

Flood Mitigation Through Innovation: A Manitoba Perspective

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Outline

- Flood Risks and Flood History in Manitoba
- Manitoba's Flood Protection / Mitigation System and Flood Mitigation Philosophy
- 2011 Flood Overview and Outcomes
- Current Flood Mitigation Efforts

Manitoba Flood Primer

- Vast majority of runoff in the prairies ends up in Manitoba
- Runoff from Alberta, Saskatchewan, North Dakota, Minnesota, Montana and Ontario
- Significant flooding history on many rivers including:
 - Saskatchewan River
 - Assiniboine River
 - Red River



Fort McMurray

Grande Prairie

Thompson

Edmonton

Flin Flon

The Pas

Red Deer

Saskatoon

Banff

Calgary

Dauphin

Brooks

Swift Current

Moose Jaw

Lethbridge

Regina

Brandon

Winnipeg

Steinbach

Kenora

Lake Winnipeg Watershed

Manitoba Flood Primer

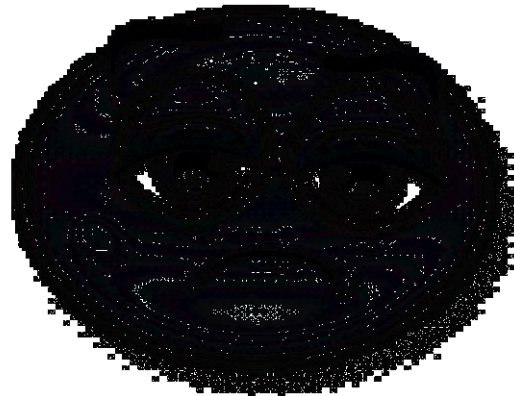
- Different kind of flood from what may be experienced in areas with more topographic relief
 - Overbank flows create large flooded areas
 - Higher flows, somewhat lower velocities
 - Generally have more time to prepare
 - Floods last for extended periods
- Ice jam induced water levels are often much higher than forecasted levels
 - Difficult to predict
 - Ice can be very destructive





Prime Manitoba Flood Conditions

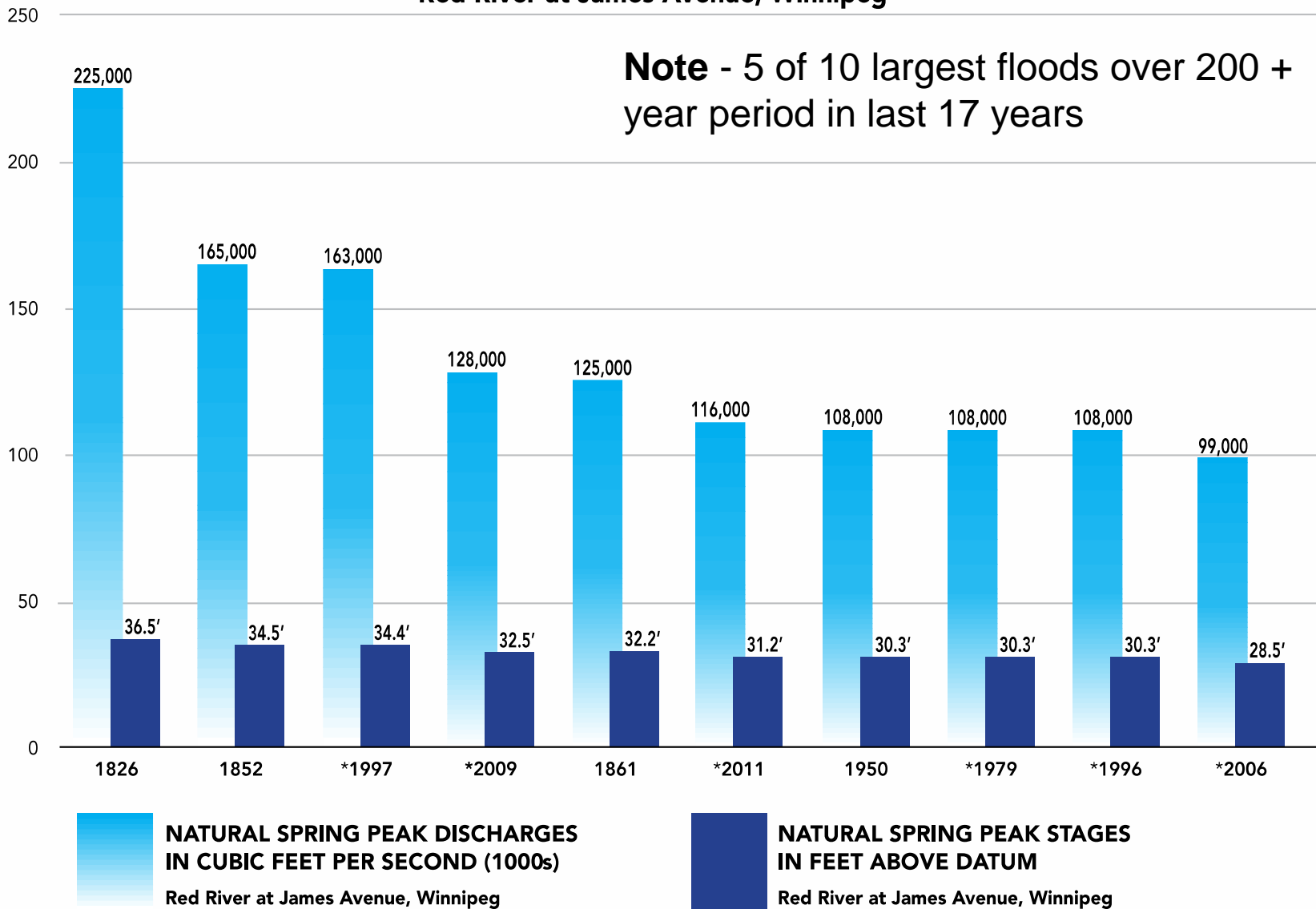
- High fall soil moisture
- Dense snowpack
- Deep ice cover
- Early spring precipitation events



