Factors Influencing Resilience in Flood Response, Recovery, and Prevention:

Case Study of the Souris River Valley, Minot, North Dakota

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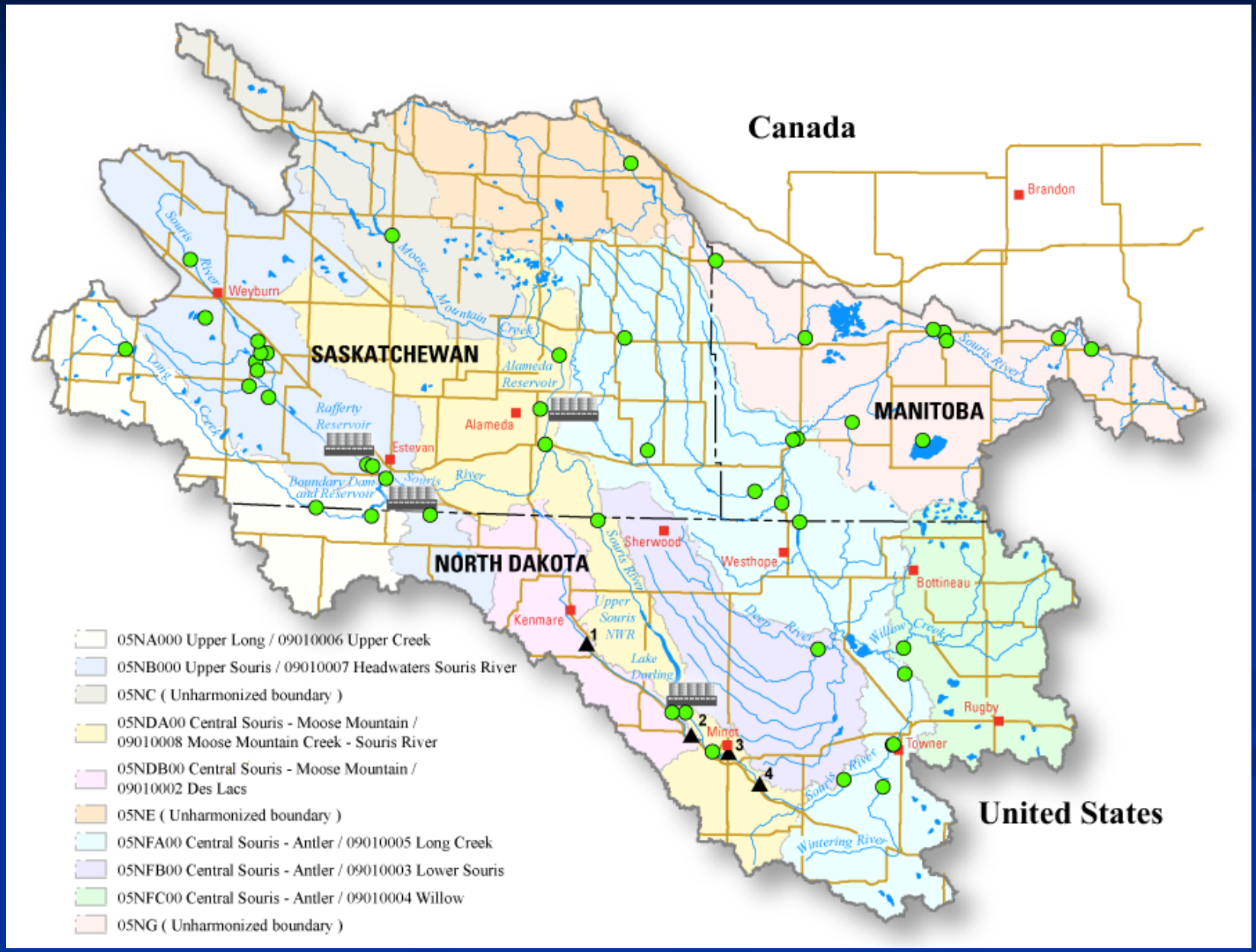
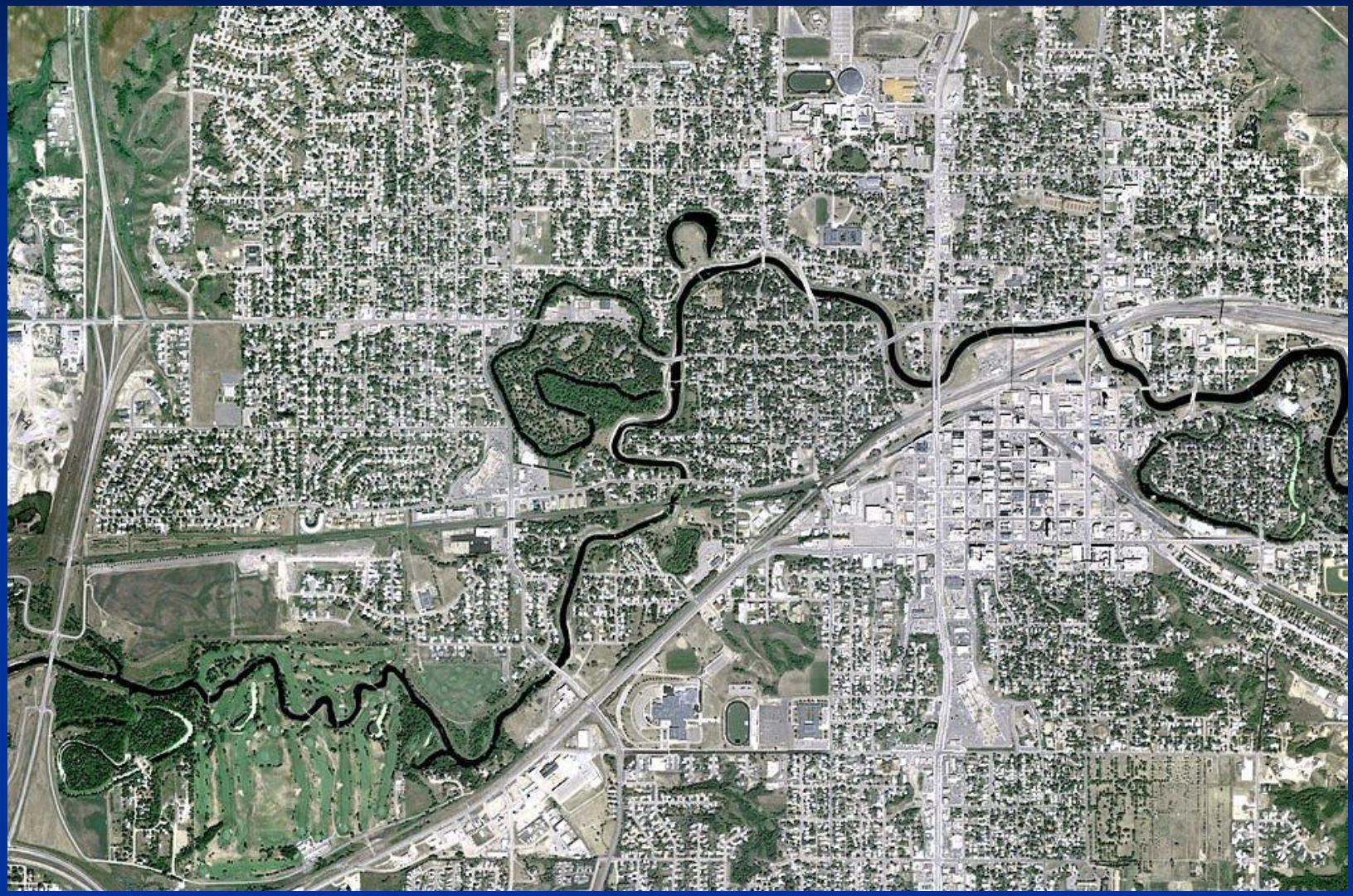
The Souris River Basin

