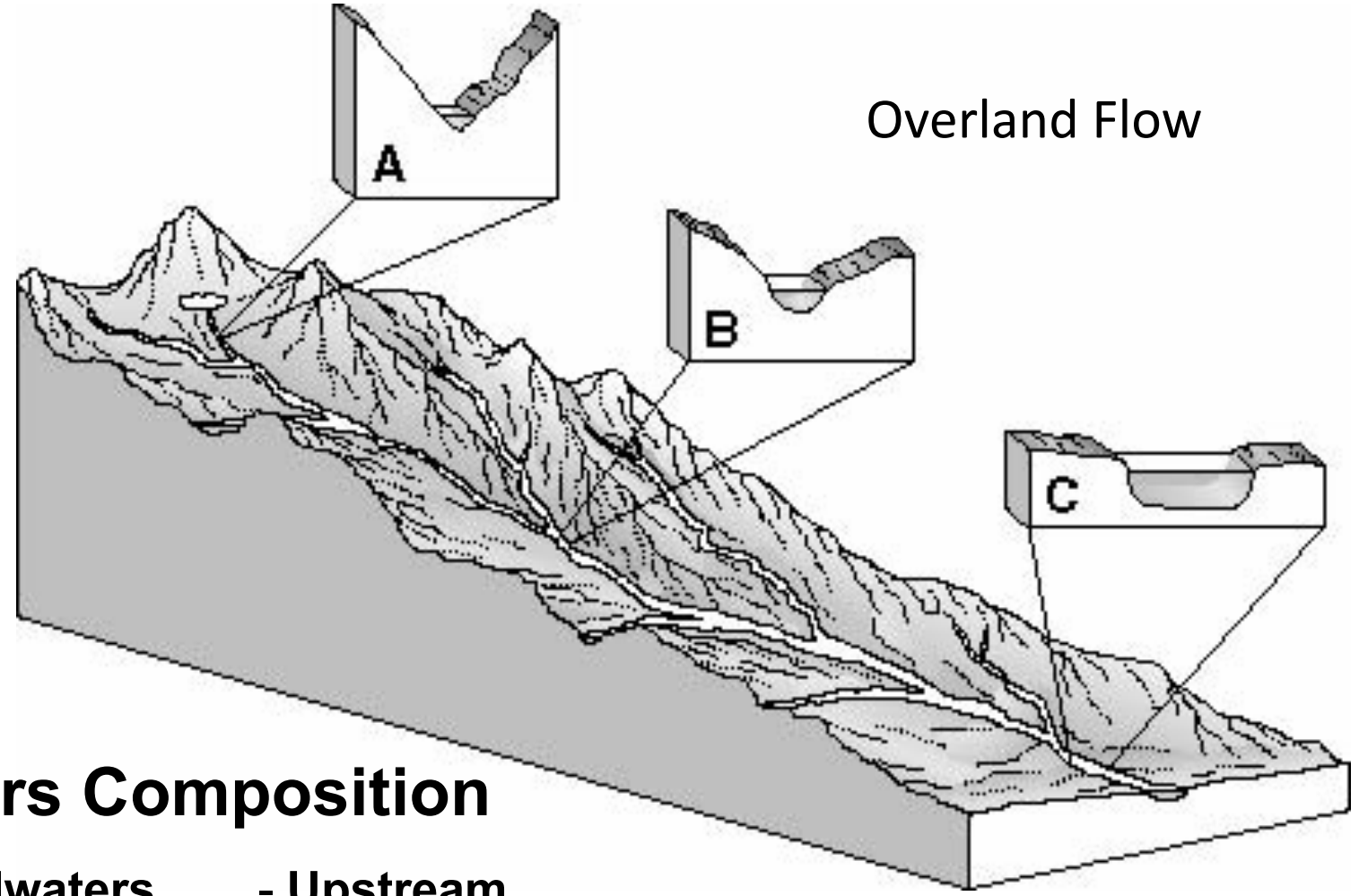
Flood and Floodplain Management

OUTLINE:

1. **The Floodplain Environment**
2. **Example of a flood event**
3. **Floodplain Management**
4. **Integrated Water Resources Management (IWRM)**