Top 10 Red River Floods since 1800

Red River at James Avenue, Winnipeg

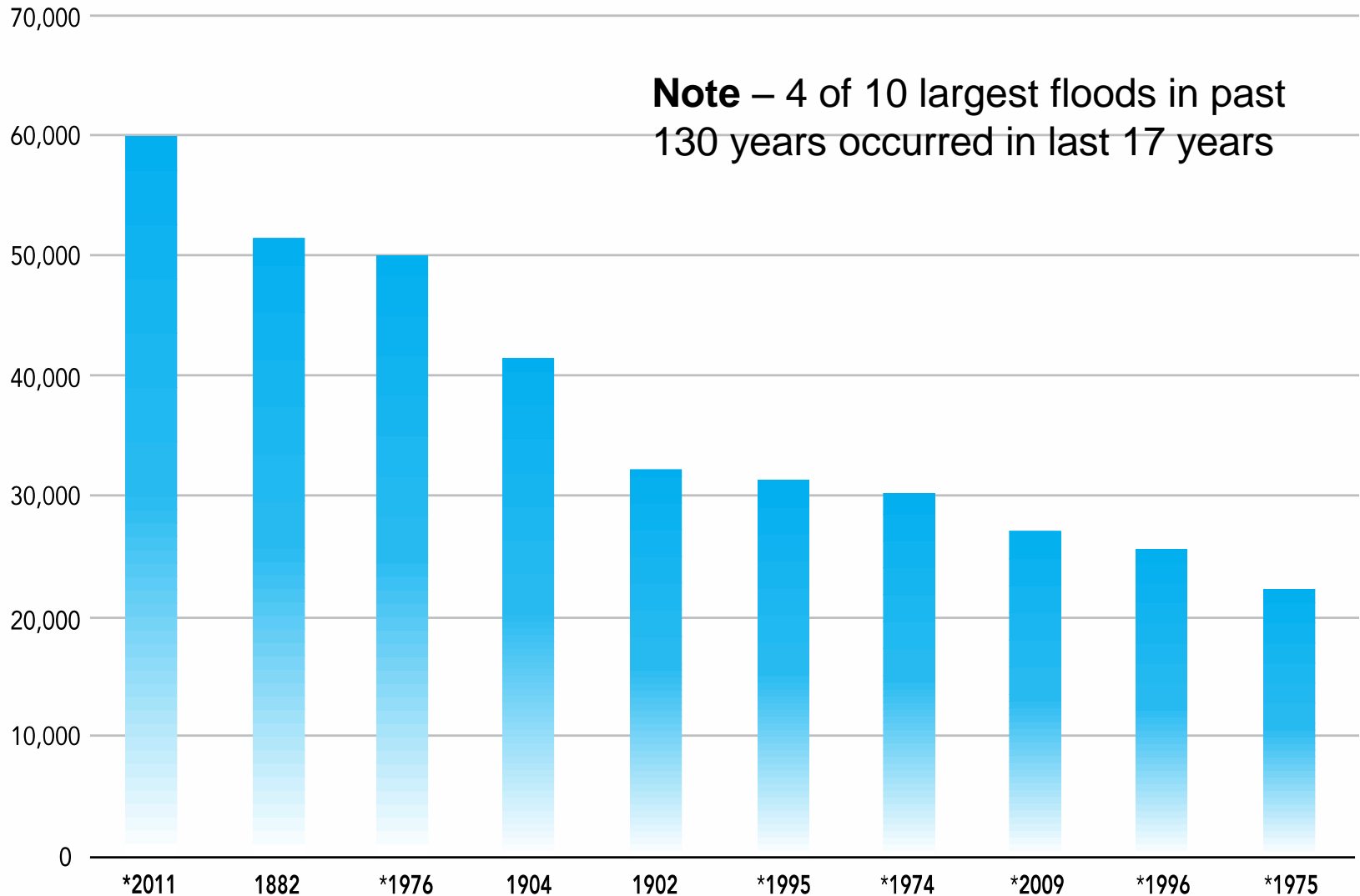
Note - 5 of 10 largest floods over 200 + year period in last 17 years



* Computed Natural Discharge Without Use Of Red River Floodway, Portage Diversion, Shellmouth Dam
Compiled by Manitoba Conservation and Water Stewardship

Top 10 Assiniboine River Floods Since 1880s

Assiniboine River at Portage la Prairie



**INFLOW TO PORTAGE RESERVOIR
WITHOUT SHELLMOUTH RESERVOIR**

* Computed discharge without the use of Shellmouth reservoir as computed by Manitoba Conservation and Water Stewardship

Background of Manitoba's Flood Protection Works

- Southern Manitoba has extensive flood control measures
- Flood controls were built after the devastating flood of 1950, which flooded the Red River Valley and the City of Winnipeg.
- Significant flood protection and mitigation activity driven by 1950 flood

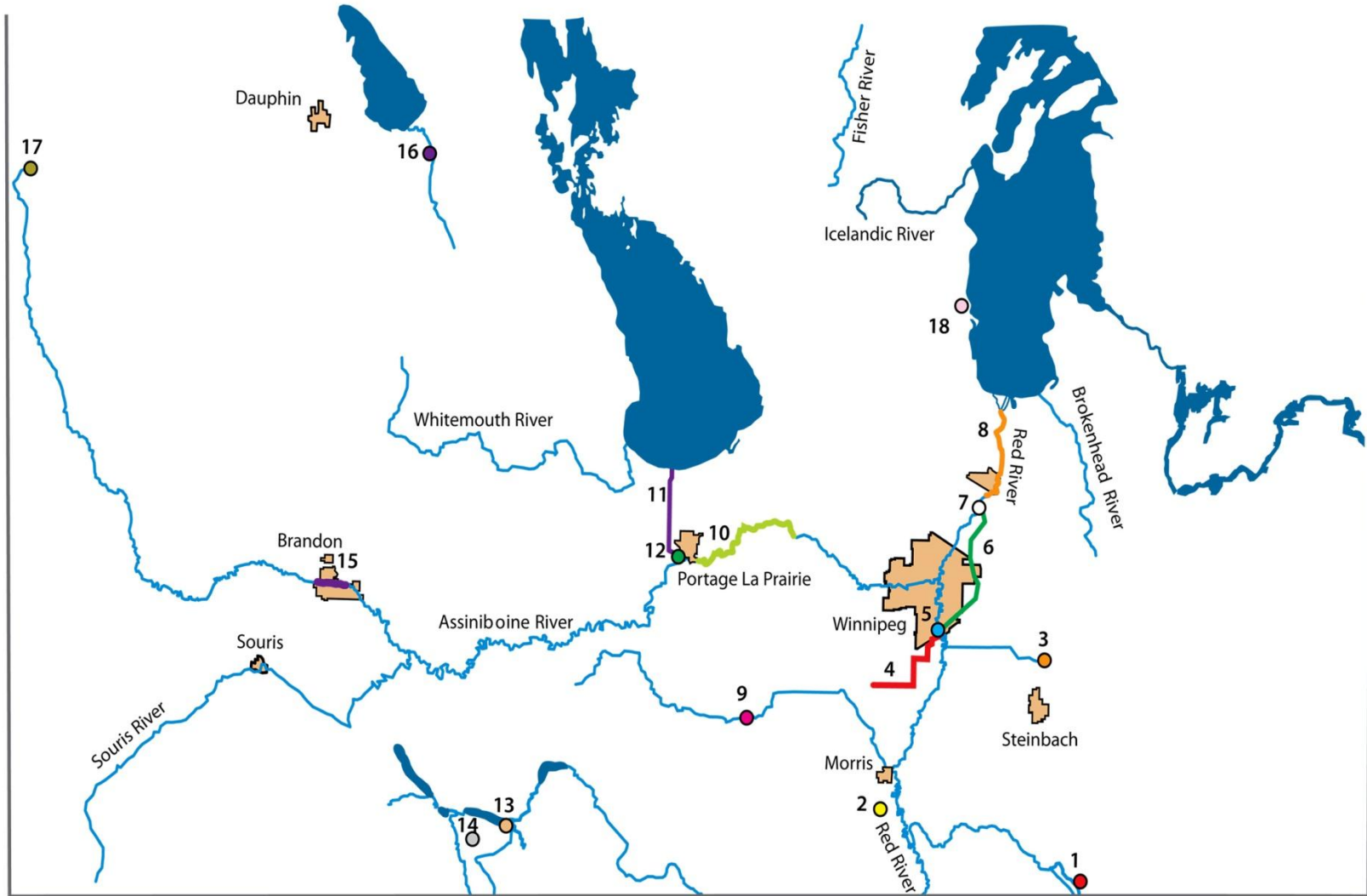
Background of Manitoba's Flood Protection Works