Monitoring in the Souris River Basin



Before

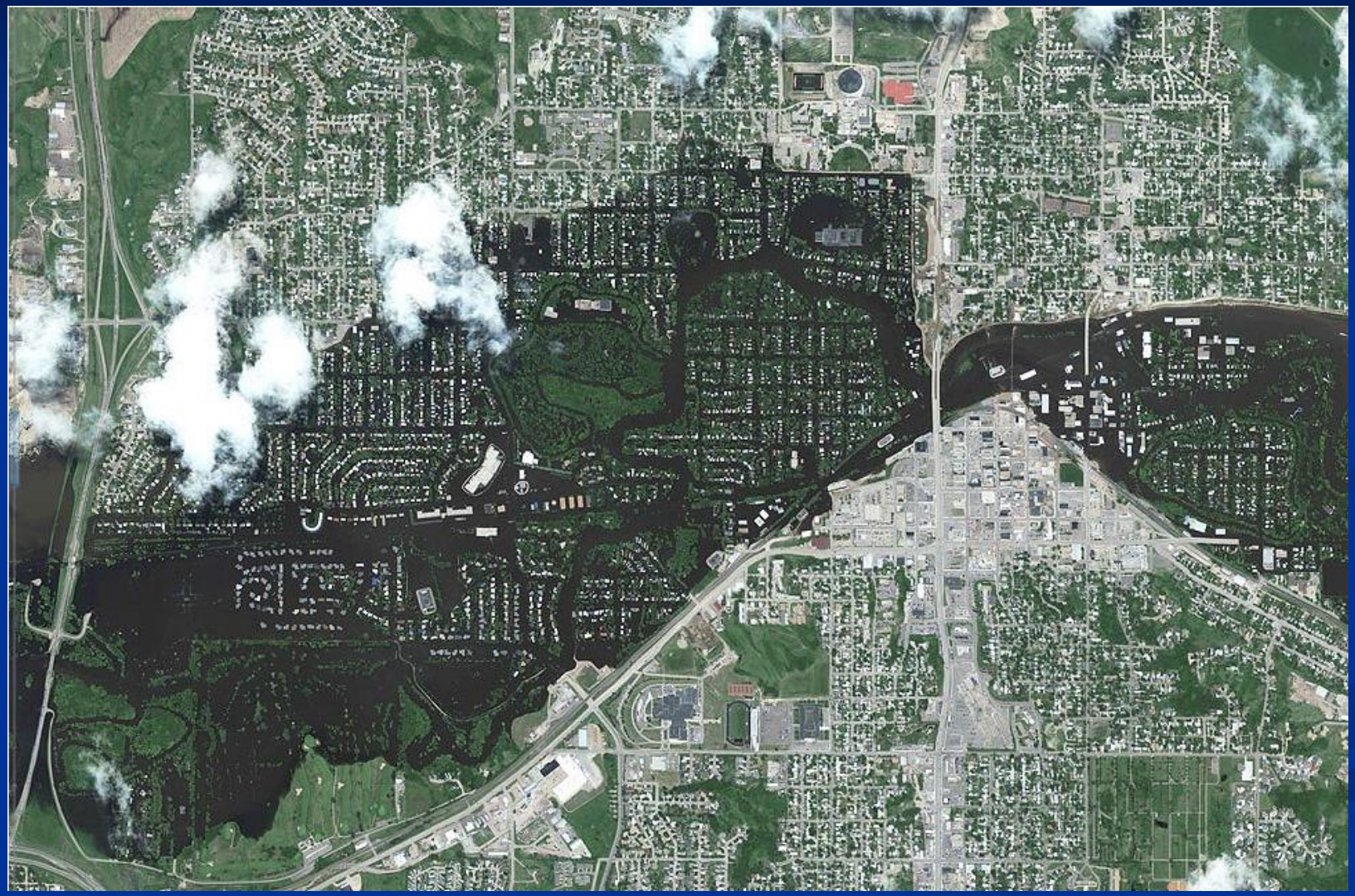


Minot on 25 July 2006

2011 Flood Background Information

- Heavy rainfall and snowmelt in North Dakota, Saskatchewan, and Manitoba from April – June 2011
- Dams in Canada and North Dakota forced to release unprecedented amounts of water
- June 22nd: 29,000 cfs flow; river rises to 1561.72 feet

After



Minot on 30 June 2011

Research Questions

1) What are the federal, state, and local regulations in regard to EM/flooding?
2) How does Minot's EM/flood prevention policy compare to others in EM/flood literature?
3) What is being done to prevent another flood?
4) Will new measures be effective?