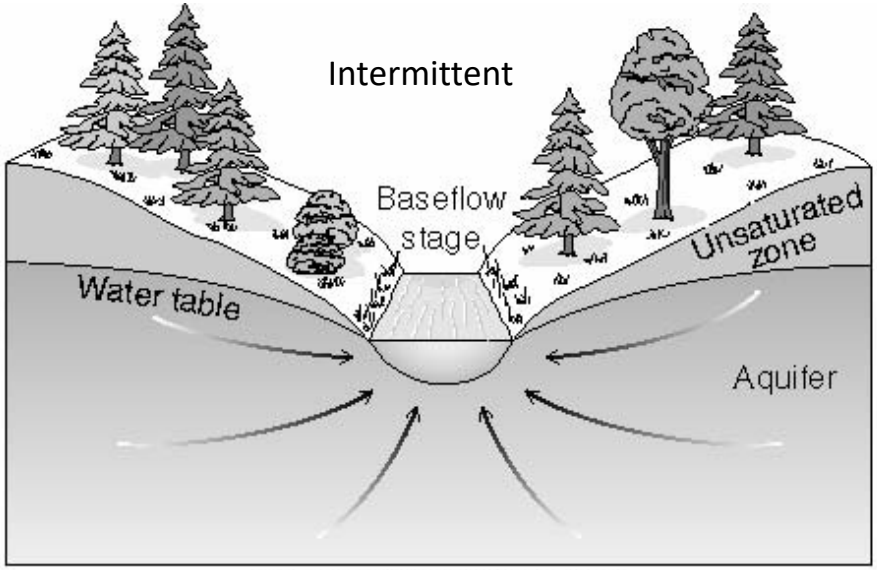
1. The Floodplain Environment



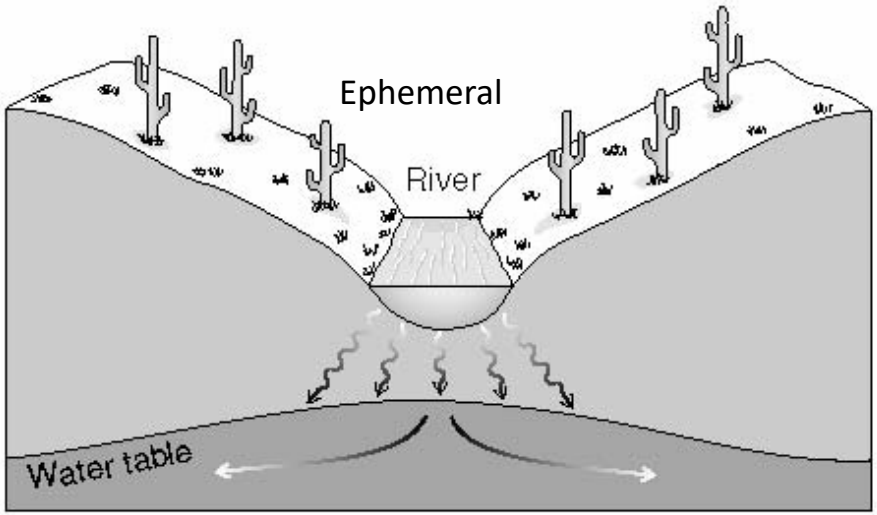
Rivers Composition

- Headwaters
- Tributaries
- Confluence
- Upstream
- Downstream
- Bank Storage

Rivers: Type and Morphology