- Water control works act as a system for flood mitigation
 - Delicate balancing act
 - Divergent interests
 - Operational philosophy to balance interests and make decisions for greater good
- Flood protection work has prevented property damage and reduced the potential impact of flooding on families and communities.
- Since the 1997 flood, more than \$1 billion has been invested in flood mitigation efforts in Manitoba.
- This investment has prevented over \$7 billion in damages throughout Manitoba.

Manitoba`s Key Flood Protection Infrastructure

- Shellmouth Dam - Assiniboine River
- Portage Diversion - Assiniboine River
- Red River Floodway –Red River - Recently Expanded to 1:700 year capacity
- Other Diversions – Community specific
- Community Diking
 - Extensive – some provincial, some municipal
- Individual Protection
 - Diking, pads, walls, etc

Southern Manitoba with Flood Protection Works



Control Structures

- | | | | |
|-----------------------------|--|--------------------------------|---------------------------------------|
| ● 1 - Gardenton Floodway | ● 5 - Red River Floodway Inlet Control Structure | ● 9 - Carman Diversion | ○ 14 - Pelican Lake Control Structure |
| ● 2 - Community Ring Dikes | — 6 - Red River Floodway | — 10 - Assiniboine River Dikes | — 15 - Brandon Dikes |
| ● 3 - Seine River Diversion | ○ 7 - St. Andrews Lock and Dam | — 11 - Portage Diversion | ● 16 - Ste. Rose du Lac Dikes |
| — 4 - West Dike | — 8 - Red River Ice Cutting | ● 12 - Portage Diversion Inlet | ● 17 - Shellmouth Dam |
| | | ● 13 - Rock Lake Dam | ○ 18 - Gimli Diversion |

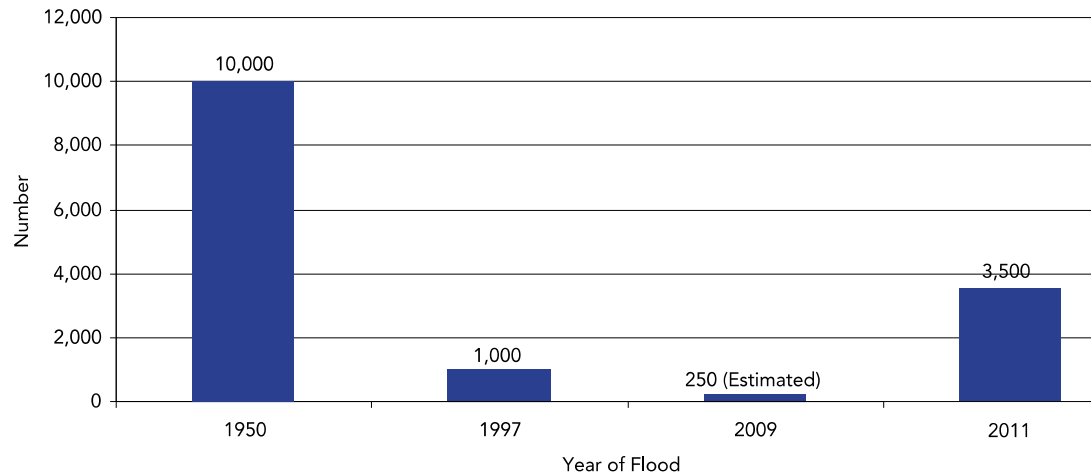
Temporary and Rapid Response

- Large inventory of regular sandbags
- six provincial sandbagging machines
- Large inventory of super sandbags
- Temporary Flood Barriers
 - Hesco cage barriers
 - Large inventory of water-filled barriers
 - 36 rapid-response trailers
- Heavy-duty steamers
- Mobile pumps
- Ice Jam Mitigation Equipment
 - 4 Amphibex Units; Ice cutting fleet

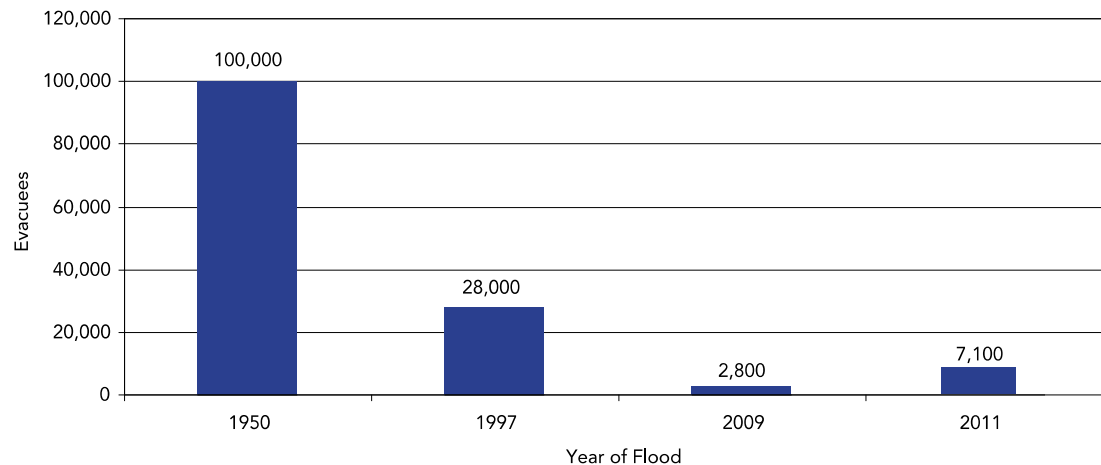


Mitigation Return on Investment

Number of Homes Damaged During Spring Floods



Number of People Evacuated During Spring Floods



Manitoba's Philosophy

- Objective to reduce risk and damages
- Balanced approach to water management and operation of flood control works
- Need to consider costs beyond DFA
 - Confidence, community stability, impact on attracting economic investment, societal impacts
- Flood mitigation enhances confidence and investment climate

Manitoba's Philosophy

- Flood mitigation network minimizes effort and damage in all but extreme events
- Level of effort to prepare for extreme events reduced
- Structural and non-structural measures required to mitigate impacts and damages
- Documentation of events provides legacy info
- Large floods events are an avenue to introduce innovation

