Identifying Breach Analysis Needs of Multiple Dams with Limited Resources

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INTRODUCTION

Natural Resources Conservation Service (NRCS) policy is to review the safety of individual NRCS-assisted dams every five years. The policy created a need for each state to manage the number of dams that could be reviewed each year with available staff. The State of Texas NRCS keeps track of its assisted dams each year as to which requires a five-year review. The dams to review are of low and significant hazard classification and NID inventory size. In 2008, Texas NRCS had 541 dams scheduled for hazard review on the five-year cycle. In a January 2008 Texas NRCS Bulletin, a plan of action was included to accomplish this task. A descriptive tiered approach was in that bulletin.

Hazard Class Verification – Actions required by District Conservationists and Zone/Field Office Engineers

Actions were established at the following levels to minimize time requirements at the field level:

Level 1: District Conservationists, with assistance of Zone and Field Office engineers, reviewed aerial photography, combined with local knowledge of the area; no field visits were required. This level was designed to handle only the most obvious situations. Zone engineers reported on the dams that needed field review and surveys for levels 2 and 3 as soon as they became aware of the need, but not later than March 31, 2008. District Conservationists submitted a spreadsheet of the results by County to the Zone Office by May 1, 2008.

Level 2: Zone and Field Office engineers performed on-site evaluations and collected minor additional survey data. Other Field Office personnel assisted with surveys or provided access to dams. Level 2 evaluations were completed and submitted by May 31, 2008.

Level 3: Detailed breach evaluations were conducted by State Office engineers. Some assistance on surveys or access to dams was obtained from Field Office personnel. Level 3 evaluations were completed by August 1, 2008.

Conservative shortcut for Level 1

Experienced and lesser-experienced staff performed Level 1. The chosen method to reduce time of training, human error and to establish uniformity in results of review was of two parts. The first part used highly experienced Water Resources Staff members to gather required in-house information on selected dams and assess the dams in the field as to if they required Level 2 analysis or a recommendation of greater hazard classification. The second part was to generate

conservative boundaries or zones of interest below dams that simplified the Level 1 task for available staff with less hazard review experience. This shortcut gave the field staff a conservative aerial limit of view downstream of a dam by using orthophotographic imagery to identify potential breach concerns that required Level 2 analysis. The zone of interest is an in-house NRCS Texas working tool and is not considered, or conveyed to the public, as a breach boundary. The second part of the method used in Level 1 analysis is the subject of this paper.

Software and Data

GIS and HecRas software were used to estimate conservative aerial limits of view downstream of dams by using orthophotographic imagery. This allowed rapid identification of potential breach concerns that required detailed analysis. This procedure took data from the National Inventory of Dams (NID) database to compute the NRCS Technical Release 60 (TR-60) breach discharge from formula Qmax=65Hw^1.85 and to assign a breach volume. GIS was used with orthophotographic imagery, road and railroad layers, a watershed structure location layer, and elevation terrain models. The GeoRAS interface established streamlines and cross sections for export to HECRAS. The HECRAS was loaded with the NRCS TR66 derived breach hydrograph and unsteady flow profiles were created to establish maximum water surface elevations. The maximum water surface profile was imported into the GIS model and a delineated flood boundary was created.

The NID was a necessary tool for rapid data compilation. (Its data was queried to develop the list of dams to be reviewed in 2008). The NID consists of dams meeting at least one of the following criteria:

1) High hazard classification - loss of one human life is likely if the dam fails,
2) Significant hazard classification - possible loss of human life and likely significant property or environmental destruction,
3) Equal or exceed 25 feet in height and exceed 15 acre-feet in storage,
4) Equal or exceed 50 acre-feet storage and exceed 6 feet in height.

The NID contained dam height and storage volume values used in computing the breach discharges and flood hydrographs.

The required dams for hazard review were selected in the NID point file GIS attribute table and were readily located on the map. Study areas were defined when the structures were located and then the GeoRas processing created georeferenced geometry for HecRas modeling.

A template spreadsheet computation of a breach hydrograph for a conservative discharge of each dam was made using NID data (height of dam, Hw and Volume to top of dam) and NRCS TR-66. This was used for HecRas unsteady flow computations. HecRas modeling computed Maximum Water Surface Elevations for each cross section that is still identifiable on the GIS model. The HecRas output was exported to GIS after review.

