

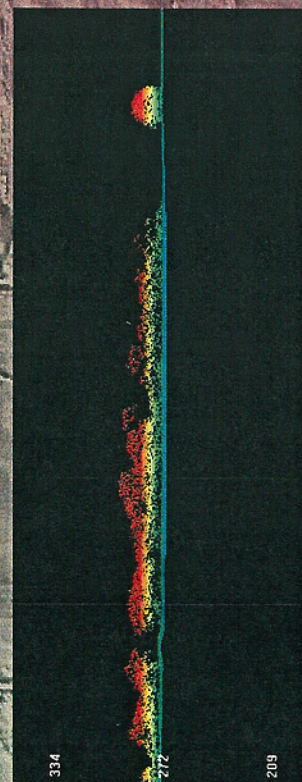
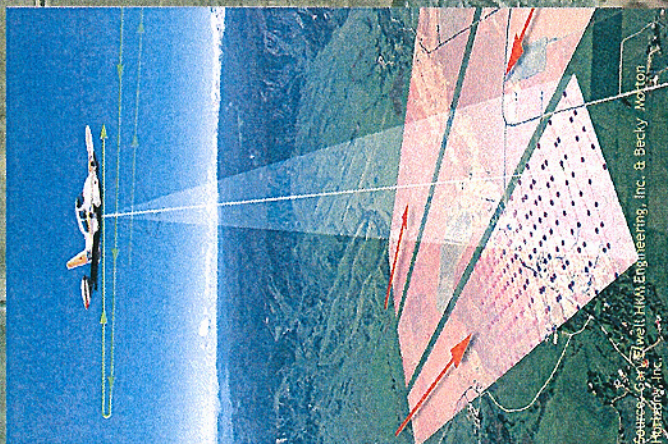
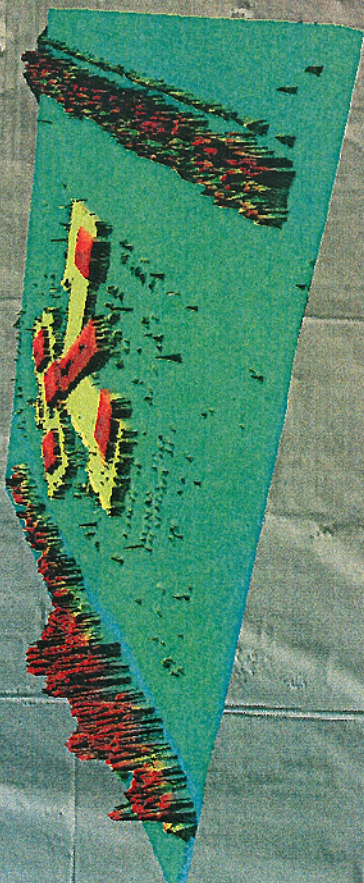
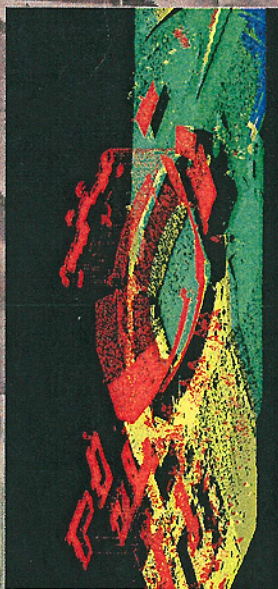
Red River Basin Mapping Initiative

“Redefining the landscape”

North Dakota Legislature

Natural Resources Committee

October 31, 2007



334

272

209

Local/International Support

- MN Red River Watershed Management Board
 - Joe River WD, Two Rivers WD, Roseau River WD, Middle-Snake-Tamarac Rivers WD, Red Lake WD, Sand Hill River WD, Wild Rice WD, and Bois de Sioux WD
- MN Buffalo-Red Watershed District
- ND Red River Joint Water Resource Board
 - Nelson, Grand Forks, Walsh, Steele, Pembina, Trilli, Cass, Ransom, Sergeant, Richland, and Wells
- ND Upper Sheyenne Joint Water Resource Board
 - Barnes, Benson, Eddy, Foster, Griggs, McHenry, Nelson, Pierce, Sheridan, Steele, Stutsman, Wells, and Spirit Lake Nation
- International Red River Board
 - City of Fargo, ND
 - City of Moorhead, MN
 - City of Wahpeton, ND
 - City of Breckenridge, MN
 - Grand Forks, ND
 - East Grand Forks, ND
 - Cass County, ND
 - US Geological Survey (USGS)
 - Natural Resources Conservation Service (NRCS)
 - Red River Basin Commission
 - MN Wheat Growers Association
 - ND Corn Growers Association
 - ND Grain Growers Association
 - Red River Valley Sugar Beet Growers Association
 - ND Soybean Growers Association
 - MN Governor's Council on Geographic Information

ND Farmplace Union October 2007

International Watershed Institute

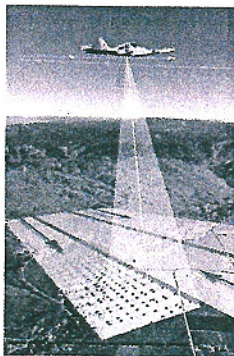
RRBMI PROJECT OBJECTIVES

1. Collect high-resolution elevation data
 - 15cm vertical and 1 - 1.4 meter horizontal RMSE (FEMA Floodplain Specifications/Standards)
 - Entire US Portion of Red River of the North Basin (39,400 miles²)
 - Strategic Imagery
2. Third party quality assurance/quality control
3. Establish web-based public data archival and dissemination vehicle
4. Public Outreach

October 2007

International Watershed Institute

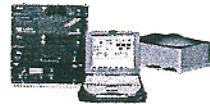
Light Detecting And Ranging - LiDAR



Aircraft + Laser + GPS




Leica, Inc.




Leica, Inc.