2011 Flood Event

2011 Flood Summary

- Unprecedented scale of flood response
- Severely stressed flood protection systems
- No fatalities
- Province met challenges but at very high cost
- Property damages minimized compared to size of event – Flood mitigation investment was key
- Lake Manitoba issues
- Length of event greatly taxed resources (> 100 days)

Manitoba's Flood Fighting Team

- Strong municipal / provincial partnership
- Local jurisdictions have excellent knowledge and strong role
- Provincial efforts led by Flood Steering Committee Co-Chaired by EMO and MIT
- Manitoba EMO – Provincial coordination Regional leads work with RM
- Forecasting, operation of provincial infrastructure and local response assistance from MIT
- Strong network of knowledge and leadership greatly mitigated impact – good decision making
 - Challenges due to length of event
- Last but not least – Partnership with Canadian Armed Forces

2011 Flood Summary

- 15 million sandbags (7 million province)
- 3 million unseeded acres affected
- 800 road closures, including 120 provincial highways
- Hundreds km of roads damaged; 80 provincial structures; hundreds of municipal structures
- Key flood protection infrastructure damaged
 - Portage Diversion, Assiniboine Dikes, various dams/dikes
- Over \$1 billion in response / recovery
- DFA – over 4000 individual files

2011 Flood Summary



- Required emergent infrastructure modifications
 - Portage Diversion capacity increased nearly 40% in 7 days
 - Assiniboine Dikes raised approx 2 feet in 1 month (80 km)
 - New green field emergency diversion channel constructed in 3 months
 - Emergent diking undertaken in many communities
 - Red, Assiniboine, Souris, Lake Manitoba, Lake St. Martin

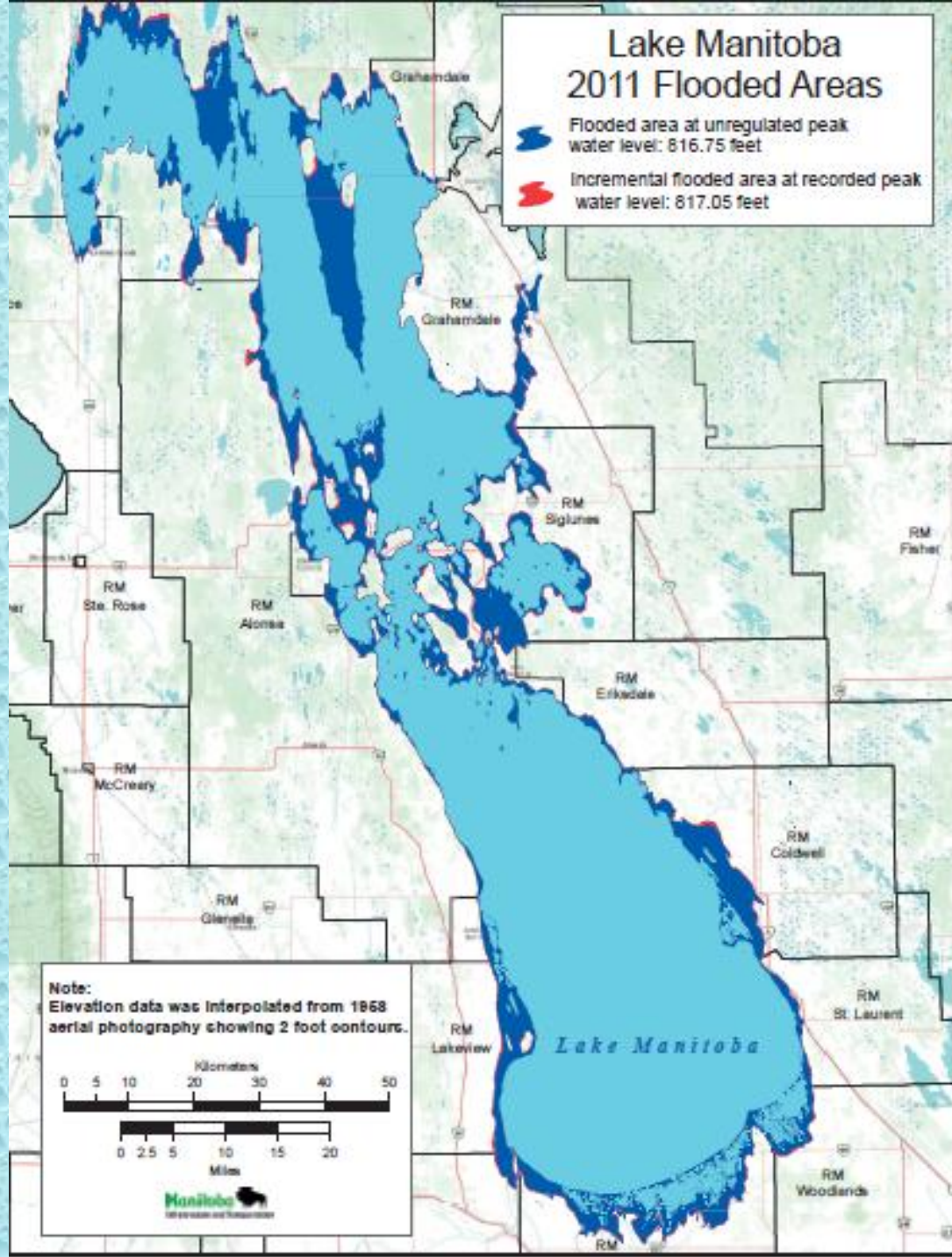
2011 Magnitude

- Large geographic area
- Multiple watersheds
- Multiple response areas
- Multiple area EOC's

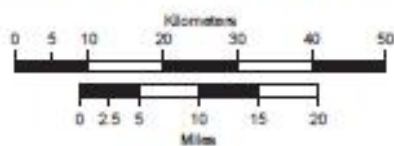


Lake Manitoba 2011 Flooded Areas

-  Flooded area at unregulated peak water level: 816.75 feet
-  Incremental flooded area at recorded peak water level: 817.05 feet



Note:
Elevation data was interpolated from 1958
aerial photography showing 2 foot contours.



2011 Flood Return Periods

- Assiniboine at Brandon - 250 (highest ever recorded)
- Assiniboine at Portage - 220 (highest ever recorded)
- Souris at Westhope - 210 (highest ever recorded)
- Qu'Appelle at Welby - 140 (highest ever recorded)
- Pembina at Neche - 43 (third highest recorded)
- Red River at James Ave - 30 (sixth highest recorded)
- Saskatchewan River at The Pas (highest since 1940's)
- Lake Manitoba water level – 400 +
- Lake Manitoba water / wind event – 1000 +/-

2011 Flood Summary

- EOC open > 100 days; 3x normal event
- 3500 evacuees; some still evacuated
- 70 State of Local Emergency, 30 Prevention Orders, 3 Provincial State of Emergency
- 1000 provincial staff; 1000 Armed Forces; 1000's of municipal resources; countless volunteers

Lake Manitoba Devastation – May 31, 2011









What Did We Learn ?