Effluent (or gaining) river

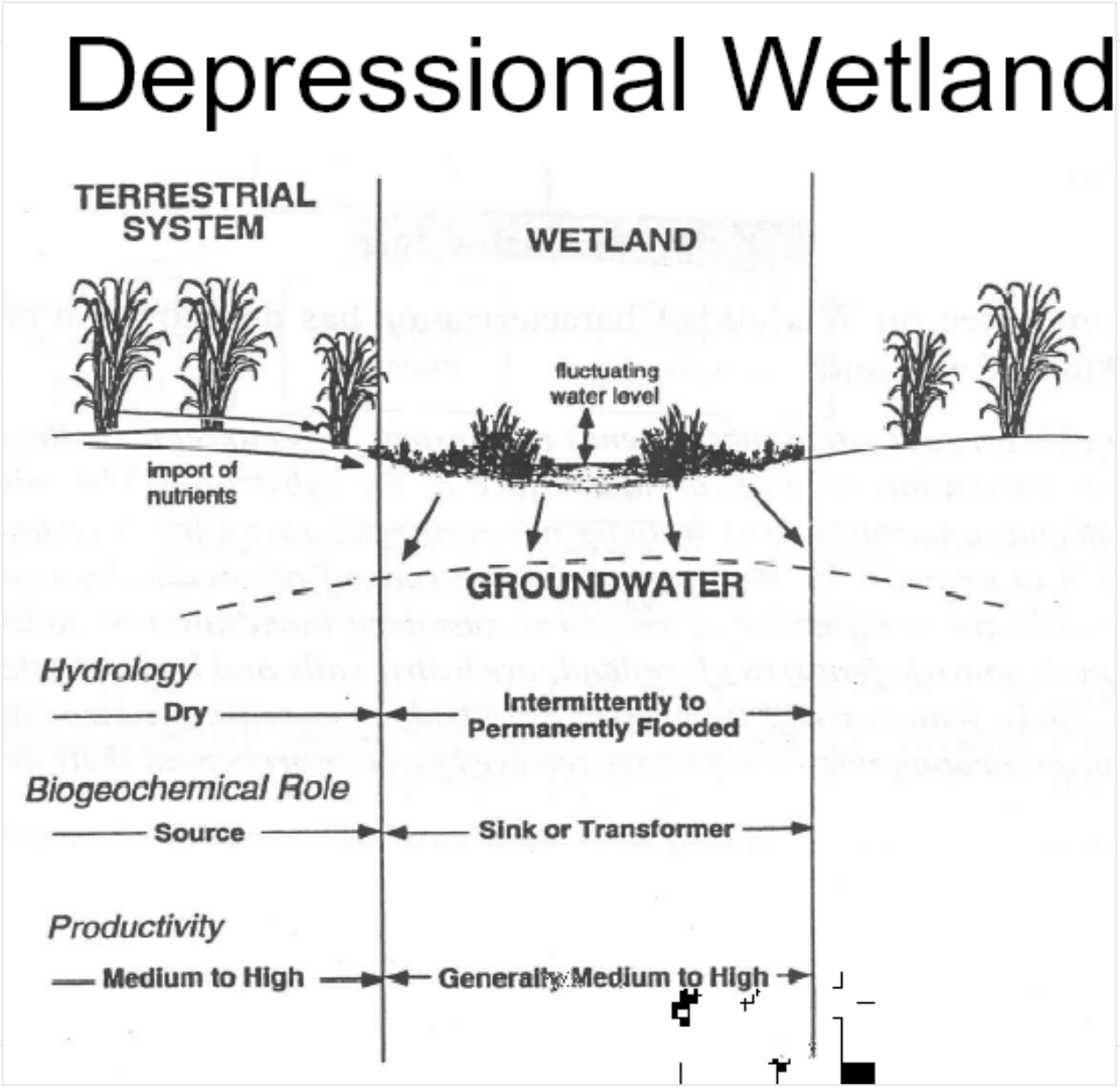


Influent (or losing) river

Gradient

- Decreases Downstream and reduces Velocity (m/km)
- Red River Elevation from N. Dakota to Lake Winnipeg averages 7.9cm/km (low of 2.4 cm/km)