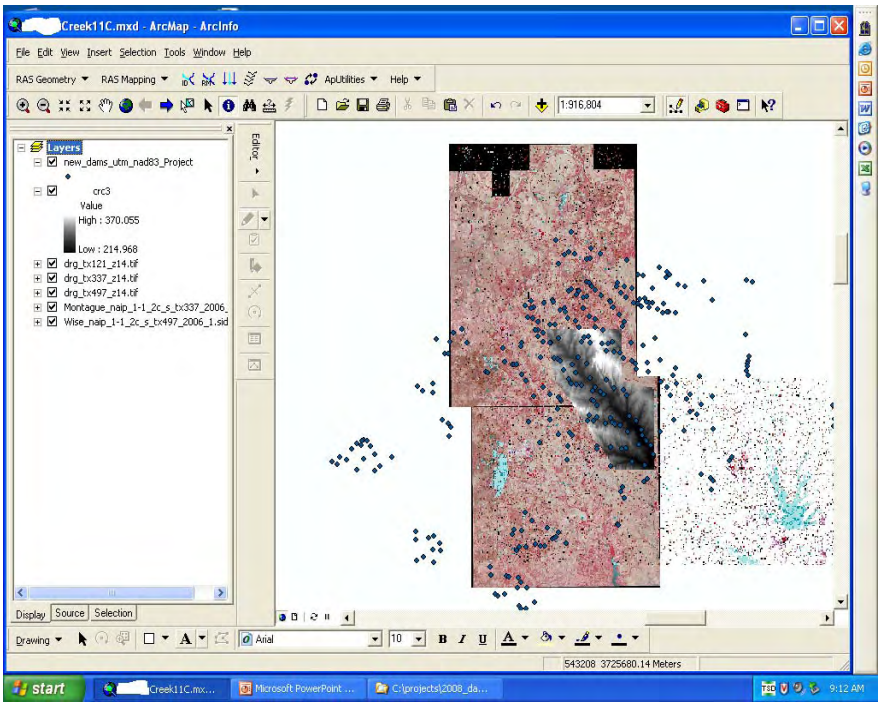

Figure 1. GIS Arc Map with GeoRas tools, NID structure locations, Elevation model, Ortho, and USGS quadrangle imagery.