- Flood outlooks key to advance planning
- Flood forecasting difficult business
- Provincial practice to prepare for upper decile conditions confirmed as best practice
- Provincial flood protection systems and people in general are very resilient
- Extended flood event introduces fatigue
 - capacity and sustainability issues
- Knowledge transfer required - documentation
- Large flood scenario planning is critical

2011 Flood Conclusions

- Extreme emergencies can provide genesis of mitigation through innovation
 - New temporary flood mitigation technologies
 - New forecasting methods
 - New infrastructure or water management philosophies

2011 Flood Strategic Outcomes

- Initiatives
 - Flood Review Task Force
 - Lake Manitoba /Lake St. Martin Regulation Review
 - Provincial Surface Water Management Strategy
 - Completed almost 2 years after main event
- Outcomes
 - Over 150 recommendations
 - Draft surface water management strategy

Strategic Flood Mitigation Components

- Structural
 - Individual Properties
 - Community Infrastructure
 - Systems Infrastructure
- Non-Structural
 - Designated Flood Area (DFA) Legislation
 - Ice Jam Mitigation
- Temporary / Rapid Response Measures

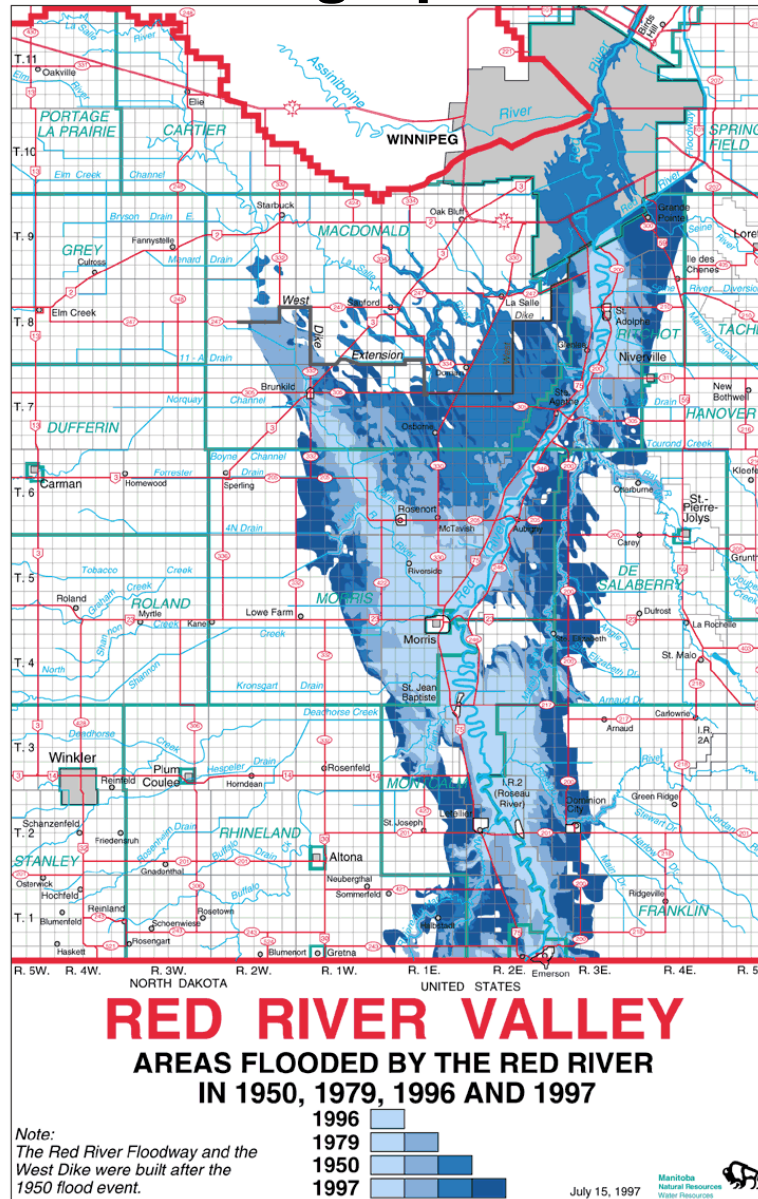
Non-Structural Mitigation Tool Designated Flood Areas (DFA)

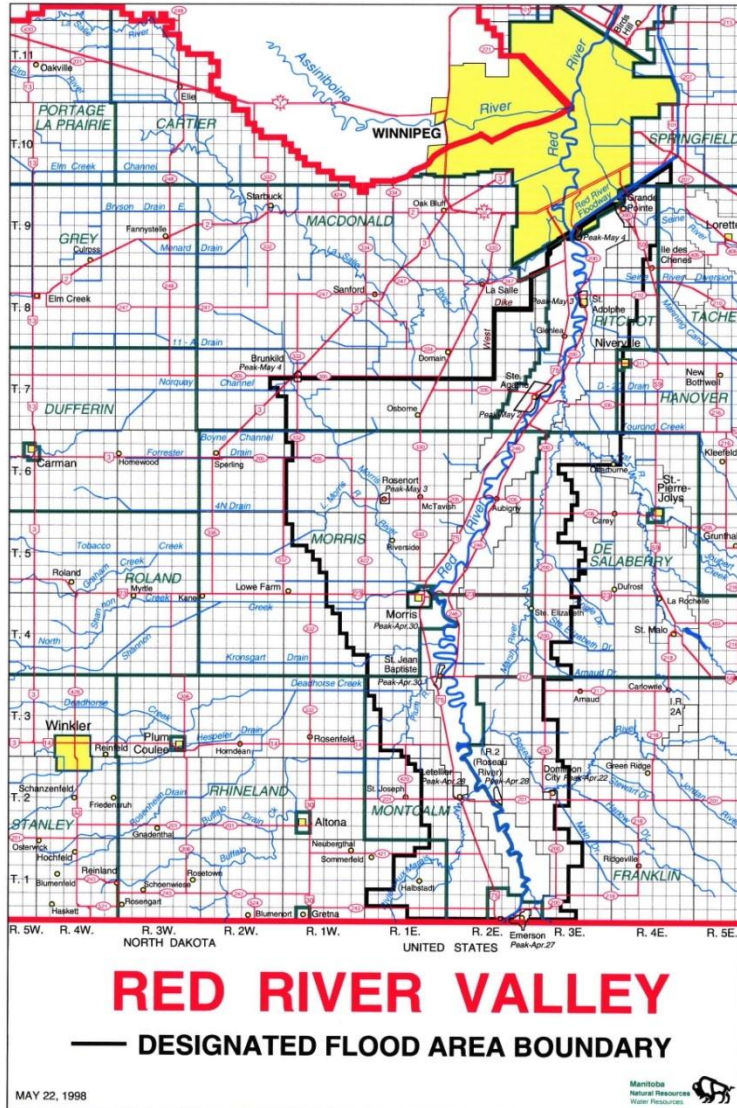
- Two Designated Flood Areas (DFA's) within the Province of Manitoba
 - the Red River Valley Designated Flood Area (RRVDFA) and
 - the Lower Red River Designated Flood Area (LRRDFA).