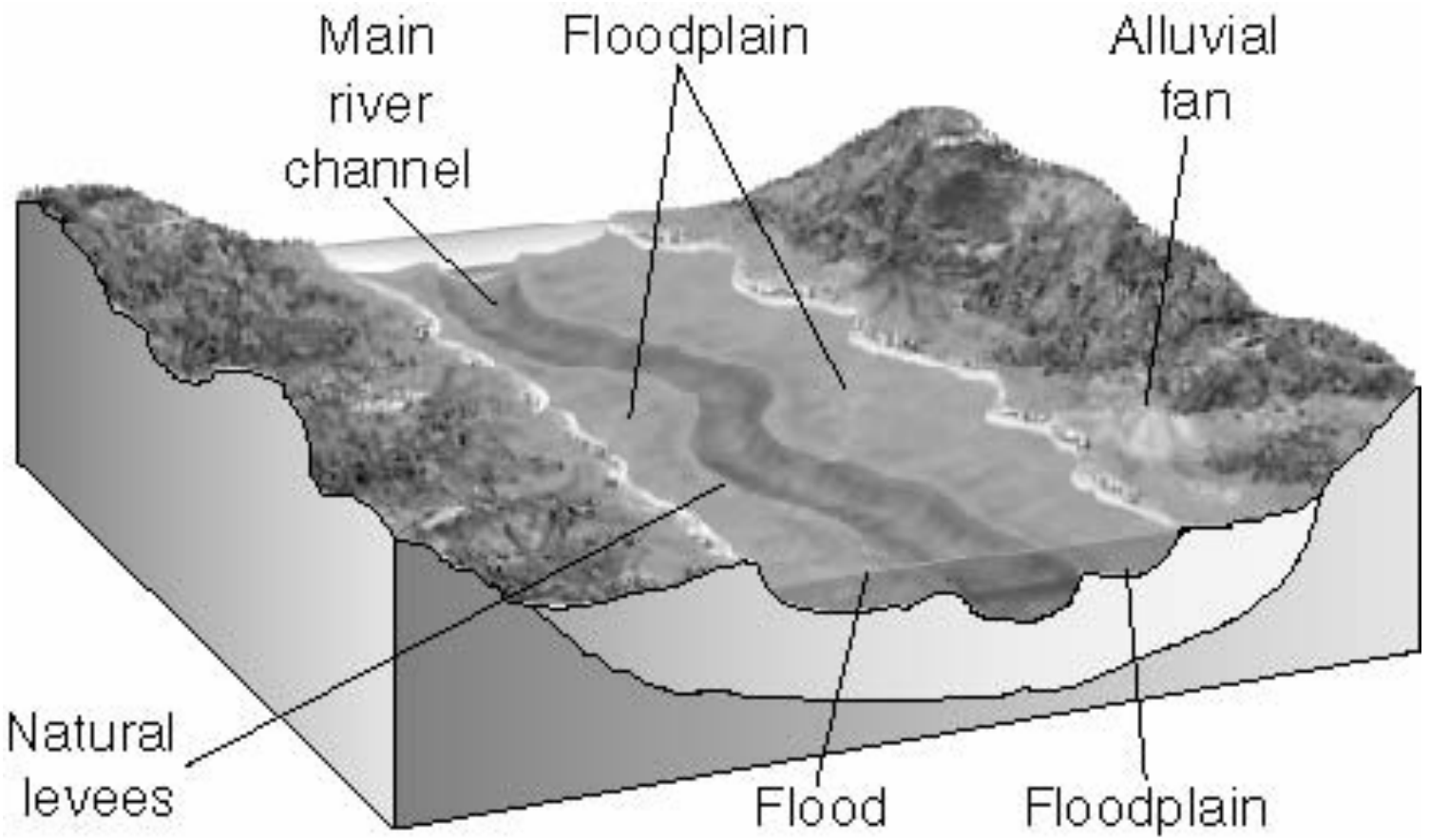
Function of Wetlands During Floods



Transport and Deposition

It was the river which had laid down the new land; it was the river which took it away. The endless cycle of building up, tearing down and rebuilding, using the same material over and over, was contributed to by the river. It was the brawling, undisciplined, violent artery of life and would always be.

- James A. Michener, Centennial



Water Measurement

Overland Flow

Q = KiA

Where: Q = peak rate of runoff in m3/sec

K = runoff coefficient

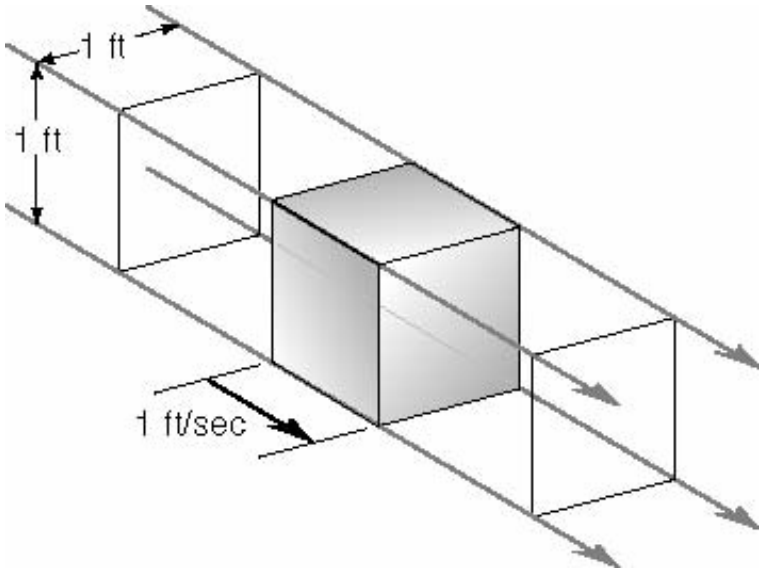
i = intensity of rainfall (cm/hr)

A = watershed area in ha

TABLE 3.3 Runoff Coefficients for the Rational Formula

Runoff Area	Value of K
Business	
Downtown	0.70–0.95
Neighborhood	0.50–0.70
Residential	
Single-family	0.30–0.50
Apartments	0.50–0.70
Industrial	
Light	0.50–0.80
Heavy	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35

Source: American Society of Civil Engineers, "Design and Construction of Sanitary and Storm Sewers," *Manuals and Reports of Engineering Practice* No. 37, 1970. Reproduced by permission of the publisher, ASCE.