Minot's Flood History: The Top 5

Year	Water Level (ft)	Flow Rate (cfs)	Damage Costs (in millions of $)	Preventative and/or Reactive Actions
1881	1558.00	?	?	None
1904	1555.15	12,000	?	None
1969	1555.40	6,300	$15 to $20	Temporary dikes; more permanent protection was in the works but not finalized when the flood hit; after flood permanent levees built to withstand 5,000 cfs
1976	1556.08	14,800	$10.622	6 pumping stations; channel deepening & widening
2011	1561.72	29,000	Over $600	Temporary dikes were built to withstand 11,000 cfs, but weren't enough; Mouse River Enhanced Flood Protection Project

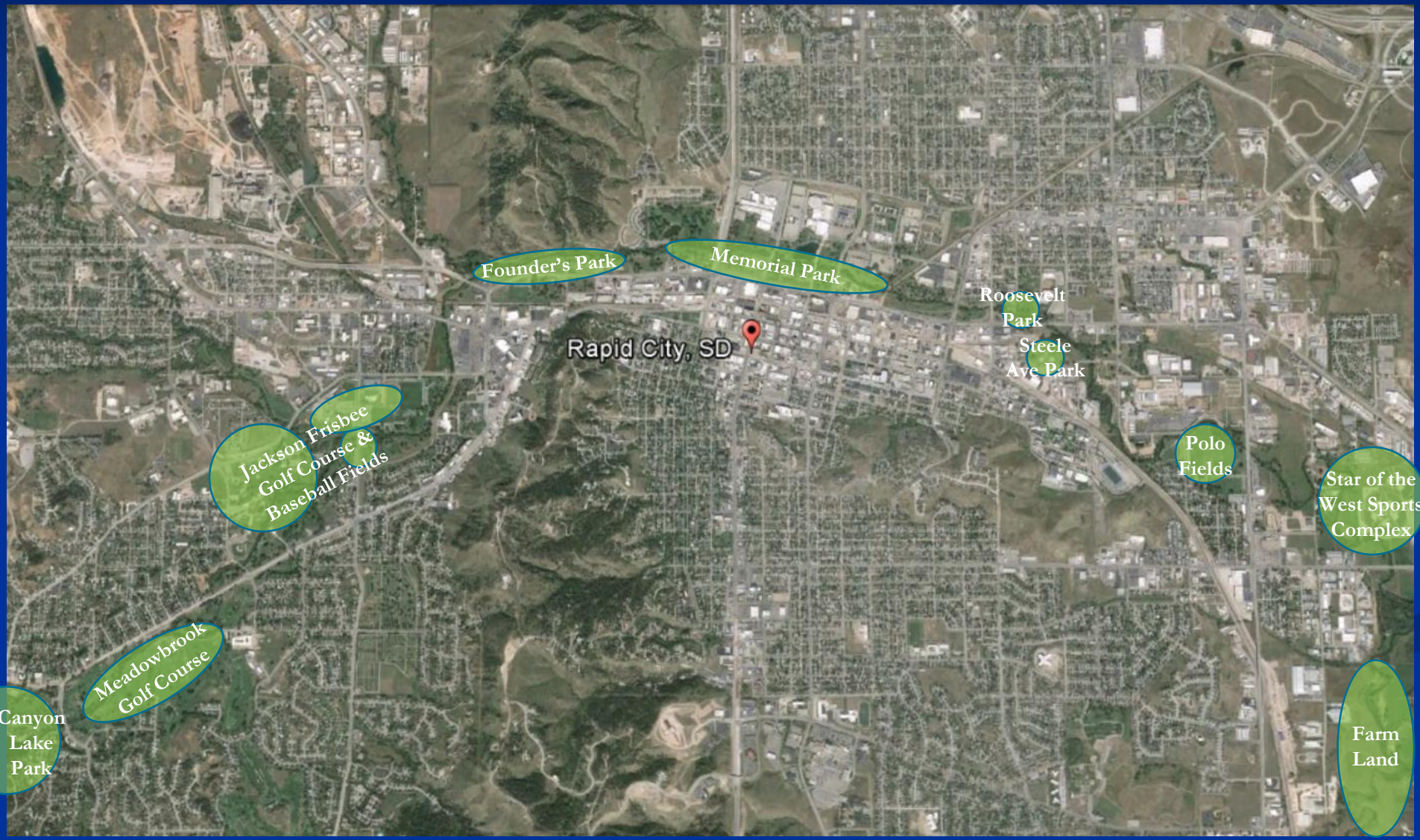
Evolution of Emergency Management

