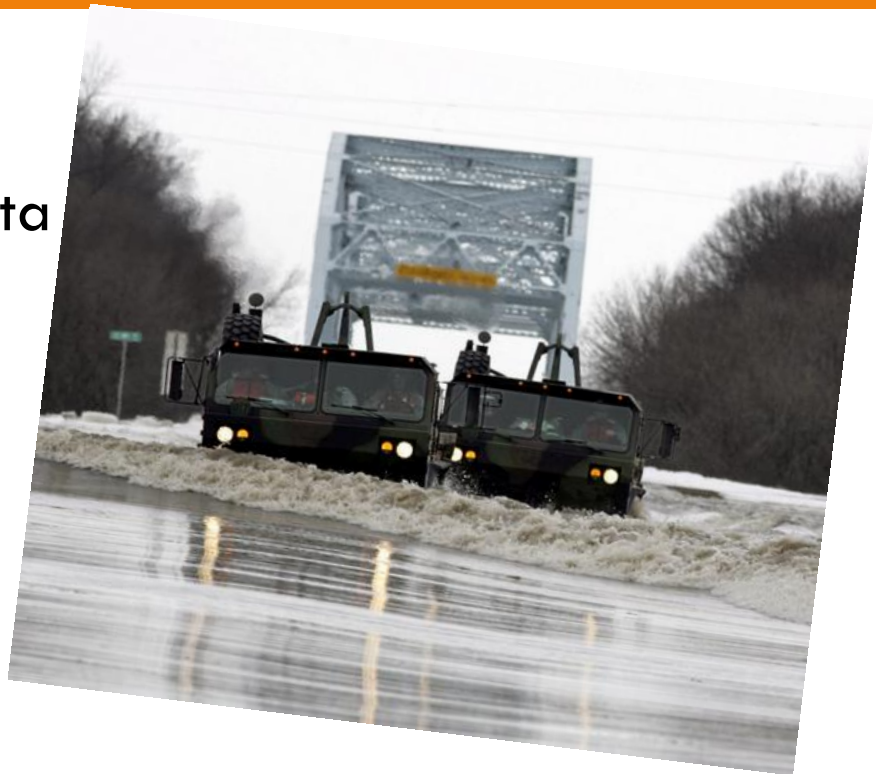
# FINDING LONG TERM FLOOD SOLUTIONS TOGETHER FOR THE RED RIVER BASIN OF THE NORTH

RED RIVER BASIN COMMISSION 2009-2011

# Impetus for LTFS Project

- Spring 2009 basin wide flood
- State legislative charge North Dakota & Minnesota
- "Comprehensive plan of action" to address, mitigate, and respond to flooding and related water quality and land conservation issues
- Funding and report
  - $500,000 each – ND & MN



# LTFS Report Process

- RRBC Board of Directors
  - Oversight Committee
  - Advisory Committee
    - Technical Subcommittee
    - Policy Subcommittee
    - Economic Subcommittee
    - Impediments Subcommittee
- The public: flood forums, surveys

# Assumptions

- **Agriculture** will continue to be the dominant land use throughout the basin. Adequate surface drainage has been and will continue to be integral to maintaining productivity of cropland. Sub-surface drainage is likely to become increasingly popular.
- **Current development and infrastructure** trends will continue into the foreseeable future. The major urban centers and communities will continue in their present locations. The major metropolitan areas will continue to grow. Future development will occur in compliance with floodplain management regulations.
- **Floods** will continue into the future. Floods larger than historically experienced can be expected to occur.
- **Flood damage reduction** will need to be implemented in the basin based primarily on the identified needs of the basin residents and their willingness to provide or seek the funding necessary to implement the measures which they believe are appropriate, effective, and justified. State and federal agencies will facilitate the implementation of the various measures based on their policies, regulations and availability of funding.
- Flood damage reduction is just one issue that affects the sustainability of the region. **Other key resource issues need to be considered** as this plan is developed and implemented, including droughts, water supply, water quality, and other natural resource areas.

# Level of Protection Goals

***Level of Flood Protection Goals for the Red River Basin***

| Area Protected | Estimated Recurrence Interval |
|---|---|
| Major urban/metropolitan areas (1) (2) (4) | 500 year or greater |
| Critical infrastructure (1) (2) | 500 year or greater |
| Cities/municipalities (1) (2) | 200 year or greater |
| Rural residences & farmsteads (1) (2) | 100 year or greater |
| Agricultural cropland: Summer flood | 10 year or greater |
| Transportation (2) (3) Critical transportation system and emergency service links | 200 year or greater |

Notes

(1) Protection for urban areas, critical infrastructure, cities, rural residences, and farmsteads should all have appropriate freeboard (i.e., contingency or risk and uncertainty allowance) with any projects designed to provide the specified level of protection.

(2) If a flood of record has occurred which exceeds the specified level of protection goal, the flood of record should be used in place of the specified level of protection goal.

(3) The critical transportation systems should be maintained passable during a flood of the described level of protection to assure safe and reliable transportation and provision of emergency services. The transportation system should not increase flooding problems either upstream or downstream.

(4) Includes Fargo-Moorhead, Grand Forks-East Grand Forks, and Winnipeg.

# Level of Protection Goals

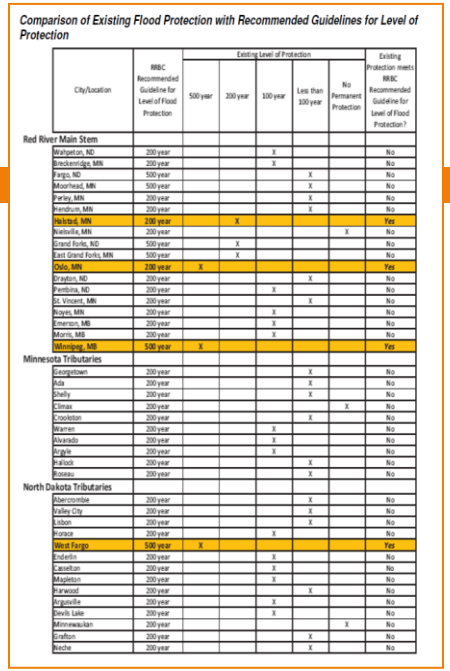
Comparison of Existing Flood Protection with Recommended Guidelines for Level of Protection for all cities on Red & Tribs.