October 2007

International Watershed Institute







International Water Institute
Flood research and watershed education for the Red River Basin


Formed in 2000 (International Flood Mitigation Initiative - IFMI)


Mission:

"Provide a forum for research, public education, training, and information dissemination relating to flood damage reduction and natural resource protection and enhancement in the Red River Basin"

October 2007







BRIEF PROJECT HISTORY

- 1997 Flood
- Documented Need
 - International Joint Commission
 - International Flood Mitigation Initiative
 - Other Organizations/Agencies
- International Water Institute
 - 1st Basin Mapping meeting - 2000
 - 2nd Basin Mapping Meeting - 2002
 - 3rd Basin Mapping Meeting - 2004
 - 4th Basin Mapping Meeting - 2005

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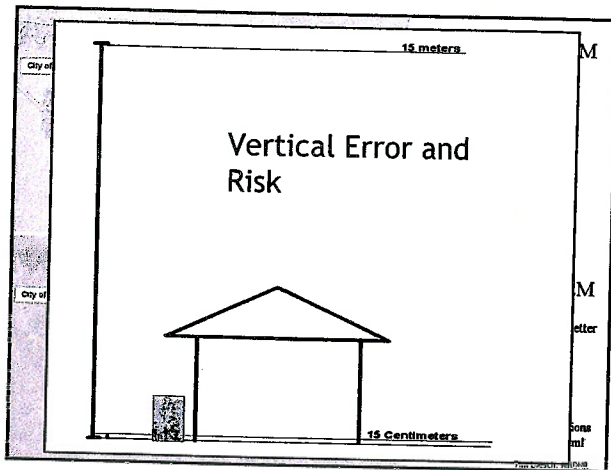



RATIONALE for BASIN COLLECT

- Established/Documented Need
- Proven Technologies
- Local Desire for Seamless Watershed/Basin Elevation Dataset
 - financial commitments
- Other Large-Scale Collects Completed and Underway (Manitoba, North Carolina, Iowa, Washington, etc.)
 - No "re-inventing"
- Economies of Size
 - Smaller scale - project specific - collects being planned/ implemented by many
 - Cheaper by the dozen

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BENEFITS

- Identified/Known
 - Agriculture/Precision Farming
 - Water resource management/decision-making
 - Utilities management
 - 3-D modeling
 - Civil works planning and development
 - Conflict resolution
 - Resource monitoring and assessment
 - Problem identification
 - "...and the list goes on and on..."
(Mark Bittner, Fargo City Engineer)

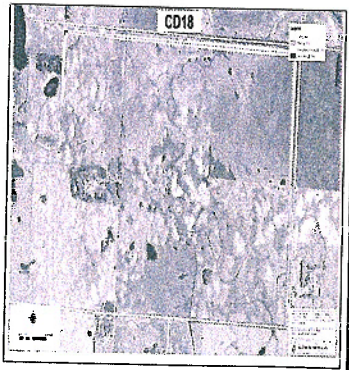



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International Water Institute



FDR/NRE PROJECT DEVELOPMENT

- USGS Quad
- DOQ
- HR DEM
- 1 Ft Contour Map
- Soils
- Wetland/Water
- H&H Design
- Prelim. Plan Prep.



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Budget Overview by Category

1. Data Collection - \$4,000,000
2. Quality Assurance - \$275,000
3. (Dissemination/Archival/Applicati
on Development) - \$185,000
4. Project Management
(Administration/Public
Outreach/Coordination) -
\$540,000

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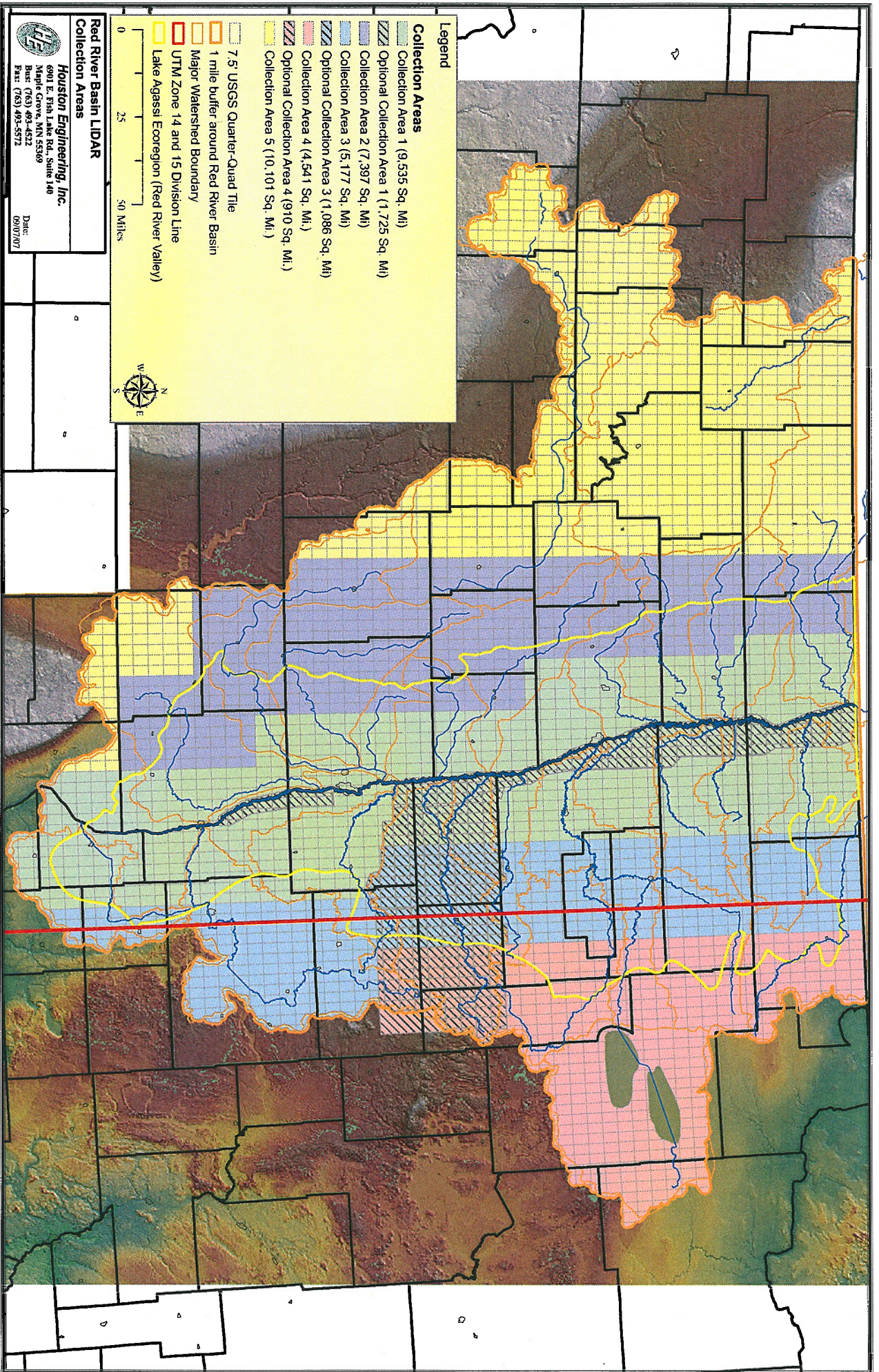
International Water Institute

Project Status (October 2007)