- Sandbars and debris cleared to protect navigation for ships
- 1889: American Red Cross founded
- Flood Control Acts of 1917, 1928, and 1936
  - FCA of 1928: Charged Army Corps of Engineers with building flood control structures, but also granted it legal immunity
- Cost-sharing between federal and local government

Evolution of Emergency Management

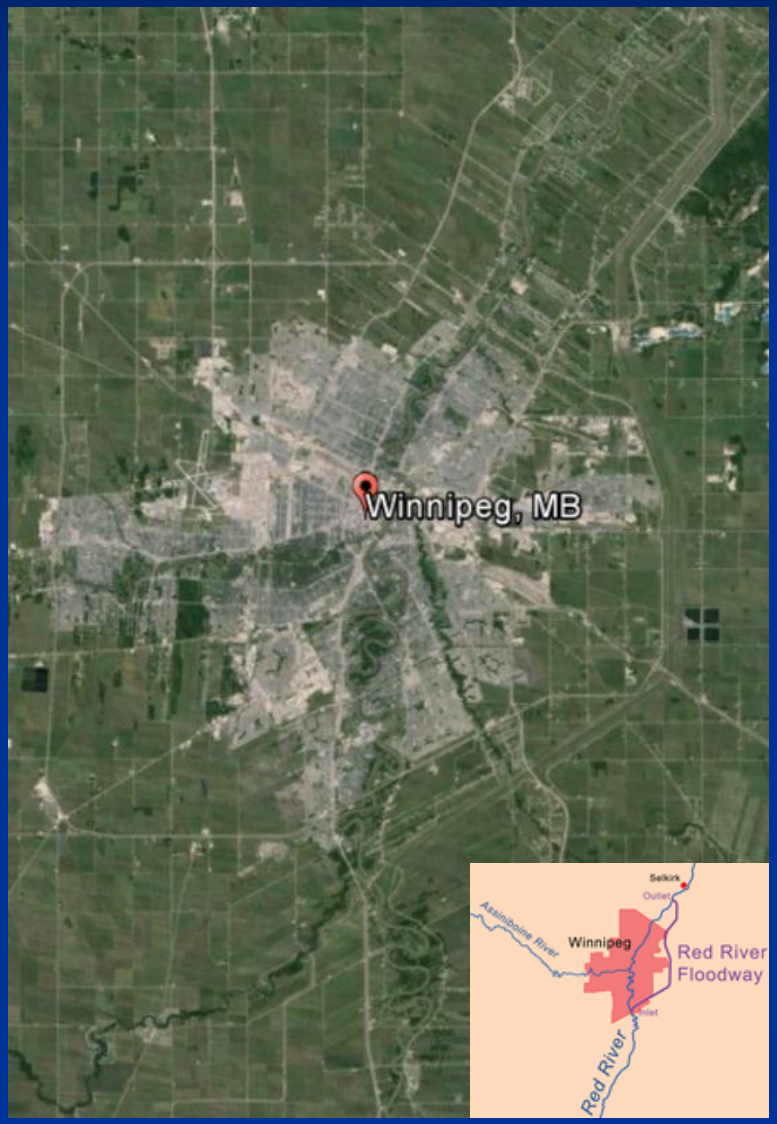
- Mid-20th century: use of large structures becomes prevalent
- 1968: National Flood Insurance Act
- 1970: Environmental Protection Act
- 1979: Federal Emergency Management Agency founded
- Past 30 Years: return to natural flood mitigation in conjunction with structural methods

