does not show pluvial flooding. Floodplain Administrators and emergency responders know the risk is real and have expressed desire for this risk to be identified in the mapping. In vast flat areas where there is not a defined stream there are paths the water follows that experience flash flooding. While not as damaging as fluvial flooding that goes through cities, often located near water sources, pluvial flooding is nonetheless a risk to be aware of for road access and emergency response related issues. With Statewide 2D BLE available as foundational data, traditional and non-traditional end users will be able to modify the base modeling to better meet the needs of their specific purposes.

Figure 2. 1D mapping is confined to an actual stream being present on the surface to help decide where to start mapping, the blue shading shows the 1% annual chance flood risk modeled using the 1D approach. 2D mapping, green shading, is not confined to a stream being present to help decide where to start mapping. Instead, the whole surface is used to map flood risk in areas over 1 square mile.

Finally, the benefit for future development of cities and rural housing developments will be tremendous, as there will be a comprehensive understanding of flood risk throughout Iowa. Through smart planning and coordination development can start, or continue, with an eye to the future as 2D analyses are dynamic and can be used to answer *"what if"* questions for mitigation efforts. There will be more information that is easily usable so instead of reacting to unknown risk, this risk will be planned for and mitigated. Our 2D data and information will be free to all Iowans and will be promoted as best available data for jurisdictions to use for informed decision making and planning. Again, this data will not be regulatory unless a community expresses their desire to make it so and the Iowa DNR will assist with that process.

Additional Tools for Flood Plain Managers

- Raster format data for analysis through GIS
- Water Surface Elevation (WSEL) grids for Floodplain management/emergency response
- Potential for cumulative rise/change calculations during development planning
- Velocity grids for better understanding of flood risk
- Depth times Velocity (DxV) calculations for floodway determination
- Shear stress calculations for determining areas at risk for soil or bank scour

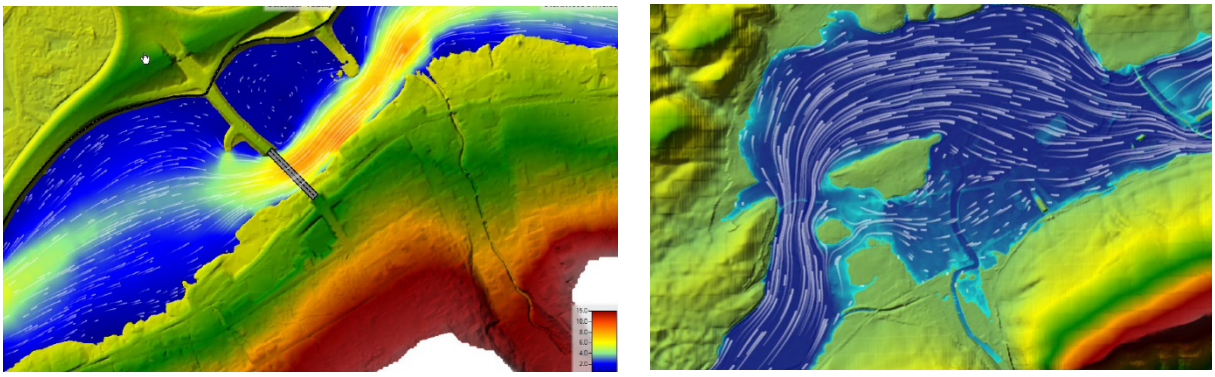

Figure 3. Additional information for flood plain mangers created with 2D BLE includes velocity grids (left) which show where the water moves fastest during specific flooding events. This information along with particulate movement grids (right) show where scour potential is the greatest which can be used for infrastructure maintenance and mitigation planning.

Source: HEC-RAS_6.0 2DModelingUsersManual

MISSION OF THIS PROJECT

Our mission is to raise awareness and increase resilience through mitigation. This will be accomplished by applying the latest engineering and mapping methodologies, along with outreach and community engagement, to accomplish the following goals:

Improve Risk Reduction through Mitigation

The goal is to improve risk reduction by communicating the impacts of flooding, while also promoting mitigation actions that seek to increase resilience. This will be done by developing accurate statewide flood risk data and educating stakeholders about proper floodplain and stormwater management. We seek to empower individuals, organizations, and communities to take steps to increase resilience by highlighting areas of high risk and pinpointing locations that are ideal for mitigation projects in order to be prepared for future flooding events.