**The following cities meet the recommended guidelines for Levels of Protection:**

Halstad, MN – 200 year
Oslo, MN – 200 year
Winnipeg, MB – 500 year
West Fargo, ND – 500 year

**Communities with less than 100 year protection:**

Fargo, ND
Moorhead, ND
Perley, ND
Hendrum, MN
Drayton, ND
St. Vincent, MN
Georgetown, MN
Ada, MN
Shelly, MN
Crookston, MN
Hallock, MN
Roseau, MN
Abercrombie, ND
Valley City, ND
Lisbon, ND
Harwood, ND
Grafton, ND
Neche, ND



*Comparison of Existing Flood Protection with Recommended Guidelines for Level of Protection*

| City/Location | RRBC Recommended Guideline for Level of Flood Protection | Existing Level of Protection: 500 year | 200 year | 100 year | Less than 100 year | No Permanent Protection | Existing Protection meets RRBC Recommended Guideline for Level of Flood Protection? |
|---|---|---|---|---|---|---|---|
| **Red River Main Stem** | | | | | | | |
| Wahpeton, ND | 200 year | | | X | | | No |
| Breckenridge, MN | 200 year | | | X | | | No |
| Fargo, ND | 500 year | | | | X | | No |
| Moorhead, MN | 500 year | | | | X | | No |
| Perley, MN | 200 year | | | | X | | No |
| Hendrum, MN | 200 year | | | | X | | No |
| **Halstad, MN** | **200 year** | | **X** | | | | **Yes** |
| Nielsville, MN | 200 year | | | | | X | No |
| Grand Forks, ND | 500 year | | X | | | | No |
| East Grand Forks, MN | 500 year | | X | | | | No |
| **Oslo, MN** | **200 year** | **X** | | | | | **Yes** |
| Drayton, ND | 200 year | | | | X | | No |
| Pembina, ND | 200 year | | | X | | | No |
| St. Vincent, MN | 200 year | | | | X | | No |
| Noyes, MN | 200 year | | | X | | | No |
| Emerson, MB | 200 year | | | X | | | No |
| Morris, MB | 200 year | | | X | | | No |
| **Winnipeg, MB** | **500 year** | **X** | | | | | **Yes** |
| **Minnesota Tributaries** | | | | | | | |
| Georgetown | 200 year | | | | X | | No |
| Ada | 200 year | | | | X | | No |
| Shelly | 200 year | | | | X | | No |
| Climax | 200 year | | | | | X | No |
| Crookston | 200 year | | | | X | | No |
| Warren | 200 year | | | X | | | No |
| Alvarado | 200 year | | | X | | | No |
| Argyle | 200 year | | | X | | | No |
| Hallock | 200 year | | | | X | | No |
| Roseau | 200 year | | | | X | | No |
| **North Dakota Tributaries** | | | | | | | |
| Abercrombie | 200 year | | | | X | | No |
| Valley City | 200 year | | | | X | | No |
| Lisbon | 200 year | | | | X | | No |
| Horace | 200 year | | | X | | | No |
| **West Fargo** | **500 year** | **X** | | | | | **Yes** |
| Enderlin | 200 year | | | X | | | No |
| Casselton | 200 year | | | X | | | No |
| Mapleton | 200 year | | | X | | | No |
| Harwood | 200 year | | | | X | | No |
| Arguseille | 200 year | | | X | | | No |
| Devils Lake | 200 year | | | X | | | No |
| Minnewaukan | 200 year | | | | | X | No |
| Grafton | 200 year | | | | X | | No |
| Neche | 200 year | | | | X | | No |

# REPORT

**End product/deliverables:**

- ✓ Two reports:
  - ✓ Comprehensive
  - ✓ Legislative
- ✓ Recommendations to policy makers
- ✓ Tools for water managers, local governments, state & federal agencies

# REPORT

**Part 1 Background**

Chapter 1: Crisis of Red River Basin Flooding

Chapter 2: Past Responses & Challenges

Chapter 3: Long Term Flood Solutions Study

# REPORT

## Part 2 Carrying Out the Charge

Chapter 4: Costs of Basin Flooding

Chapter 5: Building Foundations

Chapter 6: Long Term Flood Solutions Study

# REPORT

## Part 3 Long-Term Strategies for Flood Protection

Chapter 7: Floodplain Management

Chapter 8: Local Flood Protection

Chapter 9: Flow Reduction

Recommendations

# DATA-Technical Appendices

**Identifying the unknown**

- Maps
- Peak flow data
- Updated runoff models
- Difference in flood levels
- Economic/flood damage data
- Existing storage in the basin
- Effects of planned upstream storage
- Levels of protection
- Current or pending flood projects
- 20% flow reduction
- Community unmet needs

RED RIVER BASIN COMMISSION

# Mainstem Flow Reductions

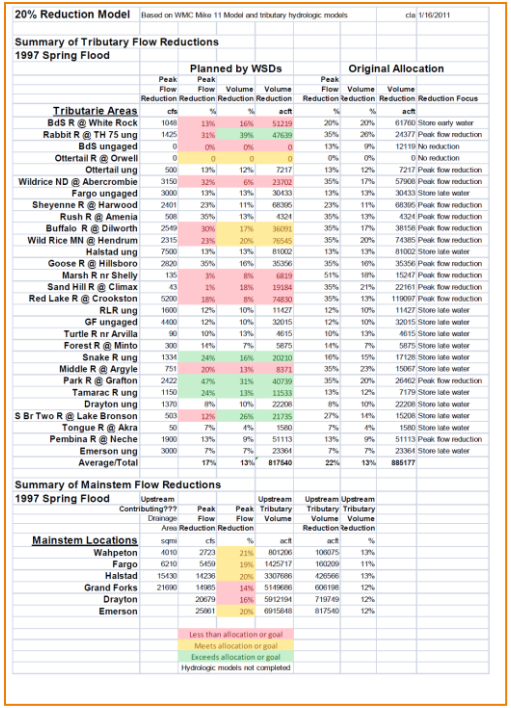
20% Flow Reductions for the Red River Basin at the International Boundary

Are there enough locations to achieve this?

Based on the modeling from the specific tributary areas:
Total Volume Reduction: 885,177 acre feet

Effects of flow reductions at mainstem locations (peak flow reduction %):

| | |
|---|---|
| Wahpeton | 21% |
| Fargo | 19% |
| Halstad | 20% |
| Grand Forks | 14% |
| Drayton | 16% |
| Emerson | 20% |