Funding	Amount Requested	Status 9/2007	Source
Federal Government (NRCS, USGS)	\$2,500,000	\$300,000	ND Nat. Resources Conservation Service (NRCS)
		\$50,000	NRCS Soil Survey Department (National)
		\$150,000	US Geological Survey
		\$2,600,000	US Corps of Engineers (Dorgan) Watershed Feasibility
ND Local Partners	\$550,000	\$473,000	Red River Joint Water Resources Board
		\$77,000	Remuneration - Tom Fischer and Mark Bittner
MN Local Partners	\$550,000	\$500,000	Red River Watershed Management Board
		\$50,000	Buffalo-Red Watershed District
Cities	\$200,000	\$98,118	Fargo
		\$31,296	Woonhead
		\$46,910	Grand Forks
		\$7,331	East Grand Forks
		\$8,350	Wahpeton
		\$3,461	Breckenridge
		\$14,530	West Fargo (denied 6/07) - Tom Fischer and Mark Bittner
State of Minnesota	\$600,000	\$25,000	MN Dept. of Transportation
		\$500,000	NRN 2008 Bonding Bill (Lancaster et al.)
State of North Dakota	\$600,000	\$400,000	Included in 2007 State Water Commission budget
		\$200,000	2009 Legislative session (Tom Fischer et al.)
Total	\$5,000,000	\$2,133,466	

October 2007

International Water Institute



RED RIVER BASIN MAPPING INITIATIVE

Availability of good information lies at the heart of effective and equitable decision making (Allen and Kibington 1999)

INTRODUCTION

The purpose of this document is to propose a plan and implementation strategy for a Red River Basin Mapping Initiative to develop a high resolution digital elevation model (DEM) for the Red River of the North Basin (RRB) south of the U.S./Canada border using Light Detection and Ranging (LIDAR).

BACKGROUND

Highly accurate DEMs and associated imagery are essential to improving disaster preparedness, protecting existing infrastructure, evaluating and planning flood and drought damage mitigation projects, enhancing agricultural production, and strengthening decision-making capacity at all levels of government. Current technology allows for efficient collection and processing of DEM data across large land areas through the use of airborne LIDAR and digital photography platforms. Local, state, and federal agencies have successfully used LIDAR technology to develop DEMs on an incremental (project specific) basis in the RRB; however, there is currently no basin-wide seamless high resolution elevation dataset. These and other successful projects in the US and elsewhere have demonstrated the efficacy, need, and benefits for basin-wide DEM development in this region.

Standard national elevation and topographic data available for the RRB consist of 10 meter or 30 meter elevation models which are based on existing US Geological Survey (USGS) 7.5 minute topographic maps. However, the region's unique geography with large areas of very low relief compromises the usefulness of standard national coverage topographic data sets and their application to the decision-making process (IJC 2000). Accurate topography has numerous applications, some of which are fundamental to developing disaster resiliency – our ability to predict, understand, respond, and change behavior before, during, and after disaster events – in the Red River Basin. Accurate topographical information also greatly enhances capacity of today's decision makers and resource managers and provides a crucial foundation for developing innovative, effective, and defensible natural resources and flood and drought mitigation strategies.

The need for accurate topographic data in the RRB has been established by a number of organizations following the devastating flood of 1997.

- The International Joint Commission (IJC) formed the Red River Basin Task Force to assess causes and effects from the 1997 flood. The Task Force made a series of risk reduction recommendations including the need to collect high resolution topographic data and develop a consolidated digital database aimed at improving regional forecasting and modeling capabilities (IJC 2000).
- The US Federal Emergency Management Agency funded the International Flood Mitigation Initiative (IFMI) in 1998. IFMI was charged with developing a series of recommendations aimed at reducing damages from future floods in the RRB. IFMI identified the need for more accurate topographic information and formed the International Water Institute to coordinate research, mapping, and education within the RRB (IFMI 2000).
- The Province of Manitoba concluded there was a compelling need for accurate topographic information after the 1997 flood and funded a large scale LIDAR project for areas south of Winnipeg. The DEM was developed and used in a web-based decision support system that increases access to vital information on flood management and preparedness for the general public, decision-makers, and emergency management personnel (Manitoba 2004).
- The US Army Corps of Engineers conducted a study to evaluate the need for high resolution digital elevation data collection in the RRB. The report concluded that a data collection plan for securing LIDAR should be developed to compliment the Canadian approach (USACOE 2004).

Eventually, we must expect that all areas of the RRB will someday have high-resolution information. The use of proven technologies and known economies of scale associated with collecting this information provide sound logic for a basin-wide collection project. The cities of Fargo, ND and Moorhead, MN and other state and local partners have funded a number of LIDAR collects in and around the municipal areas. The level of effort necessary to merge LIDAR data from the various collection efforts is considerable and costly; even when the

information was collected by the same vendor at different times (Bittner 2006). In addition to the mapping efforts in Fargo, ND and Moorhead, MN, there are a number of relatively small scale DEM projects that have been completed or are currently underway. In recent months over \$650,000 has been committed to disparate small-scale DEM projects in the Red River Basin. Although the accuracy and deliverables specified for these projects appear to be comparable, the costs range from \$165/square-mile (Busing 2006) to over \$350/square-mile Basin (Yohe 2006 and Oosterveen 2006).

There are also a number of statewide digital elevation projects such as North Carolina and Iowa (Ensminger 2006) which demonstrate the economies of scale and the need for a coordinated DEM effort in the Red River Basin. The lessons learned from these larger-scale projects and the other smaller-scale mapping initiatives in the region will ensure data accuracy requirements are met (through third party benchmark surveys and validation) and provide a working model for data archival and dissemination of the information via the Internet. Most importantly, these efforts magnify the importance of a coordinated and large-scale collection effort that maximizes the return on investment of public funds.

BENEFITS

The Red River Basin Mapping Initiative has a documented need and benefit to basin residents and decision-makers. The benefits will be extensive and profound; enhancing resiliency, capacity, performance, and economic efficiency at every level of decision-making in North Dakota, Minnesota, and Manitoba. Known uses and benefits of high-resolution elevation data include:

- Increased agricultural productivity
 - Precision agriculture, fertility mapping, micro-drainage, updated soil mapping units, erosion, culvert sizing, identify lime/saline areas, carbon sequestration prioritization
- Enhanced flood and drought damage mitigation
 - Enhanced flood and drought forecasting, more accurate flood plain maps, flood prevention and flood plain management, powerful decision-making tools for residents and decision makers
- Enhanced planning and project development
 - Transportation infrastructure, land use management, flood storage volume calculations, project alternatives analysis, flood storage pool impacts, preliminary design and quantity cost estimate, wetland and stream restoration, riparian zones, site prioritization for runoff storage and natural resources enhancement, archeology, dam rehabilitation and breach analysis studies, confined animal feeding operation placement
- Detailed surface hydrologic and hydraulic modeling
 - Base layer for accurate modeling (i.e. HEC-RAS, Win-TR-20, FLO-2D, MIKE 11, and NRSC Hydro), permit reviews, drained area delineations, supplement river cross section data, water quality modeling, sediment and erosion analysis, debris flow hazard, landform and surface feature identification and extraction, calculate sheet and rill erosion, water risk assessment
- Ecological monitoring
 - Reference site assessment and selection, grass buffer strips, field data collection, basin studies, resources and watershed evaluations, gully and stream channel erosion and deposition, forestry management
- Conflict resolution
 - Problem identification, terrain visualization, landform positioning and identification

The high resolution elevation data will result in substantial cost reductions for all civil works projects. LIDAR data is known to reduce FTE time and costs on transportation projects (NCRST-E 2006). The MN Wild Rice Watershed District (WRWD) recently completed a LIDAR project with other local governmental partners. The WRWD expects to save over \$20,000 in preliminary survey costs this year alone (Bentz 2006). According to engineers from the Red River Watershed Management Board's Technical Advisory Committee, high-resolution LIDAR information would save a minimum of \$10,000 on a "typical" flood damage reduction project (a larger-scale project would realize even higher cost savings). Most importantly, high resolution LIDAR information would strengthen the decision-making process and enable project planning and conceptual design to occur at a much more accurate scale which would further reduce costs (Dalager 2006 and Anderson 2006).