Increase Resilience

The goal is to make Iowa more resilient so that when future floods occur, citizens and communities will be able to recover more quickly with reduced loss of life and property. This will be done by developing new engineering data, making Geographic Information System (GIS) data more accessible, and building partnerships for long-term hazard mitigation planning.

Improve Floodplain Management

The goal is to improve floodplain management activities, resulting in reduced rescue and relief efforts as well as reduced property loss through hazard mitigation planning activities. This will include strategies to guide land use and development decisions. Our aim is to enhance cooperation and information sharing among floodplain partners and professionals, encouraging smart growth for future development, transportation improvements, infrastructure enhancement, and agricultural systems. These actions will also result in lower flood insurance premiums, thereby helping Iowans become more financially resilient.

Enhance Natural Resources/Quality of Life

The goal is to enhance natural resources protection through the ethical stewardship of floodplains, resulting in reduced economic and social hardships, enabling smart economic development, improving historic preservation, and promoting environmental quality through stronger ecosystem habitats.

A NEW APPROACH TO RISK AWARENESS

Since 2D BLE is not confined to the profile baseline and instead takes the entire watershed into account, it is important to have an accurate up-to-date terrain surface. By using newly acquired Light Distancing and Ranging (LiDAR) data a more current picture of flood risk can be realized. This will make the product more reliable and acceptable to Iowans as the age of Iowa's LiDAR has been questioned throughout the regulatory mapping process over the last few years. A major aspect of outreach for the current statewide project of regulatory mapping has focused on correcting areas of post-LiDAR development in order to not penalize, through flood insurance, those that have properly developed by permit and code rather than talking about flood risk itself.

LiDAR that has been collected in late 2019 and throughout 2020 will be used for the topographic data. At no expense to the State of Iowa, FEMA, NRCS and USGS have collected new LiDAR and are making it available for our use in this project and to the citizens of Iowa for other uses. Figure 4 shows what has been collected to date.

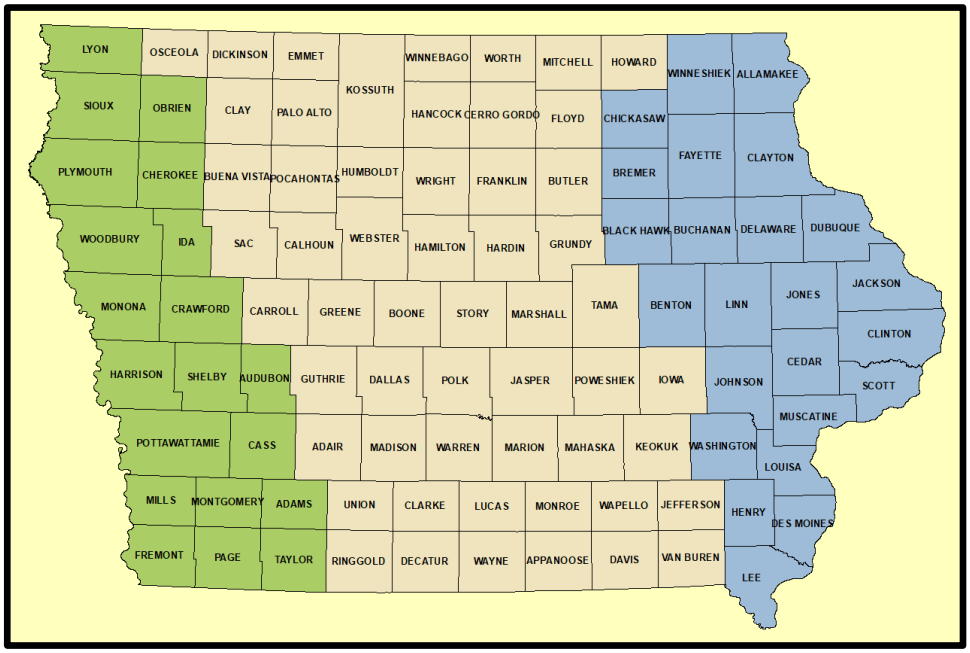

Figure 4. Counties in blue had new LiDAR collected in 2019 by the NRCS, tan counties were collected in 2020 through a FEMA initiative. The remaining green counties will be collected in early 2021 though an NRCS project.