**20% Reduction Model** Based on WMC Mike 11 Model and tributary hydrologic models cla 1/16/2011

**Summary of Tributary Flow Reductions**
**1997 Spring Flood**

| | Planned by WSDs | | | | Original Allocation | | | |
|---|---|---|---|---|---|---|---|---|
| | Peak Flow Reduction | Peak Flow Reduction | Volume Reduction | Volume Reduction | Peak Flow Reduction | Volume Reduction | Volume Reduction | Reduction Focus |
| Tributarie Areas | cfs | % | % | acft | % | % | acft | |
| BdS R @ White Rock | 1048 | 13% | 16% | 53239 | 20% | 20% | 61760 | Store early water |
| Rabbit R @ TH 75 ung | 1425 | 31% | 39% | 47639 | 35% | 26% | 24377 | Peak flow reduction |
| BdS ungaged | 0 | 0% | 0% | 0 | 13% | 9% | 12119 | No reduction |
| Ottertail R @ Orwell | 0 | 0 | 0 | 0 | 0% | 0% | 0 | No reduction |
| Ottertail ung | 500 | 13% | 12% | 7217 | 13% | 12% | 7217 | Peak flow reduction |
| Wildrice ND @ Abercrombie | 3150 | 32% | 6% | 23702 | 35% | 17% | 57908 | Peak flow reduction |
| Fargo ungaged | 3000 | 13% | 13% | 30433 | 13% | 13% | 30433 | Store late water |
| Sheyenne R @ Harwood | 2401 | 23% | 11% | 68395 | 23% | 11% | 68395 | Peak flow reduction |
| Rush R @ Amenia | 508 | 35% | 13% | 4324 | 35% | 13% | 4324 | Peak flow reduction |
| Buffalo R @ Dilworth | 2549 | 30% | 17% | 36091 | 35% | 17% | 38158 | Peak flow reduction |
| Wild Rice MN @ Hendrum | 2315 | 23% | 20% | 76545 | 35% | 20% | 74385 | Peak flow reduction |
| Halstad ung | 7500 | 13% | 13% | 81002 | 13% | 13% | 81002 | Store late water |
| Goose R @ Hillsboro | 2820 | 35% | 16% | 35356 | 35% | 16% | 35356 | Peak flow reduction |
| Marsh R nr Shelly | 135 | 3% | 8% | 6819 | 51% | 18% | 15247 | Peak flow reduction |
| Sand Hill R @ Climax | 43 | 1% | 18% | 19184 | 35% | 21% | 22161 | Peak flow reduction |
| Red Lake R @ Crookston | 5200 | 18% | 8% | 74830 | 35% | 13% | 119097 | Peak flow reduction |
| RLR ung | 1600 | 12% | 10% | 11427 | 12% | 10% | 11427 | Store late water |
| GF ungaged | 4400 | 12% | 10% | 32015 | 12% | 10% | 32015 | Store late water |
| Turtle R nr Arvilla | 90 | 10% | 13% | 4615 | 10% | 13% | 4615 | Store late water |
| Forest R @ Minto | 300 | 14% | 7% | 5875 | 14% | 7% | 5875 | Store late water |
| Snake R ung | 1334 | 24% | 16% | 20210 | 16% | 15% | 17126 | Store late water |
| Middle R @ Argyle | 751 | 20% | 13% | 8371 | 35% | 23% | 15067 | Store late water |
| Park R @ Grafton | 2422 | 47% | 31% | 40739 | 35% | 20% | 26462 | Peak flow reduction |
| Tamarac R ung | 1150 | 24% | 13% | 11533 | 13% | 12% | 7179 | Store late water |
| Drayton ung | 1370 | 8% | 10% | 22208 | 8% | 10% | 22208 | Store late water |
| S Br Two R @ Lake Bronson | 503 | 12% | 26% | 21735 | 27% | 14% | 15208 | Store late water |
| Tongue R @ Akra | 50 | 7% | 4% | 1580 | 7% | 4% | 1580 | Store late water |
| Pembina R @ Neche | 1900 | 13% | 9% | 51113 | 13% | 9% | 51113 | Peak flow reduction |
| Emerson ung | 3000 | 7% | 7% | 23364 | 7% | 7% | 23364 | Store late water |
| Average/Total | | 17% | 13% | 817540 | 22% | 13% | 885177 | |

**Summary of Mainstem Flow Reductions**
**1997 Spring Flood**

| | Upstream Contributing??? Drainage Area | Peak Flow | Peak Flow Reduction | Upstream Tributary Volume | Upstream Tributary Volume Reduction | Upstream Tributary Volume Reduction |
|---|---|---|---|---|---|---|
| Mainstem Locations | sqmi | cfs | % | acft | acft | % |
| Wahpeton | 4010 | 2723 | 21% | 801266 | 106075 | 13% |
| Fargo | 6210 | 5459 | 19% | 1425717 | 160209 | 11% |
| Halstad | 15430 | 14236 | 20% | 3307686 | 426566 | 13% |
| Grand Forks | 21690 | 14985 | 14% | 5149686 | 606198 | 12% |
| Drayton | | 20679 | 16% | 5912194 | 719749 | 12% |
| Emerson | | 25861 | 20% | 6915648 | 817540 | 12% |

Less than allocation or goal
Meets allocation or goal
Exceeds allocation or goal
Hydrologic models not completed

# Bois de Sioux Flow Reductions

20% Flow Reductions for the Bois de Sioux Watershed.

Identifies total acre/ft needed to achieve 20% flow reductions.

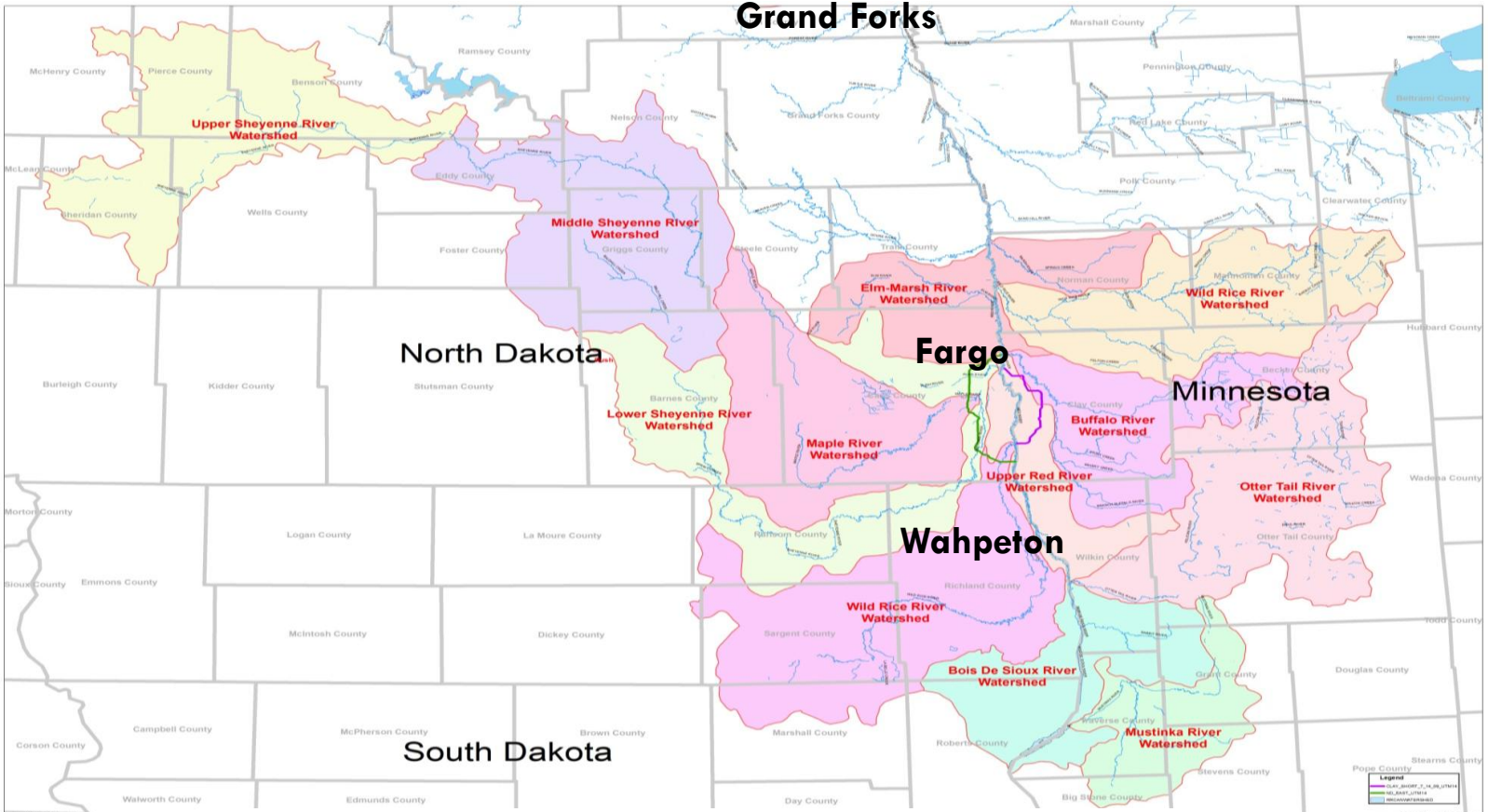
Total Acre/Ft of Storage in the Bois de Sioux Watershed District:
Gated Storage: 100,753 (ac ft)
Ungated Storage: 24,062 (ac ft)
Total Storage: 124,815 (ac ft)