High resolution topography is also a fundamental piece of information needed for precision farming. A publicly funded LIDAR collect would reduce the cost of implementing precision farming systems on private operations in the Red River Basin collection area by half. Precision farming is a fast growing industry that has consistently been shown to decrease water pollution, increase yields resulting in an economic increase of approximately \$40/acre/year, and reduce inputs by approximately \$12/acre/year. Return on investment for the sugar industry alone could be expected to exceed \$500,000/year (Nesbitt 2006).

Future applications using high resolution topographic data are limited only by our ability to comprehend how these data will eventually be integrated with new technologies and used to make decisions that enhance the regional economy and lives of RRB residents.

STRATEGY

The International Water Institute (Institute) will act as project manager and convene a Red River Basin Mapping Initiative Steering Committee to provide project oversight and management direction. The Steering Committee will be responsible for developing and submitting a request for proposals and the final selection of the vendor and third party verifier. The Steering Committee will work with the project manager and the entity contracted to perform the third party validation and quality assurance quality control to make final approval for all products submitted for payment by the chosen mapping vendor. The Steering Committee will also be responsible for developing appropriate data storage, maintenance protocols, and distribution mechanism through the Red River Basin Decision Information Network. The Committee will include selected members of the Red River Watershed Management Board's Technical Advisory Committee, selected members from ND and MN agencies, and representatives from other local, regional, and federal agencies that are funding partners.

PROJECT SCOPE AND DELIVERABLES

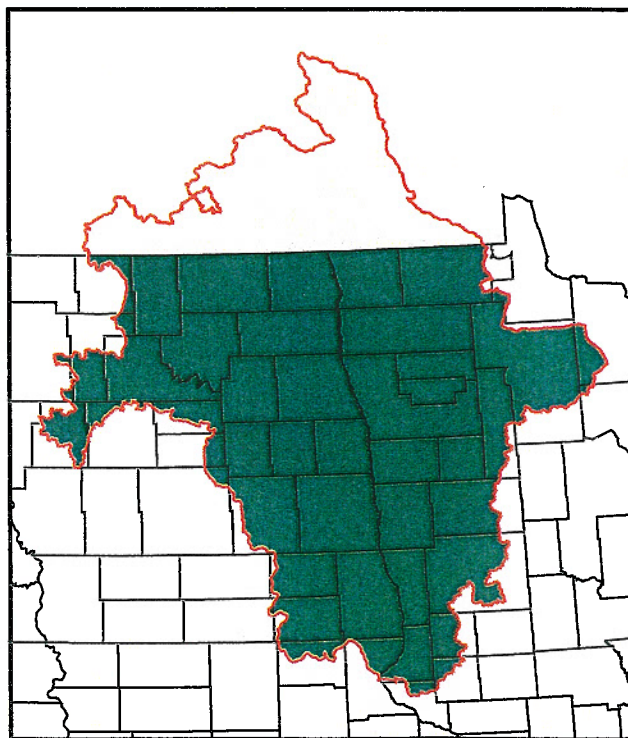
The Red River Basin Mapping Initiative planned collection area (Figure 1) consists of 39,400 square miles and includes the entire US portion of the Red River Basin (including Devils Lake). The project has 4 proposed main deliverables:

- 1) Bare earth digital elevation model/Imagery
- 2) Data QA/QC
- 3) Data archival and public dissemination
- 4) Public outreach

The bare earth DEM will consist of 15cm vertical and 1m horizontal accuracy. All spatial products will meet or exceed US Federal Emergency Management Agency standards for flood plain mapping (FEMA 2006) and the Federal Geographic Data Committee standards for geospatial metadata (FGDC 2006). All groundwork work needed to collect the information and ensure desired specifications will be the responsibility of the vendor. Deliverable quality assurance - quality control will be ensured through contracts with a third party and extensive ground surveys. We anticipate that the ground truth surveys will include 100 points/county (20 point per land cover class and 5 land cover classes per county).

The scope and resolution of digital orthophotography/imagery collection will be determined by the Steering Committee. We anticipate the imagery deliverable will not exceed our expected total project cost; however, the extent of imagery coverage would depend on available funds and the wishes of the local funding partner. If bids

Figure 1. Project Geographic Scope (USCOE 2004).



exceed the expected project cost, the Institute will work with local, state, and federal partners to prioritize areas for imagery collection and proceed accordingly.

The US Department of Agriculture collects imagery through their National Agricultural Imagery Program (NAIP). NAIP makes available national imagery that includes the Red River Basin. The information is updated annually (USDA 2006). Depending on the final project budget and the responses to the request for proposals, the NAIP may provide an alternative avenue for project partners to obtain digital imagery.

Technologies for storing and disseminating digital elevation and photography are proven and well established. The Red River Basin Decision Information Network (RRBDIN) will be used for data archival and dissemination. RRBDIN is hosted by the Institute and partners at North Dakota State University (NDSU). The Internet site was developed to serve as a one-stop-shopping for information in the Red River Basin. Spatial products from the Red River Basin Mapping Initiative will be stored on a dedicated server and delivered through the Internet free of charge. NDSU will provide operation and maintenance services and the necessary bandwidth for disseminating the information. The Steering Committee will decide which mapping products will be made available based on user needs and budget constraints. We expect to prepackage the spatial products (which will include at a minimum the raw point data, bare earth DEM and some extent of imagery) to facilitate access and deliverability via the Internet.

The Institute and partners at NDSU would be responsible for data storage and dissemination. The Institute will work with the Steering Committee to develop acceptable protocols for future updates to the seamless RRB DEM. Although most of the rural areas collected would not need updating in the foreseeable future, LIDAR information collected in and near municipal areas will need to be re-collected periodically. In many cases, small changes on the landscape (i.e. new levy construction/expansion) could be manually inputted by manipulating the DEM on a desktop computer. Future updating of larger areas that would require re-flying and LIDAR data collection would be the responsibility of the entity seeking the new information.