Two-dimensional models use topographic data to produce a 2D grid surface known as a mesh. The mesh resolution will depend on the study type (Detailed = AE, Approximate base level = A) with more detailed areas (areas with population) requiring a finer mesh than rural areas. Selection of mesh size will be dependent on various factors including project needs, complexity of project area, surrounding topography, etc. Break lines, structures and hydro connectors, along with times series flow rates and precipitation boundary conditions will be developed following guidance for special parameters when using 2D BLE. Roughness and other loss coefficients, along with boundary conditions, peak flows and hydrographs are different in 2D BLE and will require reasonableness checks thorough calibration. Iowa will rely on parameters developed by federal and state agencies, Regional Climate Centers and local flood control agencies in estimating these hydrologic parameters as well. Historic data, high water marks, and gage data will be considered when developing and calibrating model input parameters. Comparison of model results with aerial photos from flood events can also be used to check the reasonableness of results.

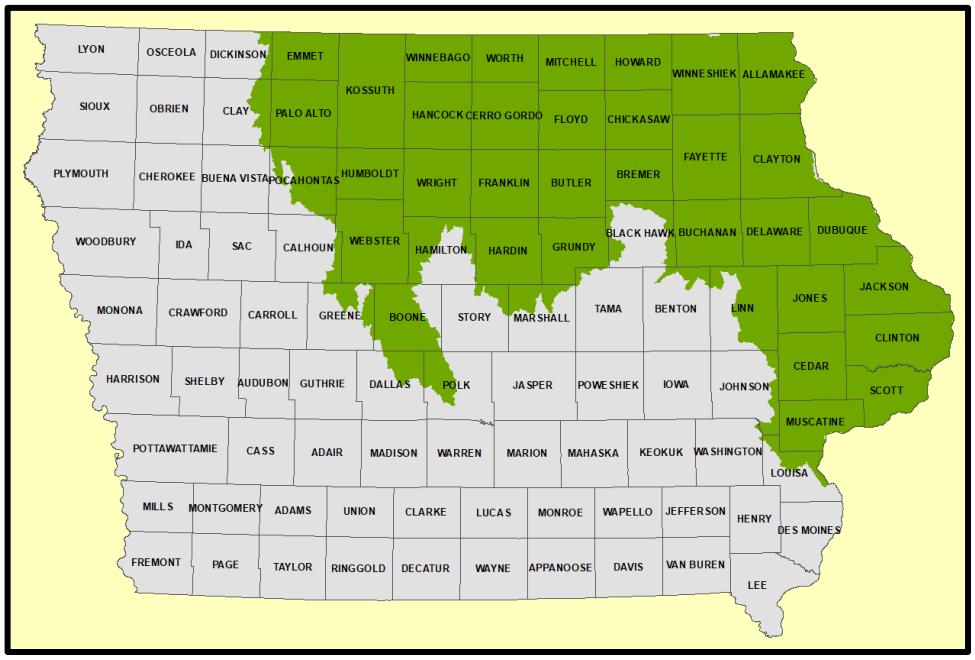

Figure 5. Area funded for FFY20 2D BLE work. Sequencing for this area will be dependent on delivery of new LiDAR collected in 2020.

The Statewide project is anticipated to take 5 years to get completely deployed. Development of new data will occur in phases as FEMA funding allows. It is important to remember that this is a flood risk awareness product rather than regulatory and the path that communities take in making this more regulatory than educational will extend the project in those areas. This phased approach will follow a basic flow of:

Phase 1 - Base Level Engineering Development	• Stakeholders are engaged to provide local knowledge of flood concerns and local engineering data where it is existing • 2D BLE is produced for scoped footprints using base methods • Stakeholders are engaged in flood hazard review and discussion with outreach activities
Phase 2 - Dataset updates based on local input and data	• BLE is refined in areas of known need based on local review, areas of likely development, and submission of local data.
Phase 3 - Refined BLE can pursue regulatory status where needed	• Communities may request mapping updates to regulate with new 2D datasets • IDNR may choose to pursue regulatory updates based on state and FEMA needs

Phase 4 – Potential Enhanced analysis is conducted on refined BLE	• Probabilistic analysis for insurance actuaries • Velocity grids and other enhanced products are developed • Varied storm analysis for floodplain management
Phase 5 - Regulatory models are maintained and updated/upgraded at regular intervals	• Regulatory map updates are seen more as upgrades than updates. Updates will no longer be accomplished by producing a new study, but rather by updating and upgrading the existing 2D modeling. • Upgrades may include additional mesh refinement, addition of structures or obstructions, inclusion of newer local data, updating to newer model software versioning