Red River Valley Designated Flood Area

- RRVDFA came into force after the 1979 Red River Flood and encompasses those lands upstream of the Red River Floodway and West Dike, which were determined by means of hydraulic modelling to be subject to flooding under 100 year conditions.
- The RRVDFA Boundary was broadened after the 1997 Red River Flood to encompass those lands which experienced actual flooding during what was the equivalent of a 100 year flood.
- Flood Protection Levels for sites within the RRVDFA are determined by the corresponding 1997 high water mark, either recorded or interpolated, plus a freeboard allowance of 0.6 metres (2 feet).

Historic Flooding Upstream of Winnipeg





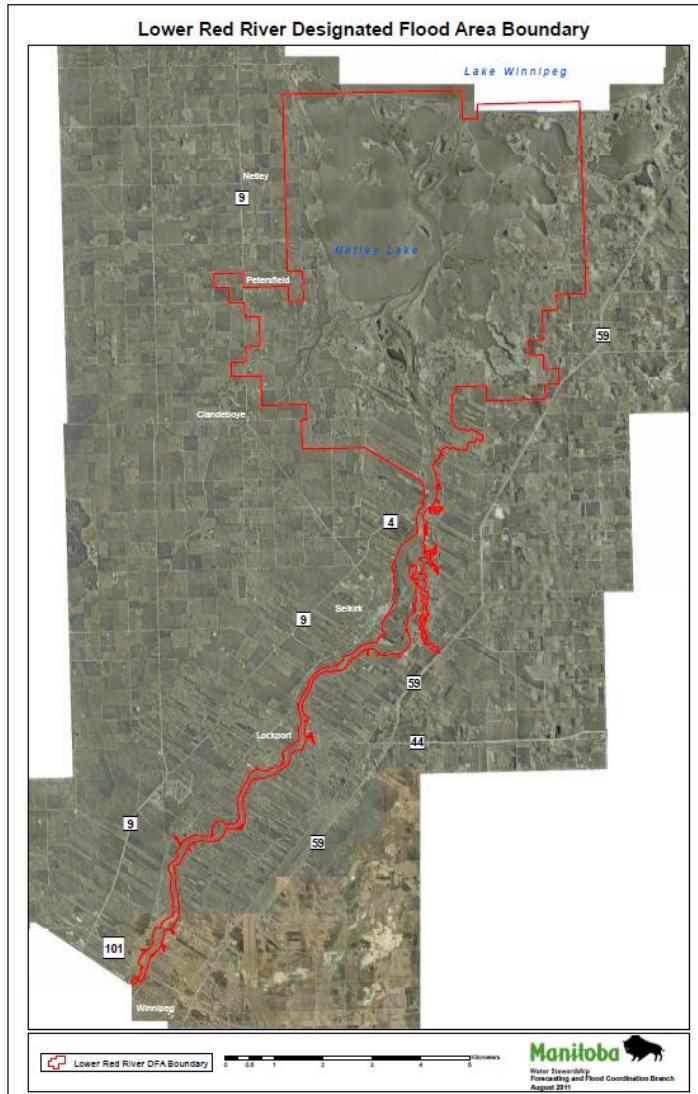
The Red River Valley Designated Flood Area

- Encompasses 2103 sq km
- Includes portions of 9 Rural Municipalities
- Contains 15 Community Dikes
- A total of 2541 permits have been issued since 1979.
- Post 1997, 1314 permits have been issued including:
 - 872 Houses & Detached Garages
 - 413 Farm/Business Buildings
 - 29 Neighbourhood Dikes

Lower Red River Designated Flood Area

- The LRRDFA came into force in September, 2011 and encompasses those lands downstream of the City of Winnipeg along the Red River, and at the lower reaches, upstream along Netley Creek, which are subject to flooding under design flood conditions.
- The LRRDFA Design Flood Profile is a compilation of 1997 open water, water surface elevations and ice jam affected water surface elevations from the years 1996, 2007, and 2009.
- Flood Protection Levels for sites within the LRRDFA are determined by the corresponding design flood level, plus a freeboard allowance of 0.6 metres (2 feet).

Lower Red River DFA



- North of Winnipeg
- Encompasses 326 sq km
- Includes portions of the Rural Municipalities of St. Andrews, St. Clements, East St. Paul, West St. Paul and the City of Selkirk.
- All construction within the Lower Red River DFA must be protected to design flood conditions plus a freeboard allowance of 0.6 metres (2 feet).
- To date a total of 42 permits have been issued.

Application to Build Within a DFA Consists of a **Two Stage Permitting Process**

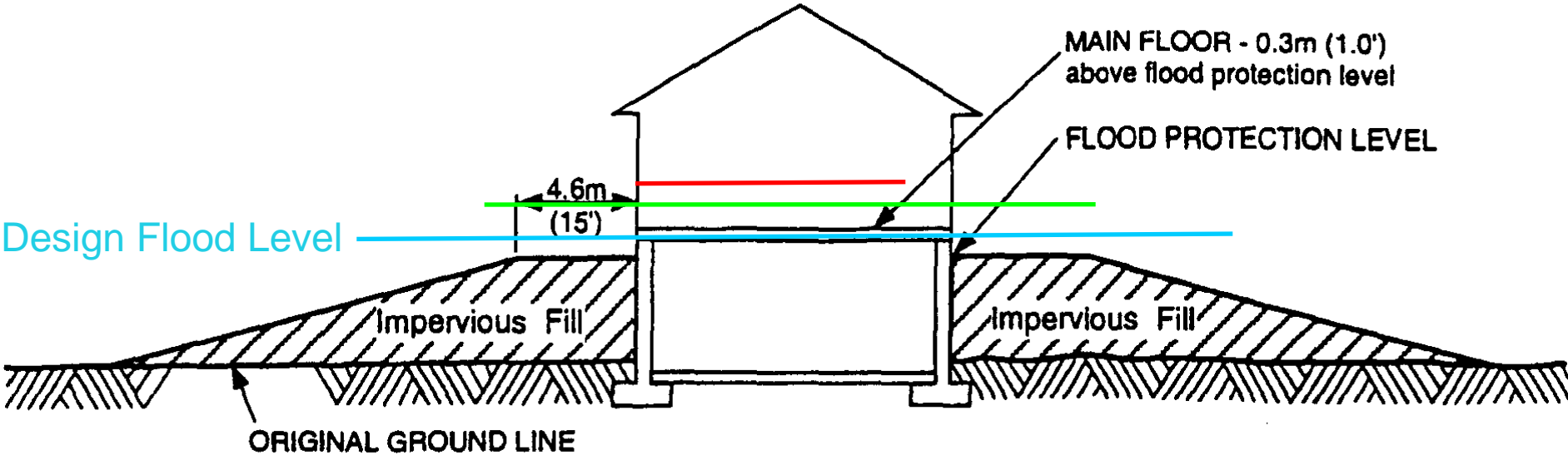
•**Stage One Permit:**

- Allows initial construction of the building's foundation Dike construction does not warrant a Stage One Permit. A Stage Two Permit is issued for such construction.