Public outreach will include brochures and media products to inform residents and decision-makers of the Basin Mapping Initiative products and explain how the information will be used in the Red River Basin. A series of focus group meetings will be held with engineers, and researchers, and floodplain managers to obtain feedback and comments on the outreach products as well as the web-based dissemination system.

PROPOSED/EXPECTED BUDGET

The project budget was developed after numerous consultations with representatives from private LIDAR vendors, civil engineers, project managers of large and small scale LIDAR projects that have been completed and are being planned in the US and Canada, and agency representatives from the USGS and other federal agencies (Table 1).

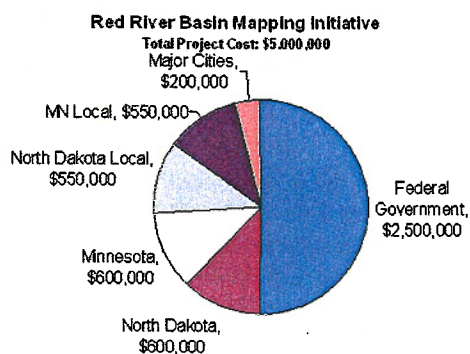
The budget was developed with the assumption that each component of the project would be sub-contracted through the International Water Institute as a separate and independent deliverable. The budget includes resources for the Institute and partners to develop the web accessible data archival and dissemination system through the Red River Basin Decision Information Network or other appropriate publicly accessible vehicle that would be determined by the Steering Committee. Initiative partners may also choose to host the relevant spatial information on other established platforms.

The proposed funding formula identifies 6 main partners (Minnesota Local, Minnesota State, North Dakota Local, North Dakota State, Red River Basin major cities, and the Federal Government). The Institute has secured formal commitments specified from Watershed Districts in Minnesota, the ND Red River Joint Water Resources Board, and the cities of Fargo, ND, Wahpeton, ND, Breckenridge, MN and Moorhead, MN (Table 2). Funding language has been introduced at the legislative sessions in Bismarck ND and St. Paul, MN. These committed partners have expressed their desire for a basin-wide DEM effort and believe the proposed project scope will provide the greatest future return on investment of public funds. The Institute hopes to have the funding partnerships committed by the spring of 2007.

Table 1. Draft Budget.

Objectives						
1	Collect bare-earth DEM/digital imagery					
2	Data archival and dissemination					
3	Quality assurance/quality control					
4	Outreach and education					
A	IWI Personnel		% FTE	Salary	Fringe (30%)	Total
1,2,3,4	Project Management		2.5	\$179,155	\$53,747	\$232,902
2,3,4	Web/IT infrastructure		Hourly	\$42,129		\$42,129
2,3,4	Secretarial/Admin Support		1.2	\$58,067	\$17,420	\$75,487
				\$279,351	\$71,167	\$350,518
1,2,3,4	Travel					\$5,000
	Equipment			# unit	Cost/unit	
2	Hardware/Software (Terrabyte server, software, archival, enclosure, etc)			6	\$10,000	\$60,000
2,3,4	Supplies/Other (Brochure, CDROM, Promo, workshop)					\$7,500
1,2,3,4	Consultant (Steering Committee)					\$22,174
					Direct Cost Subtotal	\$445,192
B	Subcontract			Salary	Fringe	Total
Ba	2	Web/IT Database Archival and Dissemination	2	\$80,000	\$24,000	\$114,000
	2	Travel				\$2,500
	2	Materials and Supplies				\$5,000
		F&A (45%)			Subtotal	\$121,500
						\$54,675
					Subtotal	\$176,175
Bb	1	Data collection (LIDAR/Digital Imagery)	Sq. Miles	Cost/sq. mile		
			39,400	\$100		3,940,000
Bc	3	Survey/Engineering - 3rd party QA/QC (NSSDA Spec)	Points	Cost/point		
			800	\$325	Subtotal	\$260,000
					Total Subcontracts	\$4,376,175
	Total Direct Costs					\$445,192
	IWI F & A (includes 34.34% of first 25,000 subcontracts)					\$178,634
	Total Project Costs					\$5,000,000

Table 2. Funding Formula.



Cost Allocation	Amount
Federal Government	\$2,500,000
North Dakota	\$600,000
Minnesota	\$600,000
North Dakota Local	\$550,000
Minnesota Local	
Red River Watershed Management Board	\$500,000
Buffalo Red Watershed District	\$50,000
Sub-Total	\$4,800,000
Major Cities along the Red River	
Fargo	\$88,118
Moorhead	\$31,296
Grand Forks	\$46,910
East Grand Forks	\$7,332
Wahpeton	\$8,351
Breckenridge	\$3,462
West Fargo	\$14,531
Sub-Total	\$200,000
Total	\$5,000,000

For More Information Contact:

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Telephone: (701) 231 - 9747/Fax: (701) 231- 5613

FREQUENTLY ASKED QUESTIONS

What is LIDAR?

LIDAR - Light Detection and Ranging integrates airborne laser and global position system (GPS) technologies. Laser pulses are directed at the earth's surface from equipment aboard aircraft flying a predetermined grid over an area of interest. The reflections are recorded and the range is calculated from the instrument's orientation in space and the time required for the reflected laser light to travel back to the aircraft.

Is the LIDAR data collection the only task for generating a DEM?

No. LIDAR data is processed in three stages:

- 1- Preprocessing
- 2- Computer surfacing
- 3- Manual editing

Final products are generated based on the objectives of the collect. Each of these stages has its own specific set of tasks and level of effort (cost) to complete.

How accurate is the information collected using LIDAR technologies?

Accuracy is directly related to the altitude of the aircraft and the power of the laser. Standard accuracies of most recent collects meet or exceed:

- Vertical
 - Bare earth: 15 cm (0.492 feet) Root Mean Square Error (RMSE)
 - Vegetation: 27 cm (0.886 feet) RMSE
- Horizontal
 - 1.0 m (3.28 feet) RMSE

All Red River Basin Mapping Initiative data will meet or exceed the US Federal Emergency Management Agency standards for flood plain mapping <http://www.fema.gov/plan/prevent/fhm/LIDAR_4b.shtm>.

How much data is collected?

The size of the data set is considerable and depends on the extent of the region being flown. As a general rule, one day of flying/data collection (using a 50 - 150 KHz laser) results in 150 – 200 million elevation points or roughly 1 gigabyte of LIDAR, GPS, and Inertial Measurement Units (IMU) data. We expect the Red River Basin Mapping Initiative data will consist of approximately 6 terabytes of data.

Are there proven hardware and software technologies to manage and disseminate these large-scale data sets?