This data will not be developed to become a regulatory product immediately so there will be more time for communities to use and review data. The data, however, will meet the standards for communities to replace in their regulatory code for approximate study reaches as best available data on FIRMs immediately if they choose to adopt it. This will give communities potential future regulatory information up front. This is beneficial for all in that there will be fewer mistakes in data and more local belief in the results/hazard while guiding development to consider risk that is identified

OUTREACH

Outreach is an essential part of the success of this project. Outreach has been effective helping communities understand new mapping in the past and will be important in promoting stakeholder's acceptance of the 2D data for wise planning and development. A series of webinars focusing on mitigation and risk awareness will be held by geographic footprints for local stakeholders as well as a separate series for larger statewide or federal stakeholders. These meetings will serve as an introduction of the project to communities and other organizations and a first review of the data with no emphasis on floodplain regulation. During the webinar information will be requested from stakeholders to improve the accuracy of the modeling as well as provide possible leverage for grant dollars with FEMA. This outreach will focus on the following categories:

Local Flooding problems

- Large Flood Problems
- Localized/Nuisance Flood Problems
- Historical Loss/Events

Available Data to be requested

- Local Hydrology & Hydraulics
- Stormwater Modeling
- High Water Marks
- Survey Data
- Updated Topo
- Historical Loss information

- Previous HMA project information where applicable

Local Development Information

- Recent significant development since last mapping update or topo collection
- Areas of likely future development
- Master Planning where available

As modeling is completed and mapping results start to be available for review Draft Map Distribution and Stakeholder Review will take place that will be very similar to Draft Flood Hazard Meetings that the Iowa DNR already performs for new mapping as Flood Risk Review (FRR). These will be very similar to FRR meetings however information other than the regulatory process will be presented and discussion of local concerns or needs will be cataloged for future action. Education regarding use of this data as best available information for future/current planning will be carried out in order to get stakeholders to use the data and be more inclined to provide feedback. A basic outline of discussion will be followed for all local level meetings as we evaluate a community's options. This will include:

- Discussion of draft mapping and map review
- Discussion of flood risk and history
- Identification of potential mitigation action for technical assistance
- Identification of needed model upgrades or refinement for Data Development
- Discussion of potential FIRM updates if needed and wanted by community

These meetings will provide an overview of mapping results and provide a location to access any data that is available. Communities will be requested to review the draft mapping and provide feedback to help inform the modeling. At this point the discussion can begin between the Iowa DNR and communities about their desire to carry this data forward as a new Flood Insurance Rate Map. If a community is interested discussion will occur regarding funding opportunities, cost sharing and projected timeline for the adoption of this new information.

A series of webinars for larger statewide or federal stakeholders will be developed separately in order to discuss possible collaboration opportunities related to current and future planned projects. This information can be used as best available data in order to plan for infrastructure improvement/development as well as mitigation projects and large-scale environmental initiatives that might be pursued at the regional level. Requests for data will also be made at these webinars that can be used to further inform the modeling.

Mapping updates will likely no longer be "start from scratch" replacement projects, rather, map updates will be opportunities to update and improve the base modeling. With every map update, the map will not only be renewed by applying updated topography but will also incorporate improvements to the existing 2D model rather than replacing it. This extends the life of the model providing a significant return on investment.

Other maintenance and updating that will occur include:

- Increase breakline density
- Expand areas of smaller mesh/increase mesh density
- Improve or expand structure information
- Apply new or better hydrology information or apply newly available hydrology methods
- Incorporate stormwater modeling if newly available in communities
- Incorporation of upgrades developed by other state or federal agencies

This outreach will also serve as a starting point to talk about mitigation for known problem areas in communities. Iowa will use Real Time Technical Assistance (RTTA) to explore *"what if"* scenarios and other mitigation-related assistance when a community expresses interest. The data that is developed through RTTA can be used by communities to apply for grants without having the significant hurdle of upfront cost to do the technical analysis themselves.