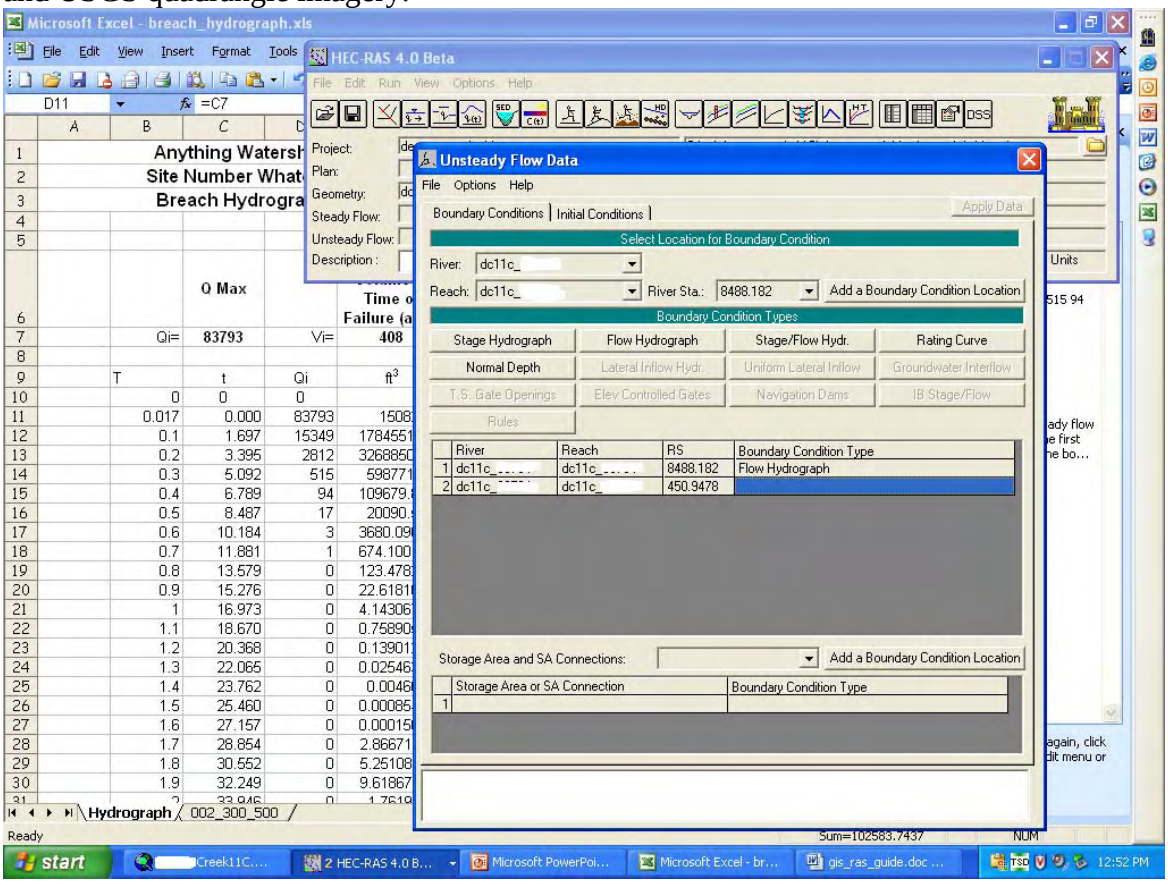

Figure 3. Hydrograph data is copied to the HecRas Unsteady Flow Data Boundary Conditions.

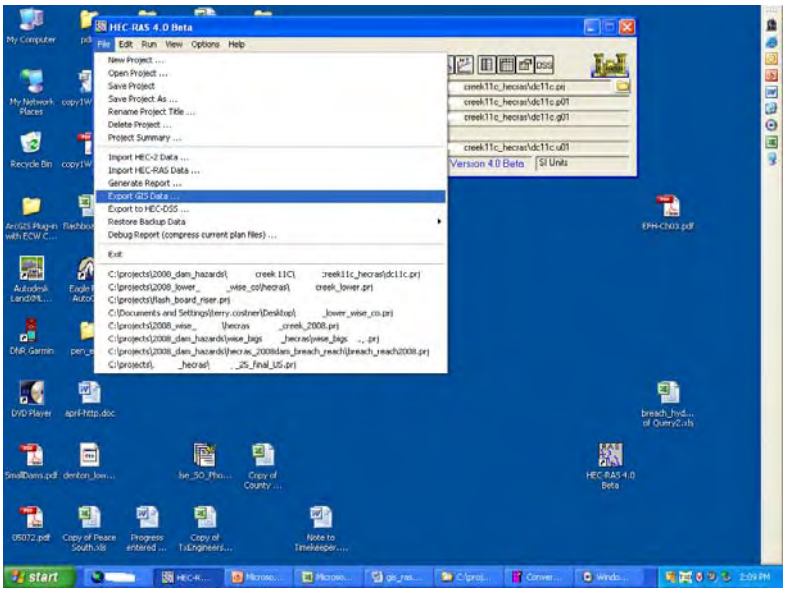

Figure 4. Export HecRas GIS data (Maximum Water Surface Elevation Profile) for GIS import.

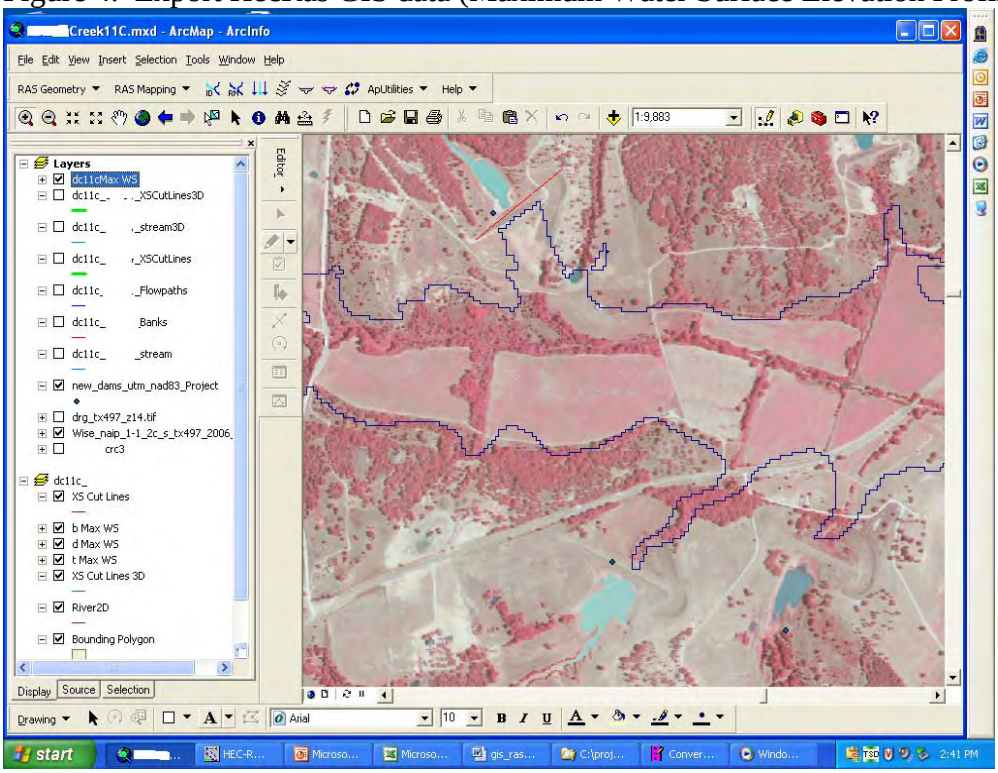

Figure 5. GIS HecRas Mapping of Zone of Interest

This example in Figure 5 shows the Zone of Interest as a blue boundary line on a 2006 background map. The field offices had access to the same GIS maps and in some cases had newer maps. The product delivered to the field was the digital georeferenced Zone of Interest layers as shown in Figure 6.