Needed to meet 20% flow reduction goal: 98,256

**Impoundment sites included in Flow Reduction Strategy**
**Bois de Sioux Watershed District**
**4/19/2009**

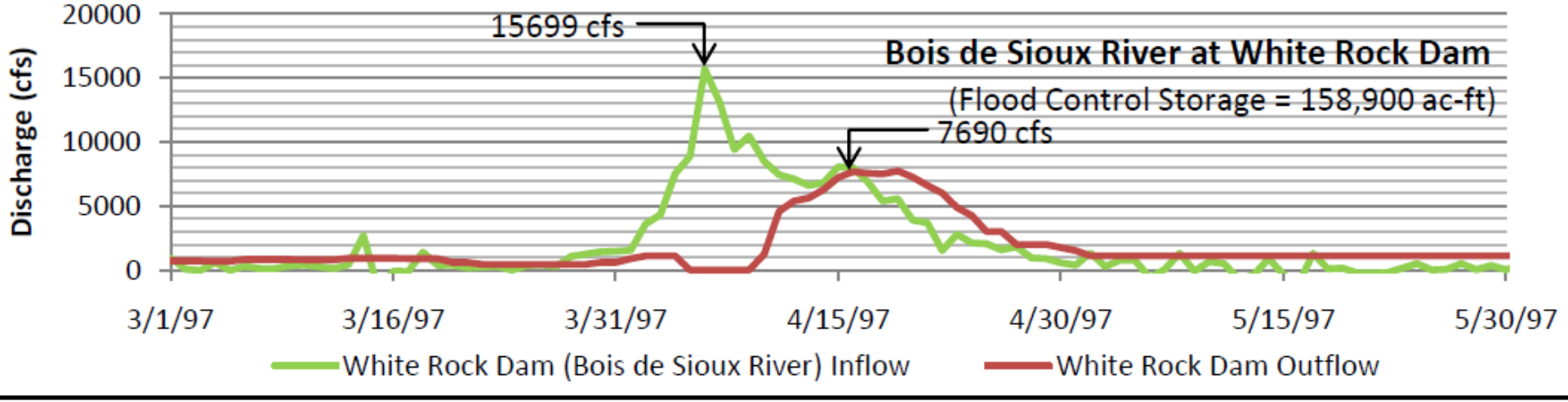
| | Gated Storage (ac-ft) | Un-Gated Storage (ac-ft) | Total Storage (ac-ft) | RRBC 20% plan Reduction (ac-ft) |
|---|---|---|---|---|
| **White Rock watershed** | | | | |
| Red Path | 13100 | 3100 | 16200 | |
| Red Path West | 5501 | 545 | 6046 | |
| Eldorodo 7 | 1700 | 755 | 2455 | |
| Big | 463 | 1325 | 1788 | |
| | 2723 | 686 | 3409 | |
| Moonshine 13 | 1520 | 328 | 1848 | |
| Moonshine 4 | 885 | 322 | 1207 | |
| Leonardsville 31E | 1046 | 413 | 1459 | |
| Dollymount 30 | 5484 | 872 | 6356 | |
| Leonardsville 31W | 1592 | 350 | 1942 | |
| 12 | 3071 | 843 | 3914 | |
| Leonardsville 12 | 6630 | 1031 | 7661 | |
| Croke 17 | 2142 | 605 | 2747 | |
| Dollymount 24 | 1499 | 552 | 2051 | |
| Walls 36 | 1897 | 850 | 2747 | |
| Moose Head | 1622 | 896 | 2518 | |
| Walls 30 | 3831 | 937 | 4768 | |
| 17 | 1695 | 518 | 2213 | |
| | 1965 | 890 | 2855 | |
| Township | 3802 | 950 | 4752 | |
| Subtotal | **62168** | **16768** | **78936** | **61760** |
| **Rabbit watershed** | | | | |
| | 16160 | 2050 | 18210 | |
| Brandrup S23 | 3020 | 980 | 4000 | |
| S34 | 3042 | 627 | 3669 | |
| S19 | 5892 | 1061 | 6953 | |
| Tintah S34 | 833 | 160 | 993 | |
| Daniels | 867 | 223 | 1090 | |
| Subtotal | **29814** | **5101** | **34915** | **24377** |
| **Bois de Sioux Ungaged** | | | | |
| | | | | |
| Subtotal | 0 | 0 | 0 | **12119** |
| **Total BdSWD** | **91982** | **21869** | **113851** | **98256** |

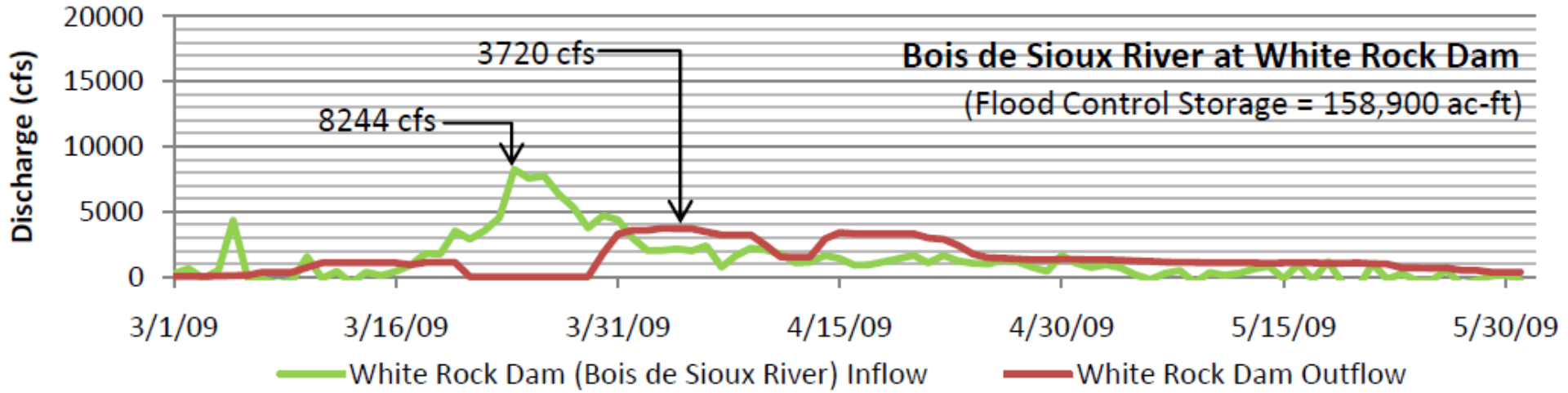
# New Hydrologic Model Development (HMS)