FUNDING

The Iowa 2D BLE program is scheduled to take place over the next 4-6 years. Figure 6 displays the proposed FFY funding schedule through FEMA's CTP grant program. We plan to start at the upper reaches of each proposed study area and work downstream to develop a comprehensive understanding of the water volume impacting watersheds as dictated by the 2D approach of modeling. Furthermore, we plan to start in the headwaters of the major rivers that affect a majority of Iowa's population. This is advantageous for several reasons. First, the population is lower in the FFY20 areas, allowing us to evaluate our process in more rural areas and then refine our outreach techniques before utilizing them in highly populated areas. Second, the proposed areas are sequenced to align with areas where new LiDAR (i.e., topographic data) is already collected. These areas have development occurring and therefore will benefit from having updated risk data for use in future projects. In order to provide up to date data across the state this project will be completed as quickly as funding will allow in order to avoid large gaps in time for risk data delivery between neighboring communities.

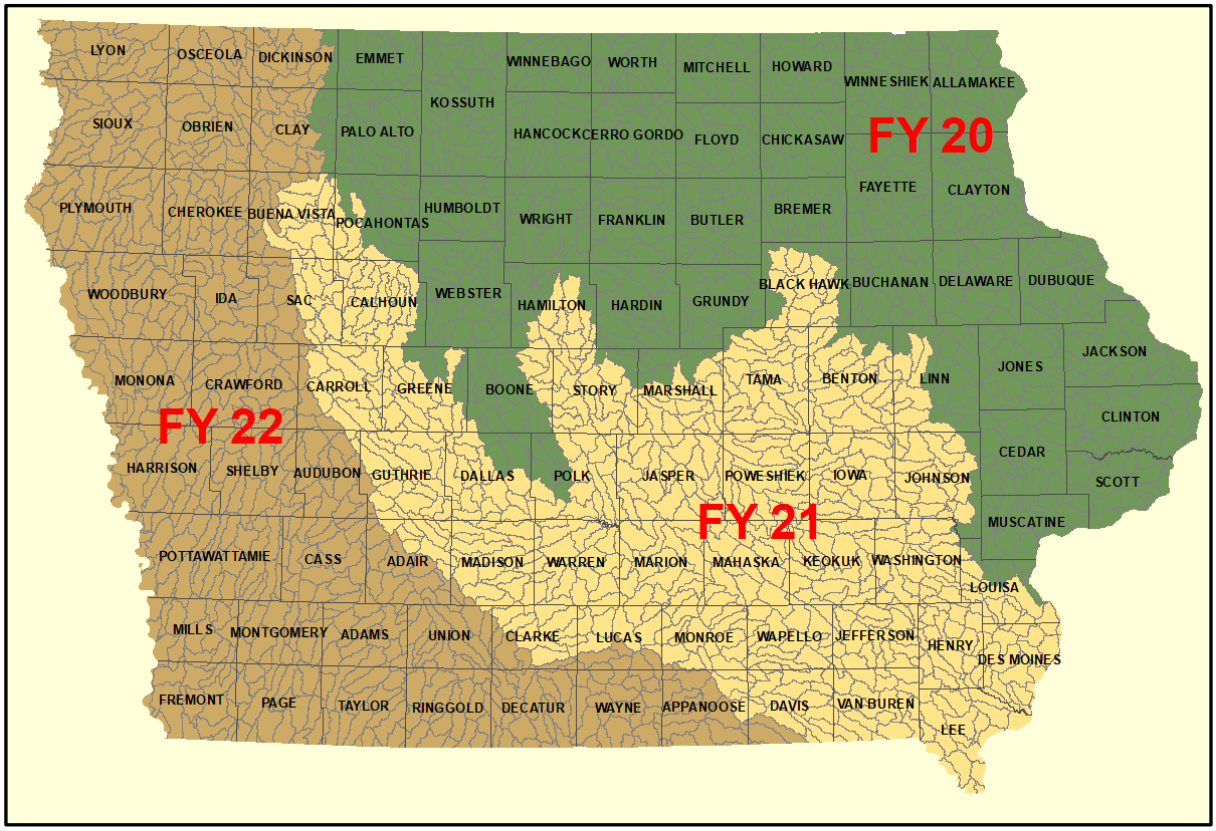

Figure 6. The FFY funding schedule for areas of 2D BLE outreach and study.