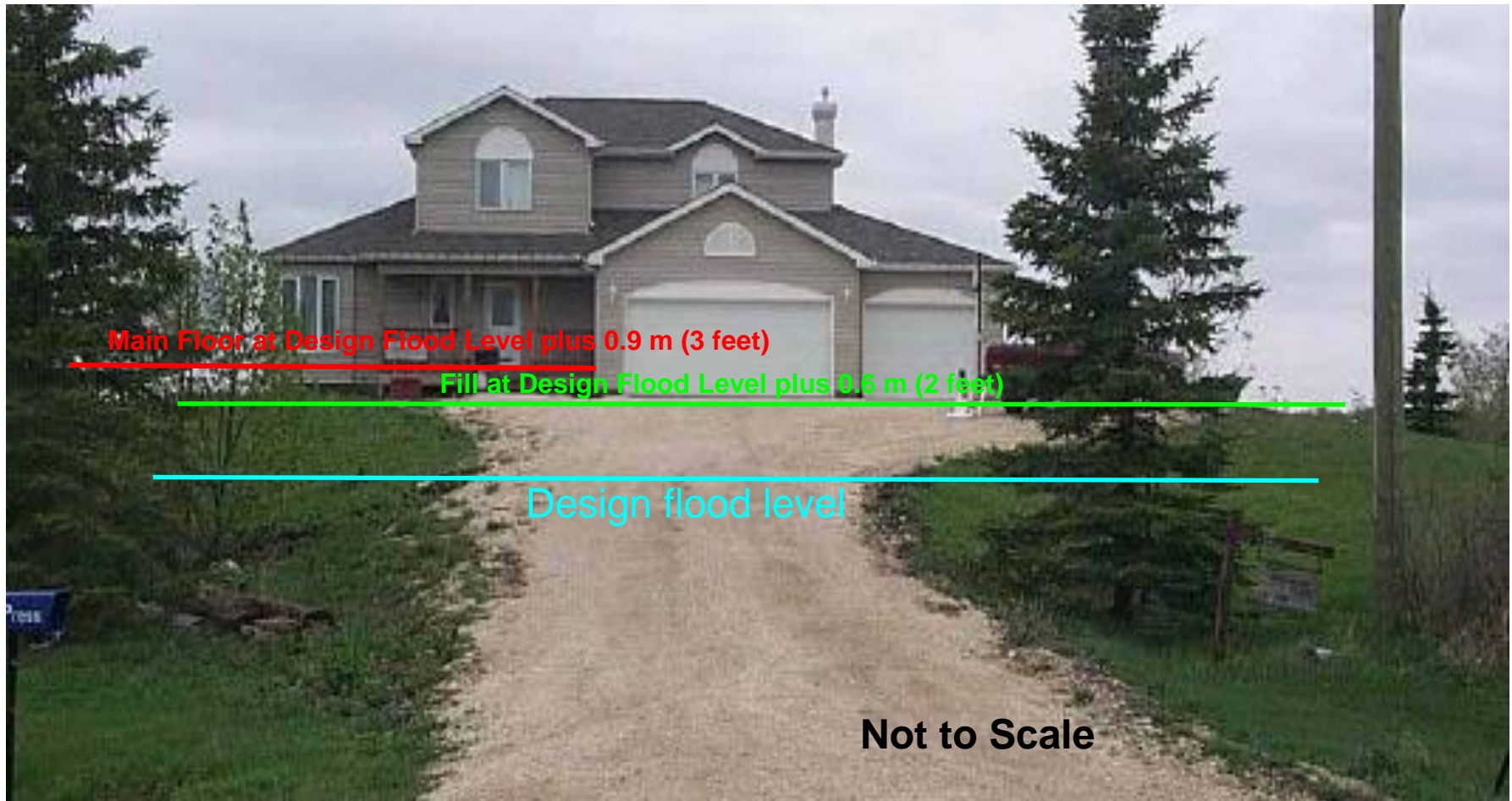
•**Stage Two Permit:**

- Allows remainder of construction to proceed once main flood elevation and foundation confirmed

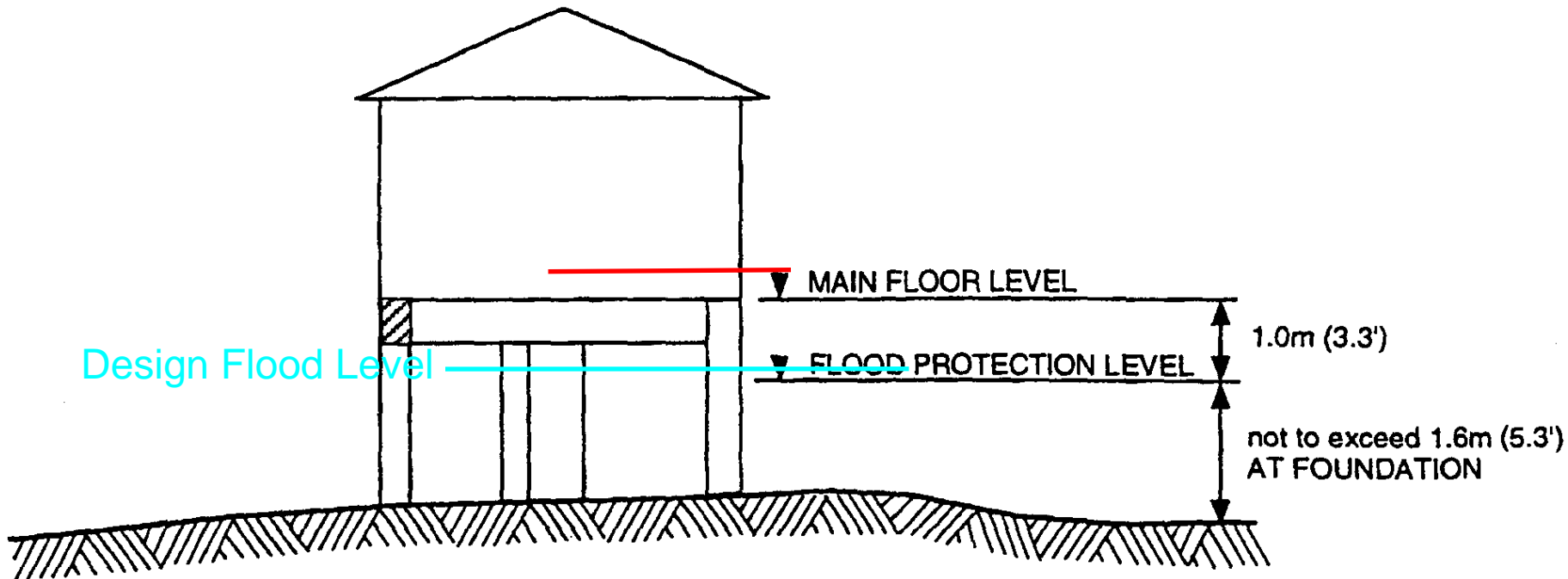
Structure Constructed on a Site Raised by Fill
With basement or cellar