## Uncertainty of Storage

## Discharges Along the RR of the North at White Rock Dam –1997 (lower)/ 2009 (top)



# Subwatershed Retention

**Effects of Proposed Flood Storage on 1997 Flood on the Red River Main Stem and Tributaries**

| Upstream/Tributary Drainage Areas | Total Volume of 1997 Flood (Mike 11 Model) | Peak Flow of 1997 Flood (Mike 11 Model) | Proposed Storage in Watershed | Modified Peak Flow with Proposed Storage | Peak Flow Reduction of Proposed Storage | **Peak Flow Reduction of Proposed Storage** | Approx. Peak Stage Reduction of Proposed Storage |
|---|---|---|---|---|---|---|---|
| | ac-ft | cfs | ac-ft | cfs | cfs | % | ft |
| Bois de Sioux @ White Rock Dam | | 7,820 | 78,900 | 6,780 | 1,050 | 13% | |
| Rabbit River @ TH 75 ungaged | | 4,570 | 34,900 | 3,140 | 1,430 | 31% | |
| Bois de Sioux ungaged | | 8,540 | *0* | 8,540 | 0 | 0% | |
| Otter Tail River @ Orwell Dam | | 1,500 | *0* | 1,500 | 0 | 0% | |
| Otter Tail River ungaged | | 3,800 | *11,000* | 3,300 | 500 | 13% | |
| **Wahpeton/Breckridge** | **742,000** | **12,890** | **124,800** | **10,170** | **2,720** | **21%** | **2.4** |
| Wild Rice River @ Abercrombie | | 9,930 | 75,500 | 6,780 | 3,150 | 32% | |
| Fargo ungaged | | 23,000 | *42,000* | 20,000 | 3,000 | 13% | |
| **Fargo/Moorhead** | **1,450,000** | **28,570** | **242,300** | **23,110** | **5,460** | **19%** | **2.3** |
| Sheyenne River @ Harwood | | 10,300 | *120,000* | 7,900 | 2,400 | 23% | |
| Rush River @ Amenia | | 1,450 | 14,900 | 940 | 510 | 35% | |
| Buffalo River @ Dilworth | | 8,370 | 63,000 | 5,820 | 2,550 | 30% | |
| Wild Rice River @ Hendrum | | 10,150 | *118,000* | 7,840 | 2,310 | 23% | |
| Halstad Ungaged (includes Elm River) | | 57,000 | *142,000* | 49,500 | 7,500 | 13% | |
| **Halstad** | **3,310,000** | **71,390** | **700,200** | **57,160** | **14,200** | **20%** | **1.7** |
| Goose River @ Hillsboro | | 8,060 | *62,000* | 5,240 | 2,820 | 35% | |
| Marsh River near Shelly | | 4,070 | *0* | 3,930 | 140 | 3% | |
| Sand Hill River @ Climax | | 4,370 | *39,000* | 4,320 | 50 | 1% | |
| Red Lake River @ Crookston | | 28,980 | 270,000 | 23,780 | 9,400 | 32% | |
| Red Lake River ungaged | | 13,600 | *20,000* | 12,000 | 1,600 | 12% | |
| Grand Forks ungaged | | 36,400 | 56,000 | 32,000 | 4,400 | 12% | |
| **Grand Forks/East Grand Forks** | **5,130,000** | **110,750** | **1,147,200** | **95,770** | **19,000** | **17%** | **2.8** |
| Turtle River near Arvilla | | 930 | 11,500 | 840 | 90 | 10% | |
| Forest River @ Minto | | 2,100 | *10,000* | 1,800 | 300 | 14% | |
| Snake River ungaged | | 5,510 | *30,000* | 4,180 | 1,330 | 24% | |
| Middle River @ Argyle | | 3,710 | *26,000* | 2,960 | 750 | 20% | |
| Park River @ Grafton | | 5,110 | 50,300 | 2,690 | 2,420 | 47% | |
| Tamarac River ungaged | | 4,820 | *13,000* | 3,670 | 1,150 | 24% | |
| Drayton ungaged | | 17,170 | 39,000 | 15,800 | 1,370 | 8% | |
| **Drayton** | **5,820,000** | **128,320** | **1,327,000** | **107,640** | **26,000** | **20%** | **1.7** |
| South Branch Two Rivers @ Lake Bronson | | 4,060 | *27,000* | 3,560 | 500 | 12% | |
| Tongue River @ Akra | | 680 | *3,000* | 630 | 50 | 7% | |
| Pembina River @ Neche | | 14,300 | *90,000* | 12,400 | 1,900 | 13% | |
| Emerson ungaged | | 42,000 | *41,000* | 39,000 | 3,000 | 7% | |
| **Emerson** | **6,740,000** | **129,800** | **1,488,000** | **103,940** | **31,000** | **24%** | **1.3** |

Indicates that Flow Reduction Goals were exceeded

Indicates that Flow Reduction Goals were met

Indicates that Flow Reduction Goals were not met

How can retention change our floods?

Reduction in flows

20 percent

Approximate Peak Stage Reduction of Proposed Storage from the 1997 flood 6 Points on the Mainstem:

1. Wahpeton/Breckenridge 21% (2.4 ft.)
1. Fargo/Moorhead 19% (2.3 ft.)
2. Halstad 20% (1.7 ft.)
3. Grand Forks/East Grand Forks 17% (2.8 ft.)
4. Drayton 20% (1.7 ft.)
5. Emerson 24% (1.3 ft.)

What does this mean for Fargo/Moorhead?

Need 12.4 feet

# Levels of Protection

Based on the RRBC Recommended Levels of Protection, how do selected cities along the Red River stack up?

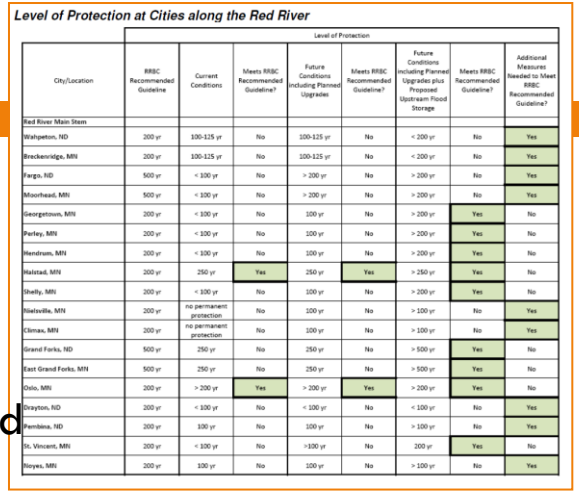
ON RED RIVER

First Green: Meet RRBC Recommended Guidelines Under Current Conditions. (Halstad/Oslo)