Rapid City, South Dakota



Grand Forks, North Dakota

Winnipeg, Manitoba, Canada



EM Policy Review

- Have a crisis preparedness/crisis management plan
- Coordination of resources
- Knowing your strengths and weakness
- Communication – clear, concise, and at all levels
- Policies and plans should be reviewed, updated, and exercised regularly
- Grow resilience across all structures (physical, social, governance/policy, etc.)

Analysis: County & State Hazard Mitigation Plans

- **Ward County**
  - River's winding course through Minot
  - Majority of shelters and medical facilities lie within the hazard area
  - Contradictions within the report — is future flooding likely or not
  - No continuity of operations/continuity of government (COOP/COG) or disaster recovery plan at the city level
  - Dependent on county, state, and federal agencies for technical assistance and funding

Analysis: County & State Hazard Mitigation Plans

- **State of North Dakota**
  - 90% of financial damages occur in Minot
  - River channel obstructions and stream bank erosion
  - Unacceptable or minimally acceptable levee ratings
  - Ward County assessed to have a high loss rating
  - Ward County assessed to have moderate to high vulnerability for riverine flooding
  - Protection provided by Minot's levees pales in comparison to other major North Dakota cities
  - Areas for improvement

Analysis: GIS Modeling of Proposed Flood Prevention Measures

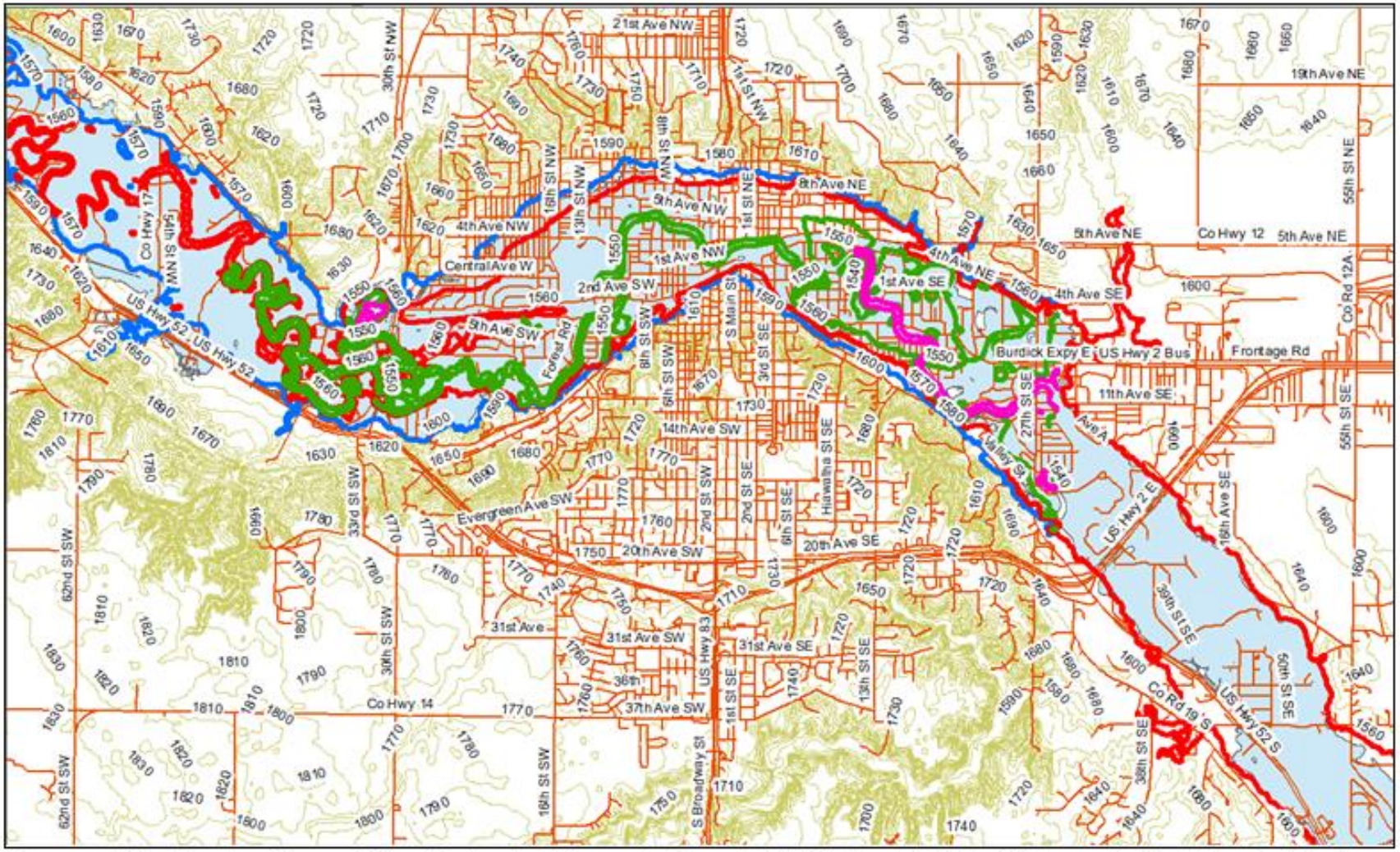
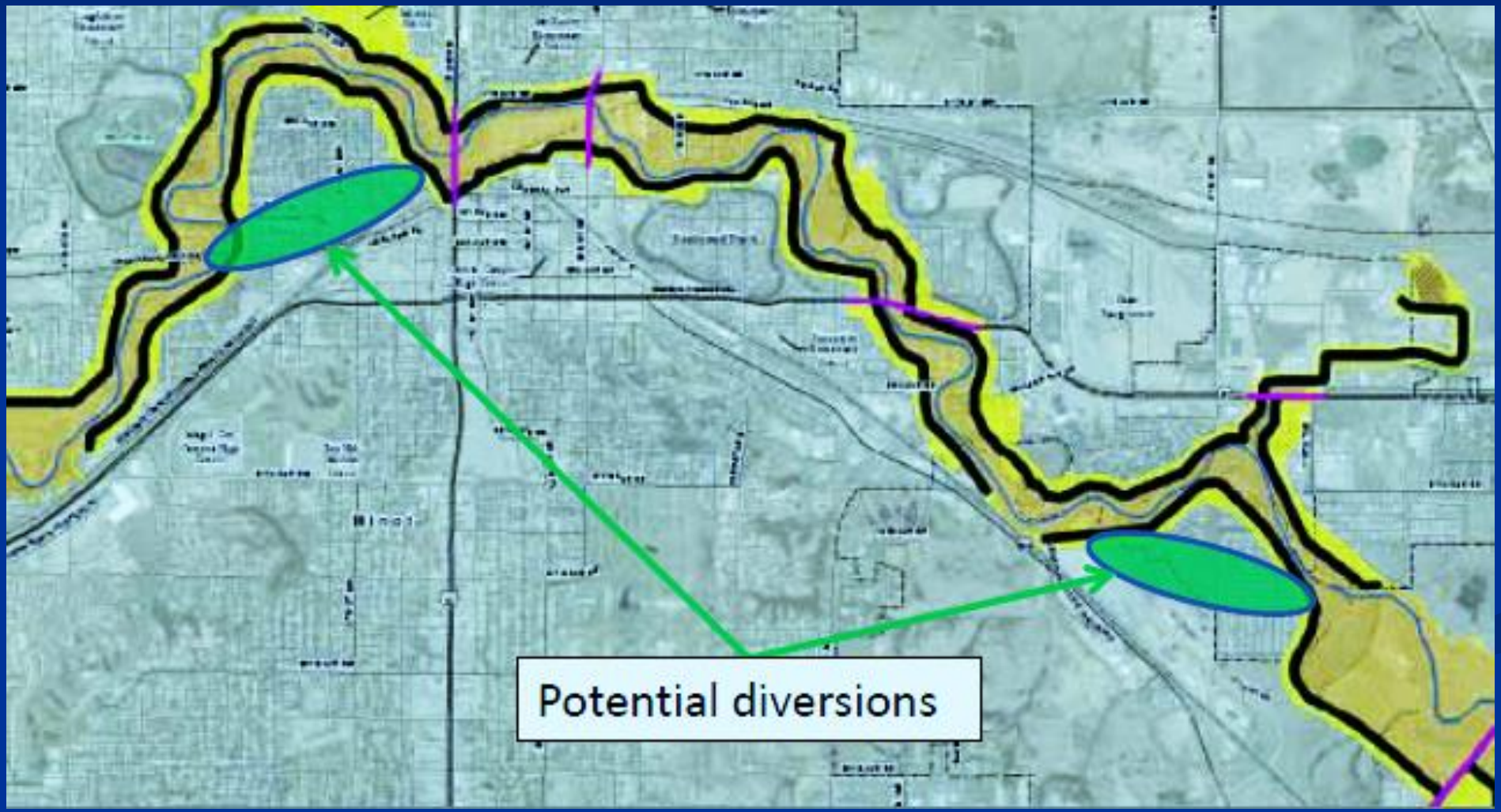