EXAMPLES IN IOWA

City of Akron, Plymouth County

2D modeling was recently used to study flood risk for the City of Akron in Plymouth County. Previous 1D modeling showed unrealistic flood depths in their industrial park due to special circumstances regarding the stream being perched, or having soil piled along the upper extents of its' banks to contain the flood risk. This was brought to our attention during our Draft Flood Hazard Product meetings by the City. This 1D data was inhibiting development in the industrial park as the City had proposed projects that appeared to be at very high risk for future flood damages. Outreach was a key component as Akron provided infrastructure details for the park to further inform the modeling. The 2D analysis showed the flood hazard area (Figure 7) and associated risk were far less than the 1D analysis, with some areas showing as much as 6 feet of difference in the flood depths. The 2D analysis allowed Akron to continue with their development plans while being proactive with mitigation, thereby creating more community resilience and avoiding future losses.

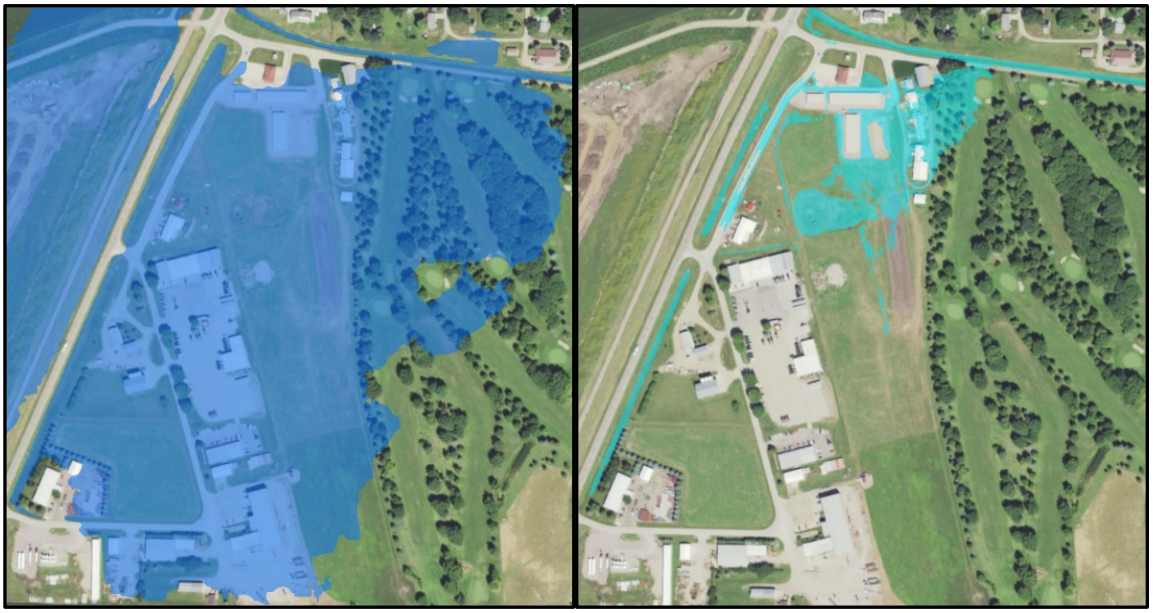

Figure 7. The City of Akron benefitted from the 2D BLE approach. The image on the left is the original draft mapping developed using 1D methodologies. The image on the right shows results of 2D modeling. This required quite a bit of outreach and coordination. By providing details about the industrial park, engineers were able to better inform the model, a key component of our outreach effort for 2D BLE. This allowed development to continue in the park with a more realistic understanding of risk as well as ideas of how to mitigate future flood risk in the park.

Dickinson County – Iowa Great Lakes

When draft mapping was presented to Dickinson County it became evident that a different approach was needed to better identify the risk associated with all of the various lakes and ponds. 1D mapping relies on a stream (i.e., profile baseline) which often does not take lakes into account. County officials expressed concern about the proposed risk information for their lakes and sought a new solution. The Iowa DNR and their consultant developed a pilot program to leverage a 2D analysis, resulting in more accurate representation of risk around the Dickinson County lakes and ponds (Figure 8).

This example further demonstrates the value of 2D analysis. For areas with flat terrain, this approach provides a more realistic display of flooding and risk. With this information the floodplain administrator is able to discuss various options with the landowner, helping to protect their investment and reduce future losses. This data has been accepted by Dickinson County and is being incorporated into their regulatory products.