Second Green: Meet RRBC Recommended Guidelines with Current Planned Upgrades. (Same)

Third Green: Meet RRBC Recommended Guidelines with Current Planned Upgrades & Upstream Storage (20%). (9)

Fourth Green: 9 still need additional measures (W-B, F-M, Nielsville, Climax, Drayton, Pembina, Noyes)

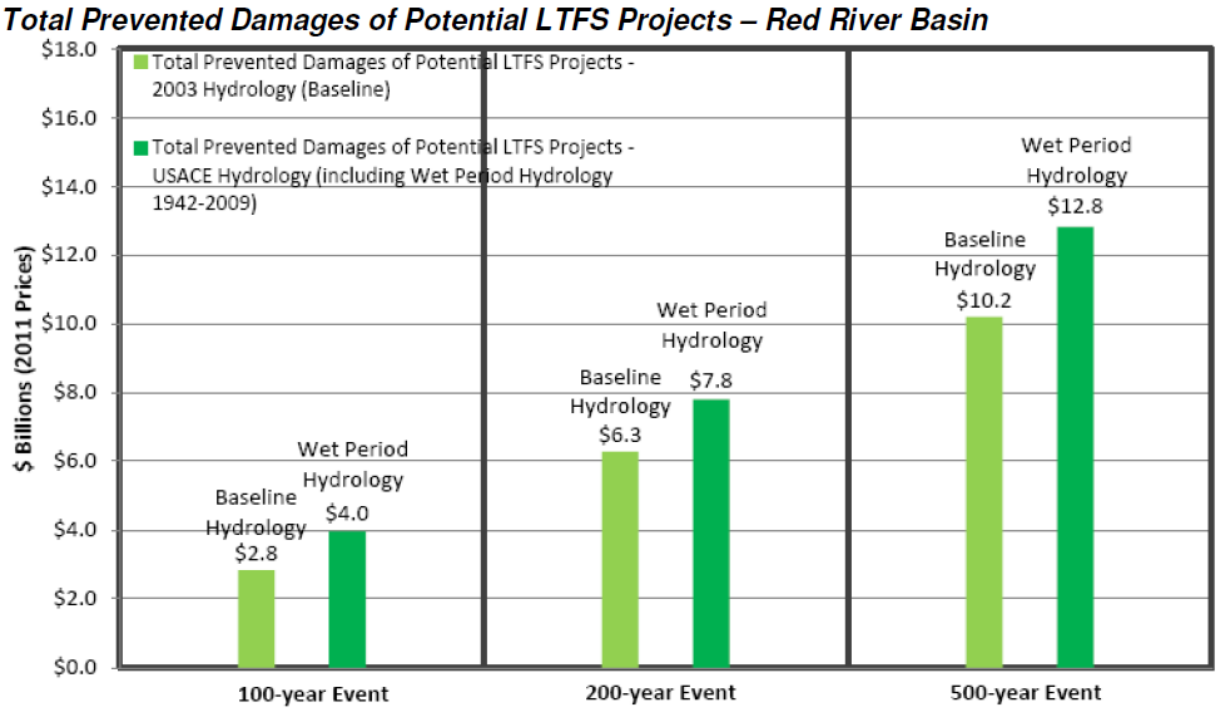


*Level of Protection at Cities along the Red River*

| City/Location | Level of Protection | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | RRBC Recommended Guideline | Current Conditions | Meets RRBC Recommended Guideline? | Future Conditions including Planned Upgrades | Meets RRBC Recommended Guideline? | Future Conditions including Planned Upgrades plus Proposed Upstream Flood Storage | Meets RRBC Recommended Guideline? | Additional Measures Needed to Meet RRBC Recommended Guideline? |
| Red River Main Stem | | | | | | | | |
| Wahpeton, ND | 200 yr | 100-125 yr | No | 100-125 yr | No | < 200 yr | No | Yes |
| Breckenridge, MN | 200 yr | 100-125 yr | No | 100-125 yr | No | < 200 yr | No | Yes |
| Fargo, ND | 500 yr | < 100 yr | No | > 200 yr | No | > 200 yr | No | Yes |
| Moorhead, MN | 500 yr | < 100 yr | No | > 200 yr | No | > 200 yr | No | Yes |
| Georgetown, MN | 200 yr | < 100 yr | No | 100 yr | No | > 200 yr | Yes | No |
| Perley, MN | 200 yr | < 100 yr | No | 100 yr | No | > 200 yr | Yes | No |
| Hendrum, MN | 200 yr | < 100 yr | No | 100 yr | No | > 200 yr | Yes | No |
| Halstad, MN | 200 yr | 250 yr | Yes | 250 yr | Yes | > 250 yr | Yes | No |
| Shelly, MN | 200 yr | < 100 yr | No | 100 yr | No | > 200 yr | Yes | No |
| Nielsville, MN | 200 yr | no permanent protection | No | 100 yr | No | > 100 yr | No | Yes |
| Climax, MN | 200 yr | no permanent protection | No | 100 yr | No | > 100 yr | No | Yes |
| Grand Forks, ND | 500 yr | 250 yr | No | 250 yr | No | > 500 yr | Yes | No |
| East Grand Forks, MN | 500 yr | 250 yr | No | 250 yr | No | > 500 yr | Yes | No |
| Oslo, MN | 200 yr | > 200 yr | Yes | > 200 yr | Yes | > 200 yr | Yes | No |
| Drayton, ND | 200 yr | < 100 yr | No | < 100 yr | No | < 100 yr | No | Yes |
| Pembina, ND | 200 yr | 100 yr | No | 100 yr | No | > 100 yr | No | Yes |
| St. Vincent, MN | 200 yr | < 100 yr | No | >100 yr | No | 200 yr | Yes | No |
| Noyes, MN | 200 yr | 100 yr | No | 100 yr | No | > 100 yr | No | Yes |

RED RIVER BASIN COMMISSION

# Total Prevented Damages



# Funding for LTFS Recommendations

- **Recommendations come with a total price tag of $4.6 billion needed for the U.S. portion of the basin:**
  - *Includes $1.77 billion for a proposed diversion channel to protect Fargo-Moorhead*
  - *Assumes federal funding totaling almost $1.7 billion*
- **50-year plan: it would take years, decades to fully implement**
  - A significant portion of the plan is devoted to temporarily storing water to reduce the severity of flooding
  - Includes funding for community projects, rural ring dikes, Devil's Lake initiatives
  - The plan calls for storing the equivalent of 1.5 million acre-feet of water south of the Canadian border to ensure a 20 percent reduction in peak flows
  - If implemented, the comprehensive plan would prevent significant damage from flooding – between $10.2 billion and $12.8 billion in the basin for a single 500-year flood.