Yes. There are numerous public and private examples of models to store and disseminate large amount of spatial data. Minnesota has developed the Minnesota Geographic Data Clearing House <<http://www.lmic.state.mn.us/chouse/index.html>> and the Data Deli <<http://deli.dnr.state.mn.us/>>. North Dakota has developed its own GIS Data Hub <<http://www.state.nd.us/gis/>>. Perhaps most notable is the USGS's Earth Observation and Science <<http://edc.usgs.gov/>> and North Carolina's web-based flood plain mapping center <http://www.ncfloodmaps.com/default_swf.asp> that was developed following a recently completed statewide LIDAR and DEM development project as a result of Hurricane Floyd. The Red River Basin Decision Information Network (RRBDIN) was developed to serve as a one-stop mapping and information system <<http://www.rrbdin.org>>. RRBDIN is currently housed at North Dakota State University and is a recognized basin-wide website established to disseminate GIS data in a decision support context.

Has high resolution elevation data been collected in other areas of the Red River Basin?

Yes, there have been a number of LIDAR collects in the U.S. portion of the Red River Basin <<http://www.rrbdin.org/data/LIDAR.jsp>>. To date, the largest single data collection effort in the RRB has occurred in Manitoba <<http://geoapp.gov.mb.ca/website/rrvfp/>>. The Energy and Environmental Research Center and the Natural Resources Conservation Service recently completed the Forest River Watershed in North Dakota (roughly 6,000 miles²). Efforts currently underway include portions of the Red River Valley in MN (Busing 2006) and an area in the Pembina River watershed along the US and Canada border (Yohe 2006).

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NEWS

THE NATIONAL ACADEMIES
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Date: Feb. 1, 2007

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FOR IMMEDIATE RELEASE

Flight-Based Laser Technology Should Be Used to Map U.S. Land Elevation And Improve Accuracy of FEMA Flood Maps

WASHINGTON -- New digital, high-resolution land elevation maps -- created using a proven remote-sensing laser technology -- are needed to support the Federal Emergency Management Agency's effort to modernize the nation's floodplain maps, says a new National Research Council report requested by Congress. The floodplain maps are used by mortgage companies and FEMA's National Flood Insurance Program to determine whether property owners should be required to purchase flood insurance.

FEMA has been partnering with state and local governments in a \$200 million-per-year modernization effort to replace paper floodplain maps with digital ones. FEMA sets accuracy requirements for the maps, but it is generally up to state and local governments to provide the data upon which the maps are based. Congress requested the report because of concerns that underlying base map information currently available for much of the nation is not adequate to support the new digital maps.

The committee that wrote the report focused on two layers of floodplain maps: base map imagery and base map elevation. It concluded that there is sufficient two-dimensional imagery available from digital "orthophotos" -- aerial and satellite photographs -- to meet FEMA's standards for mapping landmarks such as streams, roads, and buildings that show the context necessary for mapping flood hazard areas. The committee also endorsed a program known as Imagery for the Nation, a joint federal-state effort to keep orthophoto databases current.

However, there is inadequate elevation information available to map the shape of the land surface in three dimensions, which is critical in determining the likely direction, velocity, and depth of flood flows, the committee said. In fact, most of the publicly available elevation data is more than 35 years old, with 1970 being the average date of origin in the U.S. Geological Survey's National Elevation Dataset. Land development and urban expansion since then have significantly altered the surface. New road embankments and flood drainage structures also affect expected floodwater depths, as does land subsidence, which is particularly significant in coastal areas.

In addition, FEMA requires that elevation data in the new digital maps be about 10 times more accurate than most existing data in the National Elevation Dataset, which are used by many states and local communities partnering with FEMA to produce new flood maps. By last summer, digital floodplain maps had been prepared for about 1 million miles of the nation's 4.2 million miles of rivers and streams, but only 247,000 miles had been mapped using high-resolution elevation data.

The committee called for a new elevation mapping program, which it named Elevation for the Nation to parallel the existing Imagery for the Nation concept. The program should employ a technology known as light detection and ranging, or "lidar," to acquire elevation data. Lidar operates by projecting short laser pulses on

light from a low-flying aircraft and measuring the time it takes for the light to bounce back from the surface. Lidar is the only technology to produce elevation data that are accurate within one to two feet in most terrain including the bare-earth terrain beneath vegetation, and that meet FEMA's elevation accuracy requirements. The committee found a striking level of agreement among representatives of several federal agencies that lidar is the current technology of choice for measuring surface elevation.

Elevation for the Nation's first focus should remain on that part of the nation where flood risk to the population justifies collecting new data, the committee said. Existing local and regional data may be used if they are sufficiently accurate and complete, the report adds.

The committee emphasized that a seamless nationwide elevation dataset would have many applications beyond FEMA's flood insurance maps, although it acknowledged that the cost of creating such a dataset will be significant. Data collected in Elevation for the Nation should be disseminated to the public as part of an updated National Elevation Dataset.

The report was completed in a short time so that Congress could consider its findings and recommendations during the upcoming appropriations process. Meanwhile, FEMA has requested a separate, more comprehensive Research Council study of flood map accuracy, which is expected to take two years to complete.

The report was sponsored by the National Academies, which is made up of the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council. They are private, nonprofit institutions that provide science, technology, and health policy advice under a congressional charter. The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. A committee roster follows.

Copies of [Base Map Inputs for Floodplain Mapping](#) will be available from the National Academies Press; tel. 202-334-3313 or 1-800-624-6242 or on the Internet at <http://www.nap.edu>. Reporters may obtain a pre-publication copy from the Office of News and Public Information (contacts listed above).

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[This news release and report are available at <http://national-academies.org>]

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Study Director

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Red River Basin Mapping Initiative
Project Status
October, 2007

The Red River Basin Mapping Initiative is a \$5.0 million dollar project to collect and disseminate high resolution elevation data for the US portion of the Red River of the North Basin.

Anticipated project duration is 3 years.

'07 – '08 Activities:

- Steering Committee formed
- Draft Request for Proposals (RFP) prepared
 - Distributed to interested vendors in October '07
- Proposal review - December '07 – February '08
- Contract negotiation – March '08
- Contract letting – March '08 – April '08
- Anticipated start phase I data collection April '08
- Secure agreements with remaining funding partners.