House With Basement



Structure Constructed on Piles or Support System
“Elevated Structure”



Elevated Structure

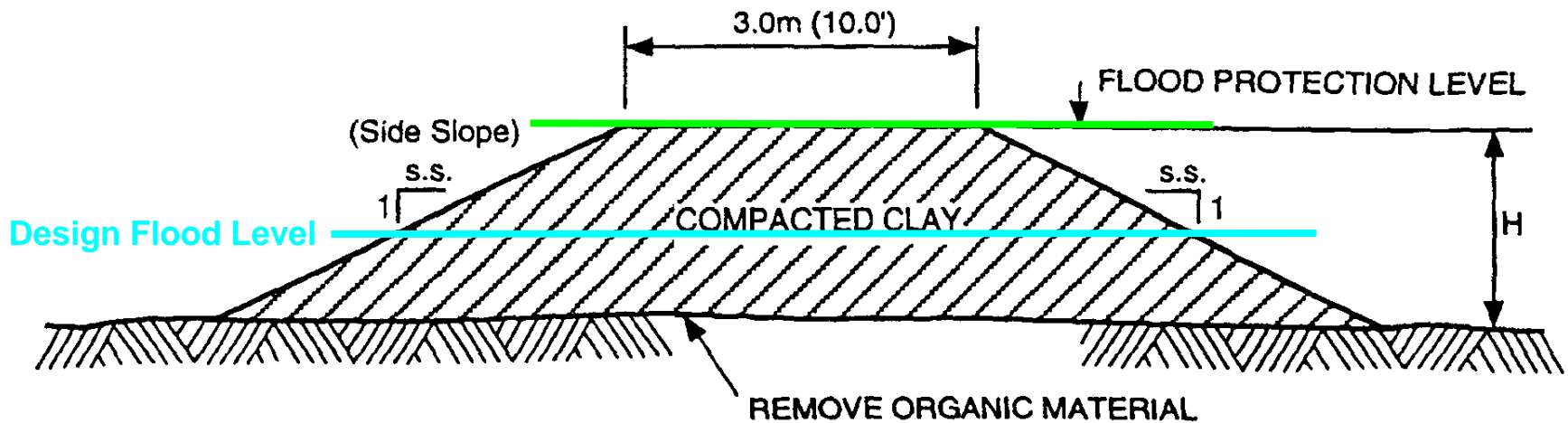


**Floodable Space
Water Resistant or Waterproof Construction**

Elevated Structure



Earth Dike Constructed for Flood Protection



Combination Dike



Neighbourhood Dikes

- Constructed around a number of private structures (residential, farm and business) at locations and in situations where individual flood protection works are not feasible due to either financial or physical constraints.
- Neighbours join together to construct a dike which will afford all of the structures within that dike protection to the corresponding design flood elevation plus freeboard.
- A legal and binding “Neighbourhood Diking Agreement” must be created and signed by all landowners

Development in the DFAs

- Nearly 2600 permits have been issued since the creation of the Designated Flood Areas in 1979.
- Overall the Regulation has been well received by Municipalities and property owners.
- Development has continued at a steady rate in these areas.
 - Restored confidence
 - Enables economic investment
 - Societal benefits

1997 Red River Flood Image

Rural Residential, Business, Agricultural Area



Post 2011 Activities

- Decision inputs
- Flood protection standards
- Structural mitigation
 - System infrastructure
 - Community infrastructure
 - Individual mitigation / protection
- Non-structural mitigation
 - Surface water management
 - Potential expansion of DFA's

Decision Inputs

- Decisions affected by:
 - Recovery progress / success
 - Post 2011 flood reviews – 150 recommendations
 - Public inputs and emotion
- Investments / decisions need to be based on good rationale not emotions
- Desired result is good public policy on mitigation where innovation can be introduced

Mitigation Decision Input

- Decision Making Dilemma
 - Overall public acceptance of risks versus need to invest not well understood
 - Good buy-in for those affected
 - Less buy-in from others

Investment Dilemma

- Consider Investing or Not Investing in Mitigation
 - 1:50 year protection means there is 2% chance of flooding every year
 - 1:100 means 1% chance of flooding every year
 - Statistical frequency not perfect distribution
 - Therefore, actual flood frequency experienced may be more frequent during a short period

Flood Mitigation Initiatives

- Flood protection standards
 - Current standard – 1:100 year event or flood of record
 - Proposed standard – 1:200 year event
 - Large urban areas have higher standard (Winnipeg currently protected to 1:700 year)
 - Some jurisdictions have up to 1:500 year standard

Flood Mitigation Initiatives

- System Infrastructure
 - 2011 Flood Task Force identified system investment needs
 - Flood Mitigation Study Underway to Review Options and Quantify Costs / Benefits
 - May Identify More Investments Required
 - Preliminary analysis indicates \$1 billion of investments recommended

Flood Mitigation Initiatives

- Major system infrastructure enhancements
 - New Lake Manitoba / Lake St. Martin Control Works
 - Shellmouth Dam enhancements
 - Portage Diversion enhancements
 - Lower Assiniboine River diking enhancements
 - These four components alone > \$600 million

Flood Mitigation Initiatives

- Enhanced community protection
 - > 20 communities in process of enhancing community flood protection to flood of record
 - Feasibility and cost/benefit part of process
 - Restores confidence
 - Social benefits
 - Economic / investment benefits
 - \$70 million program

Flood Mitigation Initiatives

- Enhanced individual protection
 - Funding to individuals to undertake flood mitigation
 - Will result in additional 1300 individual structures and businesses protected
 - First time limited program program to assist in protecting / mitigating for non-primary residence (cottages)
 - \$70 million program

Flood Mitigation Initiatives

- Non-structural measures
 - Surface water management strategy under development
 - Potential expansion of Designated Flood Area to other areas of the province
 - Extensive LiDAR mapping to clarify risks
 - Improvement to forecasting technologies / resources
 - Additional climatic stations
 - Forecasting models
 - Public communication protocols – information to consequence managers

Summary

- Flood risks are a reality in many parts of Manitoba and Canada
- Often difficult to predict
- Mitigation provides long term return on investment
 - Quantifiable damages
 - Soft, societal damages
 - Enhances confidence and promotes economic investment

Summary

- Flood events provide opportunity to introduce new ideas / innovation
- Mitigation is more than infrastructure
 - Development restrictions
 - Good forecasting
 - Good public information
 - Investments in Emergent Preparedness
 - Training
 - Planning
 - Response equipment

Thank You !

Questions