# Funding Timeline

Project Implementation Costs

**Table D-31 Funding Timeline for Project Implementation Costs along the Red River of the North and Tributaries[6][7]**

All costs in millions and are estimated at 2011 price levels

The best available information as of September 2011 is presented in this table. However it is not complete as much of the information has yet to be developed. These costs will change as additional information is developed.

| | | | Total Project Cost | Remaining Project Costs 1st Ten Years (Starts 1 July 2011) | | | | | Remaining Funding for Future (After 2021) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total Funding | Federal Funding | Non-Federal Funding[4] | Non-Federal Funding in Minnesota | Non-Federal Funding in North Dakota | | |
| **Local Protection Projects** | | | | | | | | | | |
| ***Red River Main Stem*** | | | | | | | | | | |
| | Red | Farmstead and Rural Residence Ring Dikes | $17.0 | $3.2 | $1.8 | | $0.4 | $1.0 | TBD | (8) |
| | Red | Minnesota Rural Area Buyouts | $12.0 | $12.0 | | | $12.0 | | TBD | |
| | Red | North Dakota Rural Area Buyouts | $7.0 | $7.0 | $3.6 | | | $3.4 | $0.0 | |
| | Red | Stanley Township, Cass County, ND Levees | $4.0 | $4.0 | | | | $4.0 | $0.0 | |
| | Red | Breckenridge, MN | $41.0 | $0.7 | | | $0.7 | | $0.0 | |
| | Red | Oxbow, ND | $0.4 | | | | | | $0.0 | |
| | Red | Fargo/Moorhead Diversion Project | $1,770.0 | $1,770.0 | $785.0 | $985.0 | | | $0.0 | (1, 6) |
| | Red | Fargo, ND - Other Non-Diversion Projects | $200.0 | $200.0 | | | | $200.0 | $0.0 | |
| | Red | Moorhead, MN - Other Non-Diversion Projects | $70.0 | $25.0 | | | $25.0 | | $0.0 | |
| | Red | Oakport Twp, MN | $33.0 | $8.7 | | | $8.7 | | $0.0 | |
| | Red/ Buffalo | Georgetown, MN | $3.2 | $3.2 | | | $3.2 | | $0.0 | |
| | Red | Perley, MN | $2.7 | $0.3 | | | $0.3 | | $0.0 | |
| | Red | Hendrum, MN | $2.5 | $0.3 | | | $0.3 | | $0.0 | |
| | Red/ Marsh | Shelly, MN | $3.0 | $2.0 | | | $2.0 | | $0.0 | |
| | Red | Nielsville, MN | $3.0 | $1.8 | | | $1.8 | | $0.0 | |
| | Red/ Sand Hill | Climax, MN | $3.0 | $2.3 | | | $2.3 | | $0.0 | |
| | Red | Oslo, MN | $9.0 | $9.0 | | | $9.0 | | $0.0 | |
| | Red | Drayton, ND | TBD | | | | | | | |
| | Red | Pembina, ND | $0.1 | | | | | | $0.0 | |
| | Red | St. Vincent, MN | $2.9 | $2.9 | | | $2.9 | | $0.0 | |
| ***Tributaries*** | | | | | | | | | | |
| | **Sheyenne/Maple/Rush Rivers (ND)** | | | | | | | | | |
| | Sheyenne | Valley City, ND | $60.0 | $60.0 | $39.0 | | | $21.0 | $0.0 | |
| | Sheyenne | Fort Ransom, ND | TBD | | | | | | | |
| | Sheyenne | Lisbon, ND | $10.0 | $10.0 | | | | | $0.0 | |
| | Sheyenne | Kindred, ND | $3.0 | $3.0 | | | | | $0.0 | |
| | Sheyenne | Horace, ND | | | | | | | $0.0 | (2) |
| | Sheyenne | West Fargo, ND | | | | | | | $0.0 | (2) |
| | Sheyenne | Reile's Acres, ND | | | | | | | $0.0 | (2) |
| | Maple | Enderlin, ND | $0.3 | | | | | | $0.0 | |
| | Maple | Mapleton, ND | $0.1 | | | | | | $0.0 | |
| | Rush | Amenia, ND | TBD | | | | | | | |
| | Sheyenne | Harwood, ND | | | | | | | $0.0 | (2) |
| | Sheyenne | Reed Township, Cass County, ND | $4.5 | $4.5 | $1.8 | | | $2.7 | $0.0 | |

# Funding Timeline

**Table D-31 Funding Timeline for Project Implementation Costs along the Red River of the North and Tributaries[6][7]**

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| **Wild Rice River (MN)** | | | | | | | | | |
| Marsh | Ada, MN | $9.4 | $6.0 | | | $6.0 | | $0.0 | |
| Felton Ditch | Felton, MN | $2.7 | $2.7 | | | $2.7 | | $0.0 | |
| Wild Rice | Buyouts | $1.5 | $0.3 | | | $0.3 | | $0.0 | |
| **Red Lake River (MN)** | | | | | | | | | |
| Cty Ditch 1 | Thief River Falls, MN | $1.0 | | | | | | $0.0 | |
| Red Lake | Crookston, MN | $40.0 | $6.0 | | | $6.0 | | $0.0 | |
| **Middle/Snake Rivers (MN)** | | | | | | | | | |
| Snake | Alvarado, MN | $3.0 | $3.0 | | | $3.0 | | $0.0 | |
| Middle | Argyle, MN | $0.8 | $0.3 | | | $0.3 | | $0.0 | |
| **Park River (ND)** | | | | | | | | | |
| Park | Grafton, ND | $42.1 | $41.0 | $31.6 | | | $9.4 | $0.0 | |
| **Pembina River (ND)** | | | | | | | | | |
| Pembina | Neche, ND | $3.0 | $3.0 | $1.9 | | | $1.1 | $0.0 | |
| **Roseau River (MN)** | | | | | | | | | |
| Roseau | Roseau, MN | $40.0 | $20.0 | $14.0 | | $6.0 | | $0.0 | |
| **Devils Lake (ND)** | | | | | | | | | |
| Devils Lake | Devils Lake, ND (City of) | $150.0 | | | | | | $0.0 | |
| Devils Lake | Minnewaukan, ND | $10.5 | | | | | | $0.0 | |
| Devils Lake | Fort Totten, ND | $120.0 | $120.0 | $120.0 | | | | $0.0 | |
| Devils Lake | Tolna Coulee - Control Structure | $14.0 | $13.4 | $9.9 | | | $3.5 | $0.0 | (3) |
| | West End Outlet | TBD | | | | | | $0.0 | (6) |
| | East End Outlet | $85.0 | $85.0 | | | | $85.0 | $0.0 | |
| | Gravity Outlet | $17.0 | $17.0 | | | | $17.0 | $0.0 | |
| | Buyouts | TBD | | | | | | $0.0 | |
| | Raise federal aid roads | $190.0 | $190.0 | $190.0 | | | | $0.0 | |
| | Raise township roads | TBD | | | | | | $0.0 | |
| | Raise railroads | $97.0 | $97.0 | $64.7 | | | $32.3 | $0.0 | (4) |
| | Increase Upper Basin Storage | $75.0 | $75.0 | $75.0 | | | | $0.0 | |
| ***Subtotal - Local Protection - In United States*** | | ***$3,163.5*** | ***$2,809.6*** | ***$1,338.2*** | ***$985.0*** | ***$92.9*** | ***$380.4*** | ***$0.0*** | |