Funding:

- ~ \$2.1 million secured
 - Cities \$185,469
 - ND State Water Commission - \$400,000
 - \$500,000 in federal agreements (FY 2007) have been executed:
 - USGS - \$150,000 (salaries and fringe) – no match required.
 - NRCS - \$350,000 data collection and QA/QC
 - \$25,000 ('07) MN Department of Transportation
 - ND Red River Joint Water Resources Board - \$473,000
 - Red River Watershed Management Board - \$500,000
 - Buffalo-Red Watershed District - \$50,000

Funding	Amount Requested	Status 9/2007	Source
Federal Government (NRCS, USGS)	\$2,500,000	\$300,000	ND Nat. Resources Conservation Service (NRCS)
		\$50,000	NRSC Soil Survey Department (National)
		\$150,000	US Geological Survey
		\$2,600,000	US Corps of Engineers (Dorgan) Watershed Feasibility
ND Local Partners	\$550,000	\$473,000	Red River Joint Water Resources Board*
		\$77,000	Remaining
MN Local Partners	\$550,000	\$500,000	Red River Watershed Management Board
		\$50,000	Buffalo-Red Watershed District
Cities	\$200,000	\$88,118	Fargo
		\$31,296	Moorhead
		\$46,910	Grand Forks
		\$7,331	East Grand Forks
		\$8,350	Wahpeton
		\$3,461	Breckenridge
		\$14,530	West Fargo (denied 6/07)
State of Minnesota	\$600,000	\$25,000	MN Dept. of Transportation
		\$600,000	MN 2008 Bonding Bill
State of North Dakota	\$600,000	\$400,000	Included in 2007 State Water Commission budget*
		\$200,000	2009 Legislative session
Total	\$5,000,000	\$2,133,468	

* Contingent upon evidence that all funding required for a basin wide, seamless project is in hand or formally committed by project sponsors

- Remaining (red)
 - State of Minnesota - \$600,000
 - Emphasis on the 2008 MN legislative session (winter '07/spring '08)
 - \$25,000 ('07) commitment from MN Department of transportation
 - Anticipate inclusion in the '08 bonding bill
 - ND 2009 Legislative session - \$200,000
 - ND Local ~\$90,000 (SE Cass Water Resource District, Cass County, Fargo)

FREQUENTLY ASKED QUESTIONS AND ANSWERS



International Water Institute
Flood research and watershed education for the Red River Basin

RED RIVER BASIN MAPPING INITIATIVE

ADMINISTRATIVE QUESTIONS

Question 1: What is the plan for collecting the high resolution topographic data?

Answer: An initial phased approach consisting of five data collection efforts over a period of two and one-half years (subsequent spring and fall collects) is planned and included in the Request for Proposal for consideration by potential contractors. The Request for Proposal includes an opportunity for the contractor to provide an alternative collection strategy if the contractor believes greater efficiency (and therefore cost savings) can be realized.

Question 2: Who will manage and be responsible for successfully completing the project?

Answer: The International Water Institute (IWI) is ultimately responsible for completing the project. The IWI has retained Houston Engineering, Inc. of Fargo, North Dakota to provide technical assistance through the completion of the project. The IWI has formed a Steering Committee comprised primarily of local government and state and federal agency funding partners to provide input and guidance to the project.

Question 3: How much is this project going to cost?

Answer: Funding requests to the various local, federal, and state governments were based on an initial planning-level estimated cost of \$5,000,000. This assumes one-half of the financial commitment is provided by the federal government and one-half by local and state government. The actual cost will be known upon completion of the Request for Proposal process and negotiations with the selected contractor. The IWI currently has financial commitments for \$2,133,466 of the total estimated cost.

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		\$25,000	MN Dept. of Transportation
State of Minnesota	\$600,000	\$600,000	MN 2008 Bonding Bill
		\$400,000	Included in 2007 State Water Commission budget*
State of North Dakota	\$600,000	\$200,000	2009 Legislative session
Total	\$5,000,000	\$2,133,466	

* Contingent upon evidence that all funding required for a basin wide, seamless project is in hand or formally committed by project sponsors

Question 4: Who are some of the financial sponsors for this project?

Answer: See previous table. The Earth Resources Observation and Science (EROS) data center of the U.S. Geological Survey has recently agreed to host and disseminate the information.

Question 5: What is the role of the U.S. Army Corps of Engineers?

Answer: The federal portion of the cost share has been placed in the U.S. Army Corps of Engineers (COE) 2008 budget by Senator Dorgan. The COE has made it clear their authority will only allow access to these funds through



a watershed feasibility study. The COE has further indicated the Red River Basin Mapping Initiative is a data collection effort. Data collection efforts alone are not allowed under the COE watershed feasibility authorization; however they can be undertaken as part of a broader watershed feasibility study. Therefore, the COE process will require additional non-federal match and agreements with local sponsors to participate a watershed feasibility study (the IWI does not qualify as a local sponsor). The IWI remains hopeful that these funds will be made available to the Red River Basin Mapping Initiative project and will continue to work with federal partners to secure the necessary federal funding to complete the project.

Question 6: How long will it take to collect and process the high resolution topographic data? When will the high resolution topographic data be available to the public?

Answer: Current plans are to complete the collection over two and one-half years. The contractor is obligated to provide the data to the IWI once they believe the data meet the specifications identified by the Request for Proposal. The IWI has established a quality assurance process to review the data prior to formal acceptance from the contractor. Once the quality assurance process is complete, the data will be available for public distribution. Data from the first collection area is expected to be available for distribution to the public by the fall of 2008.

Question 7: Who will store the data and how will it be distributed to the public?

Answer: The Earth Resources Observation and Science (EROS) data center of the US Geological Survey has recently agreed to provide services for hosting and disseminating the data through the Center for LIDAR Information and Coordination and Knowledge (CLICK) - see <http://lidar.cr.usgs.gov/> website. EROS is currently providing these same services for a number of other large digital elevation collection projects such as that States of North Carolina, Iowa, Pennsylvania and Ohio. The IWI feels it is important to continue this approach for disseminating the information, consistent with the rest of the collection efforts within the US. If any individual organization wants the entire dataset, the IWI can provide the data on portable hard drives that can be mailed to organizations that want to transfer and archive the data internally.

Question 8: Will there be an annual cost for housing and maintaining the data?

Answer: Hosting and distributing the high resolution topographic data is consistent with the mission of the US Geological Survey. The Earth Resources Observation and Science (EROS) data center of the U.S. Geological Survey does not anticipate an annual fee, provided current funding levels at the federal level remain consistent into the future.

Question 9: Does the IWI have plans to provide updated high resolution topographic collects in the future after the entire Red River Basin has been initially collected?

Answer: No, currently there are no plans to provide future high resolution collections.

Question 10: Will there be a charge for the data?

Answer: No.

Question 11: What technology can be used to complete the collection of the high resolution topographic data?

Answer: The Request for Proposal does not require a specific technology – any technology capable of delivering the desired products that attain the vertical and horizontal accuracy specifications identified within the Request for Proposal can be used.

Question 12: What will happen if there is a funding shortage preventing the collection of data for the entire Red River Basin?

Answer: The IWI has specifically developed a phased data collection strategy to address the issue of uncertain complete funding. The IWI prioritized the collection areas based on several criteria including the wished of the local partners. The Request for Proposal process requests contractors to provided costs for each collection area and the complete collection area. The intent is to reasonably ensure that a collection area can be wholly completed based upon the available funding, before proceeding to the next collection area. The IWI will not enter into a contract with a vendor until there is sufficient funding to complete an entire collection area.