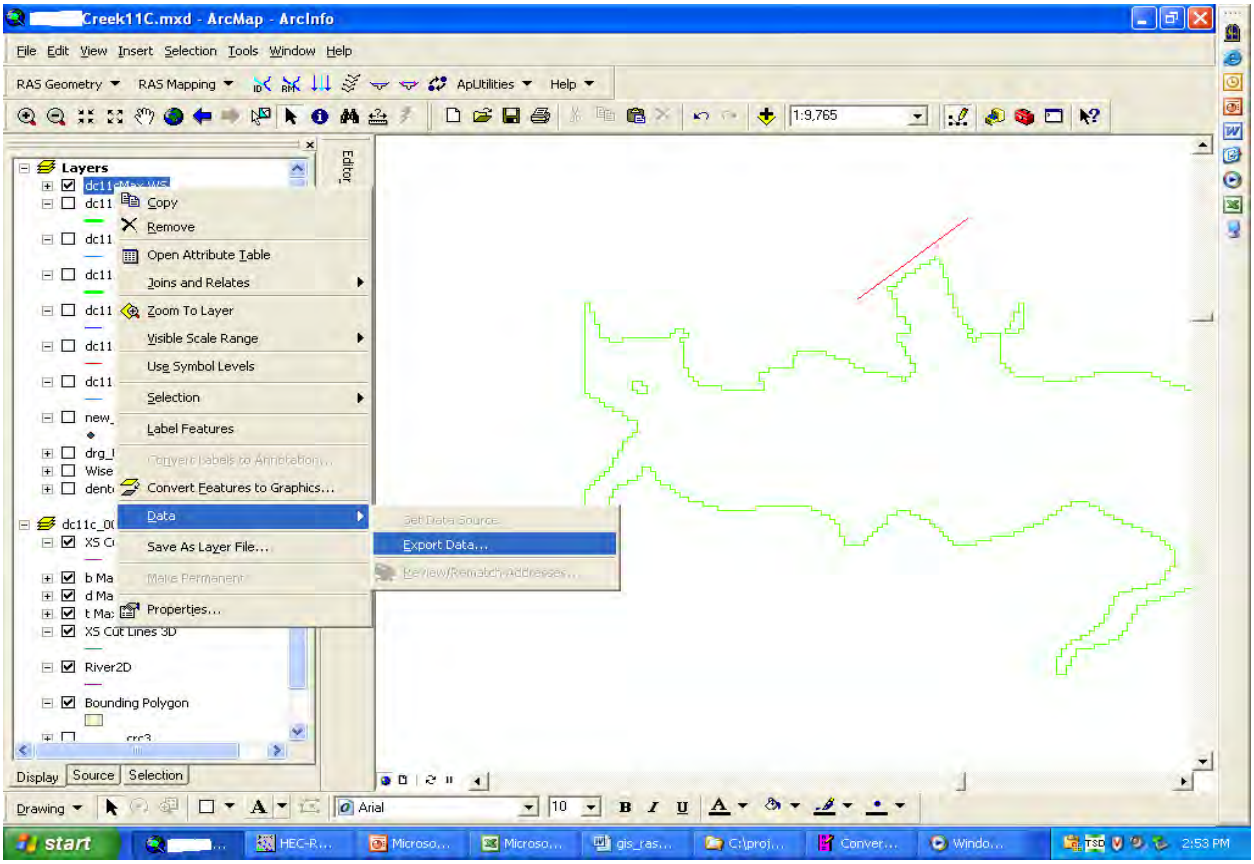

Figure 6. GIS Zone of Interest.

The Zone of Interest gave the field staff a shortcut in identifying what to look at with a conservative aerial limit of view downstream of a dam. Potential breach concerns that require Level 2 analysis were identified by using orthophoto imagery, local knowledge or field investigation within the Zone of Interest.

The GIS and HecRas models were saved to substantiate review findings and used in Level 2 evaluations with required TR60 Breach Discharge criteria and necessary field survey.

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