# Funding Timeline

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| | | | Total Funding | Federal Funding | Non-Federal Funding [1] | Non-Federal Funding in Minnesota | Non-Federal Funding in North Dakota | | |
| **Upstream Storage Projects** | | | | | | | | | |
| | **Potential Upstream Storage Projects** | ***$1,463.0*** | ***$700.0*** | ***$350.0*** | | ***$175.0*** | ***$175.0*** | ***$763.0*** | (5) |
| **Other Flood Related Activities** | | | | | | | | | |
| | Pilot Projects | $10.0 | $5.0 | $2.5 | | $1.3 | $1.3 | $5.0 | |
| | Decision Support Network | $4.0 | $4.0 | $2.0 | | $1.0 | $1.0 | $0.15/yr | |
| | Forecasting | $2.0 | $2.0 | $1.0 | | $0.5 | $0.5 | $0.15/yr | |
| | FEMA Flood Plain Mapping with LiDAR data | TBD | | | | | | | |
| | Transportation Upgrades | TBD | | | | | | | |
| | 404 Retention Permitting Coordination | $1.0 | $1.0 | $0.5 | | $0.3 | $0.3 | $1.0 | |
| | Drainage | TBD | | | | | | | |
| | Conservation Program Funding | TBD | | | | | | | |
| **Subtotal - Other Flood Related Activities** | | ***$17.0*** | ***$12.0*** | ***$6.0*** | ***$0.0*** | ***$3.0*** | ***$3.0*** | ***$6.0*** | |
| **TOTAL FOR UNITED STATES IN RED RIVER BASIN** | | $4,643.5 | $3,521.6 | $1,694.2 | $985.0 | $270.9 | $558.4 | $769.0 | |

TBD To be determined

Notes:

(1) The estimated amounts of the Federal and non-Federal Fargo/Moorhead LPP Diversion project total costs are based on the Fargo-Moorhead Metropolitan Area Flood Risk Management project Supplemental Draft Feasibility Report and Environmental Impact Statement, April 2011. Final cost sharing amounts between the non-Federal partners have not yet been determined.

(2) Additional local protection included as a part of the Fargo-Moorhead LPP North Dakota diversion project cost listed under Fargo and Moorhead at the top of this table.

(3) Tolna Coulee cost includes $14 million for the control structure to prevent significant erosion in case of a natural overflow.

(4) Cost sharing for raising railroad embankment at Devils Lake estimated to be one-third cost shared by Burlington Northern Santa Fe Railway, one-third by Amtrak, and one-third by the North Dakota Department of Transportation through a US Department of Transportation grant.

(5) Federal participation in potential upstream storage projects is assumed to be available through future U.S. Farm Bill at approximately 50 percent cost sharing; however, actual Federal funding availability and cost sharing amounts is uncertain. Also, implementation of projects in each state is assumed to be at comparable levels, however this will depend on project implementation schedules by each state.

(6) Operation and maintainance (O&M) costs of projects are not included in this tabulation, eventhough in some cases the O&M costs may be substantial. O&M costs are typically a non-Federal or local responsibility and should also be considered in the implementation decision for a project.

(7) Information on specific projects at individual communities can be found on the City Assessment tables in Appendix C.

(8) Funding for farmstead and rural ring dikes depend on the number of landowners requesting assistance. A rough estimate based on funding from recent years is included.

# RECOMMENDATIONS

1. Biggest Risks
   - Fargo-Moorhead & Devils Lakes
2. Level of Protection Goals
3. Floodplain Management
4. Retention
5. Administration, Policy, Coordination, Research, Data
6. Basin Funding Strategy

RED RIVER BASIN COMMISSION

# Immediate Needs/Critical Risks: Fargo-Moorhead, Devils Lake

- Under current conditions, the Fargo-Moorhead metropolitan area could get, in a major 500-year level flood, **$9 to $10 billion or more in basin damages,** according to the USACE.
- C**urrent levels of protection for Fargo-Moorhead are inadequate.** Protection should be increased to enable a successful 500-year flood fight.
- Protection measures for Fargo-Moorhead should be **economically viable** and provide the **least level of adverse impacts** to others.
- A **diversion** of the Red River around Fargo-Moorhead would provide the protection needed to endure a successful 500-year flood fight if it were supplemented by retention and other available options to achieve the RRBC's proposed LTFS level of protection goals.
- **Retention** to achieve the potential 20 percent flow reduction on the main stem should be aggressively pursued upstream of Fargo-Moorhead to decrease the duration, scope, and level of floods in the Fargo-Moorhead area, downstream communities, and rural areas.

# Recommendations that include Fargo-Moorhead and Devils Lake

### Recommendation for Action 1.1

The **flood protection trajectory** that has increased protection in the Fargo-Moorhead metro area since the 2009 flood should continue. State and federal funds, with local government cost share, should continue supporting ongoing dike construction, property acquisitions, flowage easements, and flood infrastructure projects to be able to fight at least a 100-year flood, and upwards of a 500-year flood in the long term.

### Recommendation for Action 1.2

Progress towards the proposed $1.77 billion **diversion should be continued** utilizing local, state, and federal funds so that, combined with current flood protection strategies, this community will have the capacity within 10 years to wage a successful flood fight equal to or greater than the LTFS 500-year flood.

### Recommendation for Action 1.3

Retention upstream of the Hickson and Abercrombie stream gage for a flow reduction of 20 percent (minimum) should be advanced with shared funding by the F-M flood Diversion Authority working with local and joint water boards, using city, local, state, and federal funds.

### Recommendation for Action 1.4

Leaders in state government in North Dakota and Minnesota, along with key local government officials and with input from the Diversion Authority and federal agencies, should convene by early 2012 to determine the **non-federal cost share formula for the Locally Preferred Plan ($1.77 billion) diversion**, and related $3.5 million operational estimates.

- **Rising levels of water in the Devils Lake** region have increased the potential for a natural overflow that could discharge approximately 14,000 cubic feet per second (cfs) of water into the Sheyenne River, triggering prolonged flooding and catastrophic downstream water quantity and quality problems in the Sheyenne and Red Rivers. This crisis should continue to be addressed with immediate local, state and federal action.

# Additional Recommendations that include Devils Lake

- **Recommendation for Action 1.5**
- The recommendations developed by **the Devils Lake Executive Committee** through the work of the Devils Lake Collaborative Working Group should continue to be supported by the state of North Dakota, local authorities, and federal and tribal governments to guard against critical risks.

- **Recommendation for Action 1.6**
- The RRBC and IRRB should distribute information with downstream interests and jurisdictions providing **progress and timelines** on Devils Lake activities.

- **Recommendation for Action 1.7**
- A comprehensive model using real-time data to determine the effects of **releases of Devils Lake water** via the various outlet channels on the Sheyenne and Red Rivers should be examined by local leaders and state and federal agencies to determine needs and related costs. The examination should include the integration of various models already in use by the USGS, the NWS, the NDSWC, and the USACE and be facilitated by the RRBC.

# NEXT STEPS

- Report to State Funders
  - MN December 2011
  - ND April 2012
- Share report with others
  - For the information
  - Act on Recommendations
  - Use as a basin-wide guide
- Begin 2012 Update

RED RIVER BASIN COMMISSION

# INPUT/QUESTIONS/CONTACT

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