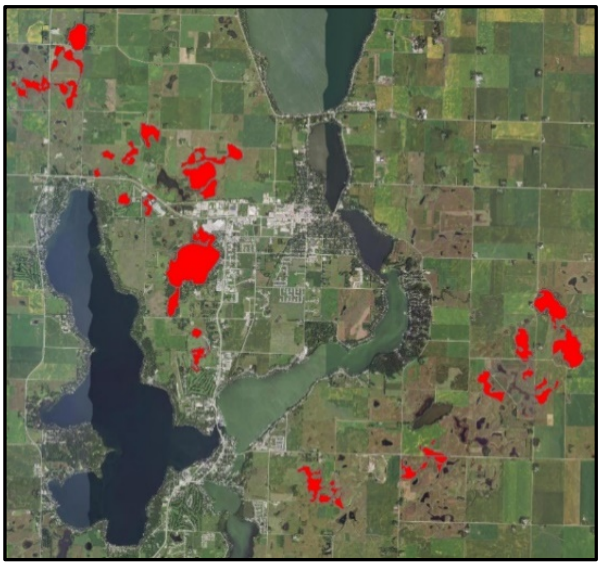

Figure 8. Lakes (in red) that were added to regulatory mapping after 2D BLE data was developed and presented to Dickinson County and the cities therein.

REGIONAL EXAMPLES

States such as Kansas, Missouri and North Dakota as well as many others outside the Midwest, are working on their own 2D BLE projects and are finding success and acceptance by local officials in the use of this data for risk awareness in their states. A description of two efforts follows.

North Dakota State Water Commission (NDSWC)

The NDSWC has a statewide BLE program that is making 2D data available for its' residents to better understand risk and plan accordingly for future development. Starting in FFY17, they have achieved full statewide coverage that took approximately 3 years to complete. Their data is being shared through a webtool which also provides a visual means to view both regulatory mapping and 2D BLE data to show a full picture of the risk at an individual level. Their site also allows users to download data for review and planning uses.