Question 13 (ND State Water Commission): Will there be a performance bond (surety bond) required of the vendor?

Answer: Perhaps. The IWI believes exposure to the risk that a contractor is unable to complete the project will be addressed by ensuring that payment occurs only following the receipt and acceptance of specific deliverables. However, a quote for a performance bond is included in the RFP. A decision on this proposed requirement will be addressed during a contract negotiation phase of the project.

Question 14 (ND State Water Commission): Why are all the funding partners not listed as additional insured in the insurance requirements?

Answer: The RFP will note that additional partners may be required to be listed as additionally insured. The Institute will discuss this issue with the selected contractor. Insuring companies are usually reluctant to name multiple insured entities. The Institute believes that the financial risk to the partners can be minimized through properly worded agreements with the partners; however, if a particular partner wishes, the Institute will ensure insurance needs and liability of the concerned project partner is covered prior to letting a contract.

TECHNICAL QUESTIONS

Question 15: What products will be available to the general public and data users?

Answer: The IWI has developed the Request for Proposal in a manner intended to maximize the number of deliverables based upon the financial resources available. The Request for Proposal identifies both mandatory and optional deliverables and requests costs for both deliverable categories. Deliverable specifications are 15 centimeter vertical RMSE and 1 meter horizontal RMSE. Mandatory deliverables that are required from the contractor include:

- All raw classified data (LAS version 1.1);
- Filtered bare-earth data (LAS version 1.1);
- Bare-earth digital elevation model (ArcInfo GRID format, 1 meter cell size);
- A project completion report; and
- Metadata for the data.

The Contractor is also requested to provide costs for the following optional deliverables:

- Stand alone open water only breakline files and bare earth DEM created with open water breaklines
- Imagery.

Question 16: Will imagery be collected?

Answer: The Request for Proposal is structured in a manner to obtain information about the cost of imagery as an optional deliverable. A final decision regarding an imagery deliverable will be made after bids from the contractors are received. Imagery can be valuable in interpreting data anomalies. The IWI believes that the recent imagery collected through the National Agriculture Imagery Program (NAIP) can be used for this purpose, as topographic features within most areas of the Red River Basin are relatively unchanged in recent years. The IWI understands that some contractors may use Light Detection and Ranging (LIDAR) technology to obtain the high resolution topographic data during nighttime flights; therefore, imagery would not be collected and may (or may not be) an option to consider.

Question 17: What are breaklines and why are you requesting these as an optional deliverable?

Answer: Breaklines essentially represent an edge or boundary of some physical feature (e.g., a road or water body). The IWI is requesting open water breaklines, which represent the open water boundary, as an optional deliverable. These breaklines are useful in using the high resolution topographic data when completing hydrologic studies and investigations. Breaklines also help depict a continuous water surface elevation in derived elevation products.

Question 18: What is the anticipated horizontal coordinate system for the high resolution topographic data?

Answer: Most of the Red River Basin (with the exception of the far eastern 1/5 of the Red River Basin) is located within Universal Traverse Meridian (UTM) Zone 14. The data are being requested in UTM Zone 14, North American Datum of 1983 (NAD83). The Request for Proposal provides an option for the IWI to obtain the data



using the NSR2007 datum. The NSR2007 datum adjustment has been made in North Dakota and is being made in Minnesota. The adjustment is nationwide and varies slightly by state. The adjustment amounts to a horizontal shift of up to 0.05 feet in North Dakota and up to 0.1 feet in Minnesota. Final decision of the datum will be made prior to contract negotiation and letting.

Question 19: What method will be used to subdivide the collection area into manageable portions that can be distributed to the general public?

Answer: Plans are for the contractor to deliver the data as quarter-quadrangles, which is consistent with the experience of the State of Minnesota and the U.S. Geological Survey. The IWI believes file sizes will be manageable using a quarter-quadrangle tiling system. The IWI feels it is important to keep the tiling scheme consistent with other large LIDAR collection efforts. The CLICK website (<http://lidar.cr.usgs.gov/>) allows downloading of the high resolution topographic data by multiple organizational methods. The CLICK dissemination portal also handles temporal data collections for the overlapping geographic areas.

Question 20: What standards are being used for the planned collection and products?

Answer: The performance standards are the Federal Emergency Management Agency's (FEMA) "Guidelines and Specifications for Flood hazard Mapping Partners, Appendix A" and "Guidance for Aerial Mapping and Surveying." At a minimum, all digital elevation data delivered shall meet a 15-centimeter root mean square error (RSME) with 1-meter horizontal RSME posting.

Question 21: Who will check the data to make sure that it is "good"? How will this checking be done?

Answer: The IWI has established a quality assurance process (described within the Request for Proposals as an informational item for the bidders) to review the high resolution topographic data prior to formal acceptance from the contractor. This process is consistent with the process specified by the Federal Emergency Management Agency. The process consists of **independently** collecting survey grade topographic check points (generally using a GPS instrument) within various land uses spatially representative of the collection area. These known elevations by land use category are then compared to the elevations provided by the contractor. The root mean square error is computed to determine compliance with the performance specifications. The IWI has tentatively identified the number of points that will be checked. Expectations are that the points within each collection area will be distributed according to the size and the proportion of the various land uses within each collection area.

Question 22: What will the data look like and what are some of the uses?

Answer: Uses of the data are many and of value to a broad range of potential users. Some of these uses include environmental planning, water resource investigations, the classification of soils, precision agriculture, urban planning, and preliminary engineering and design. Examples of many of the products can be found at <http://lidar.cr.usgs.gov/>. The Minnesota DNR has also provided example of the LIDAR products on their FTP site at ftp://ftp.dnr.state.mn.us/pub/mis/lidar_data_products. They have processed the deliverables into a few additional derived products such as contours and an ESRI terrain model.

Question 23 (ND State Water Commission): Given the collection strategy includes 5 separate collection efforts, how will the final DEM product be seamless?

Answer: Existing collection methods and capacity make it logistically impossible for a vendor to collect the entire US portion of the Red River Basin in one collection season. Therefore the project must be phased. The standardized specifications of the deliverables (LAS files) will allow the data collection efforts to be easily stitched together into a seamless DEM product for the end user.

Question 24 (ND State Water Commission): Given there are already LiDAR generated data in the Devils Lake Basin, why does the RRBMI proposed to re-collect this region?

Answer: The Devils Lake Region LiDAR data was collected in 1999 – 2000. Existing metadata for these data indicate they "should have" 30 centimeter vertical RMSE and 2.4 meter horizontal RMSE. There are known problems with this dataset and there is no evidence of any validation report (I.e. quality assurance report). Based on the recommendation of the Steering Committee, areas of the Red River Basin that have elevation data of equal or greater resolution and are of known quality may be omitted from the collection area or re-flown but not processed (I.e. MN Wild Ricer Watershed). Areas with lesser resolution or questionable quality will be re-flown.