Figure 12: Projection of the Extent of Inundation at 1540 Feet MSL (Magenta Outline), 1550 Feet MSL (Green Outline), 1560 Feet MSL (Red Outline), and 1570 Feet MSL (Blue Outline) Compared to the Extent of June 2011 Flooding (Light Blue Shading) in Minot, ND.

Analysis: GIS Modeling of Proposed Flood Prevention Measures



Analysis: GIS Modeling of Proposed Flood Prevention Measures

Flood Category or Flood Protection Description	Water Level (Feet MSL)
Action Stage	1548
Flood Stage	1549
Moderate Flood Stage	1551
Major Flood Stage	1555
June 2011 Flood Defenses vs. 9,600 cfs Flowrate	1566.75
June 2011 Flood Defenses vs. 14,800 cfs Flowrate	1567.61
June 2011 Flood Defenses vs. 26,900 cfs Flowrate	1569.37
9,600 cfs Rated Flood Defenses vs. 14,800 cfs Flowrate	1550.85
9,600 cfs Rated Flood Defenses vs. 26,900 cfs Flowrate	1552.62
14,800 cfs Rated Flood Defenses vs. 26,900 cfs Flowrate	1551.76

Table 1: Scenario-Based Comparison of Water Levels

Analysis: GIS Modeling of Proposed Flood Prevention Measures

Contour Elevation (Feet MSL)	Approximate Area of Inundation (Acres)
1540 (Contour Line in ArcGIS)	56
1550 (Contour Line in ArcGIS)	920
1560 (Contour Line in ArcGIS)	4141
1570 (Contour Line in ArcGIS)	4158
1548	747.2
1549	833.6
1551	1242.1
1555	2530.5
1566.75	4152.47
1567.61	4153.94
1569.37	4156.93
1550.85	1193.79
1552.62	1763.9
1551.76	1486.9

Table 2: Approximate Area of Inundation for Given Contour Elevations

Conclusions & Recommendations

- Develop COOP/COG at the city level
- Complete physical improvements in capability/capacity
- Improve communication between all parties
- Build a preconceived plan with prioritization for critical infrastructure and areas to protect
- Increase efforts to expand the social aspects of resilience
- Create/maintain adequate levels of critical supplies and personnel
- Continue to seek and adopt best practices

What I Learned & Where to Go from Here

- EM policy and flood prevention, control, and recovery in the U.S. and Canada
- Advocate for natural flood prevention methods
- Benefits of diversion methods, particularly for Minot
- Need for detailed engineering structural analysis if new floodwalls are topped
- Need for additional and improved monitoring capabilities
- Need for a sense of urgency in achieving meaningful protection

Questions?

Start of Construction on a Pumping Station at Minot's Water Treatment Plant – 16 Feb 2016