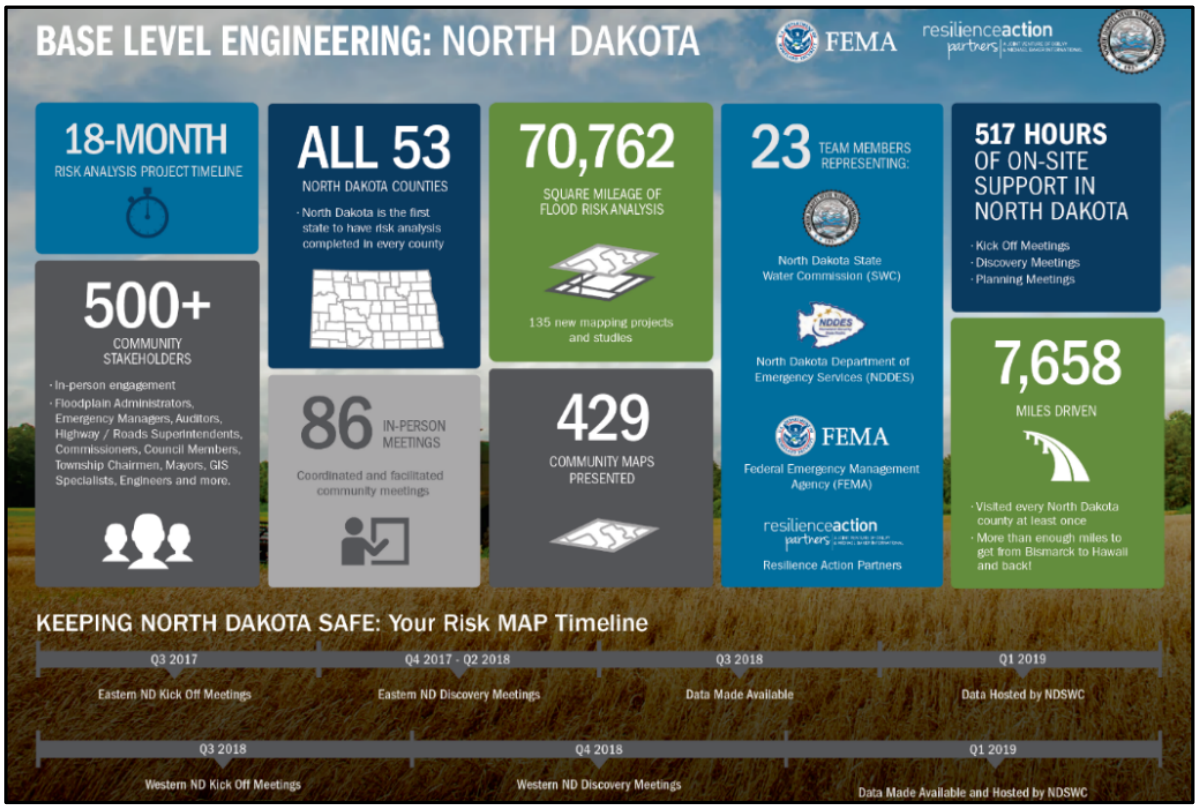

Figure 9. Dashboard for North Dakota State Water Commission 2D BLE project. Outreach is a main component to getting the word out and having public officials consult the mapping for future projects.

The NDSWC is also demonstrating how this data has been used far beyond risk communication. This data has been used for conservation efforts and water quality projects, as well as benefit cost analyses (BCAs) and mitigation grant applications.

Kansas Department of Agriculture (KDA)

The KDA is another success story, having developed 2D BLE data over the past several years. They are delivering risk awareness information to their residents similar to North Dakota. KDA is also making this information freely available to residents, showing how beneficial it is to both the KDA and residents who can leverage this information to make informed decisions without the need to pay for additional studies. The 2D data is already developed and can be modified to reflect changes in floodplain characteristics. Data is being delivered to counties though KDA's status website (Figure 7).

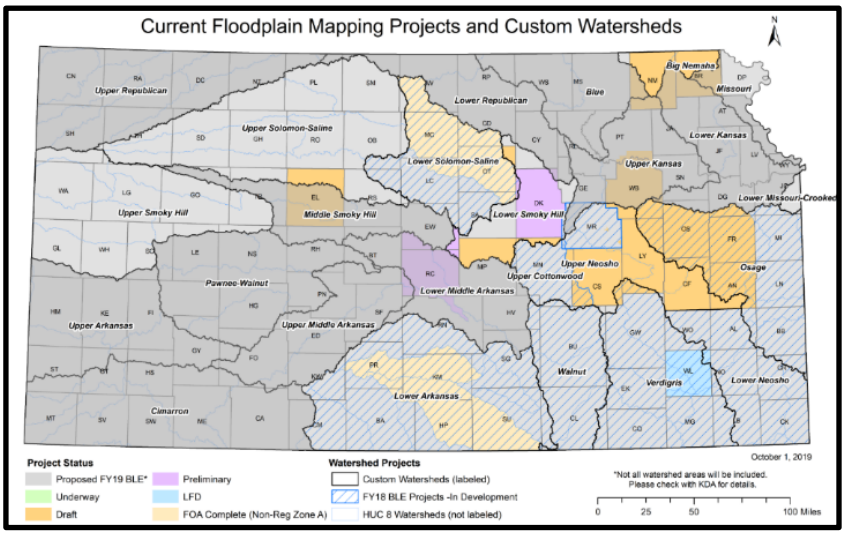

Figure 10. A map from Kansas Department of Agriculture shows BLE projects (blue crosshatch) are underway in the eastern portion of the state.

UNDERSTANDING RISK TOGETHER

There are numerous partners and stakeholders who play an active role in Iowa floodplain management and are critical to its success. Below are a few of these partners; however, there are numerous others, including local officials and citizens, who are actively working to make Iowa more resilient from future flooding impacts. Our stakeholders will be the key to this program's success. Our mission is to engage and educate all participants in order to make Iowa more flood risk aware, and therefore put mitigation at the forefront of all planning activities.

The following organizations are those we are targeting as partners in educating various state and regional groups. These and others will be invited to our kickoff outreach events to discuss their potential role in this project. If your group or agency is interested in becoming more involved, or if you wish to learn more about this program, please contact us.

- Iowa Department of Transportation
- United States Geological Survey
- Iowa State University
- United States Department of Agriculture
- University of Iowa (Iowa Flood Center)
- Federal Emergency Management Agency
- Iowa State Association of Counties
- American Planning Association – Iowa Chapter
- Iowa Engineering Society
- Iowa Silver Jackets (COE)
- Iowa Homeland Security and Emergency Management Department
- Iowa Floodplain and Stormwater Management Association
- Watershed Management Authorities of Iowa