***Discharge* = m^3/sec in Canada:**

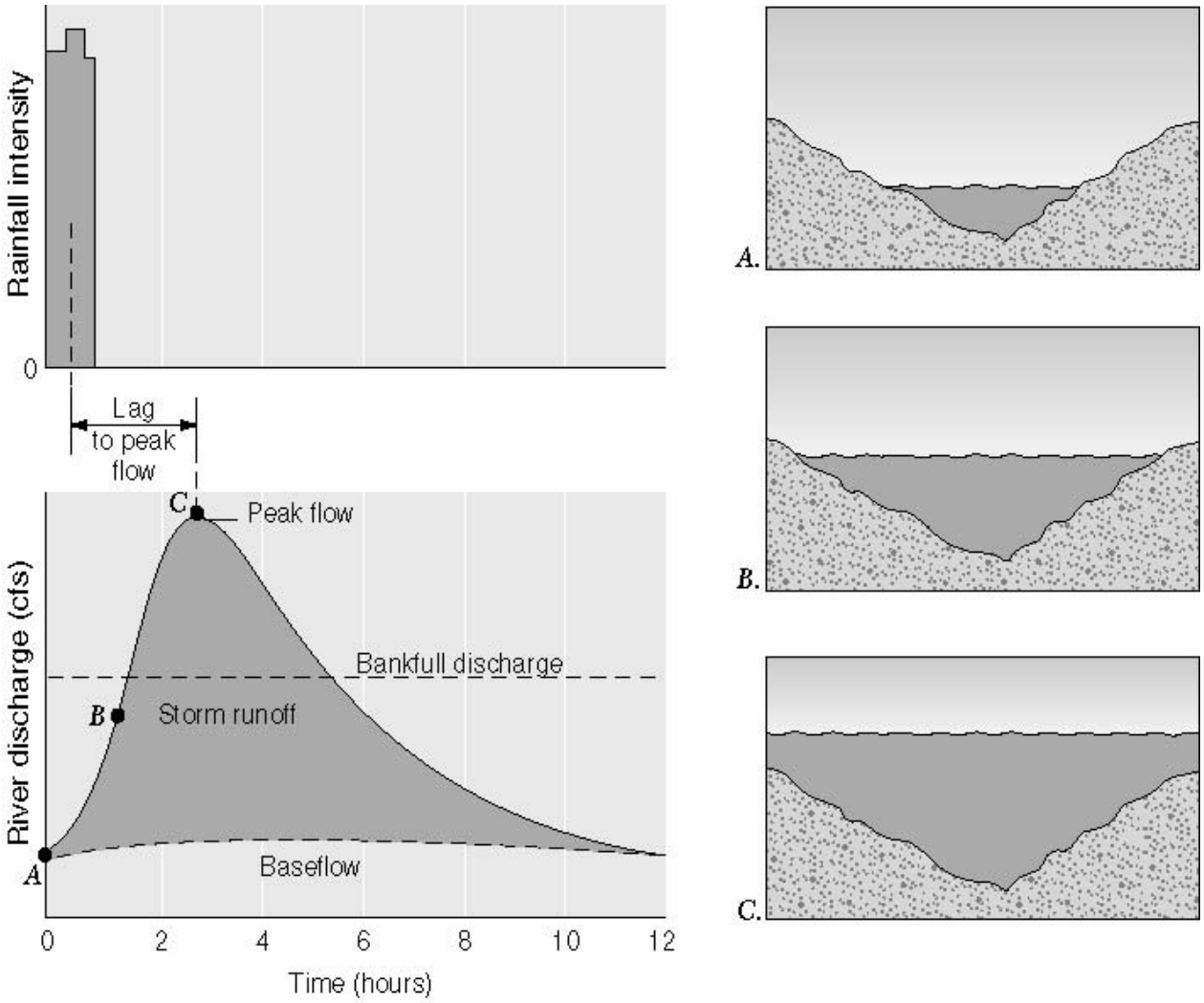
Q = AV

Where: Q = discharge

A = cross-sectional area of channel

V = average water velocity

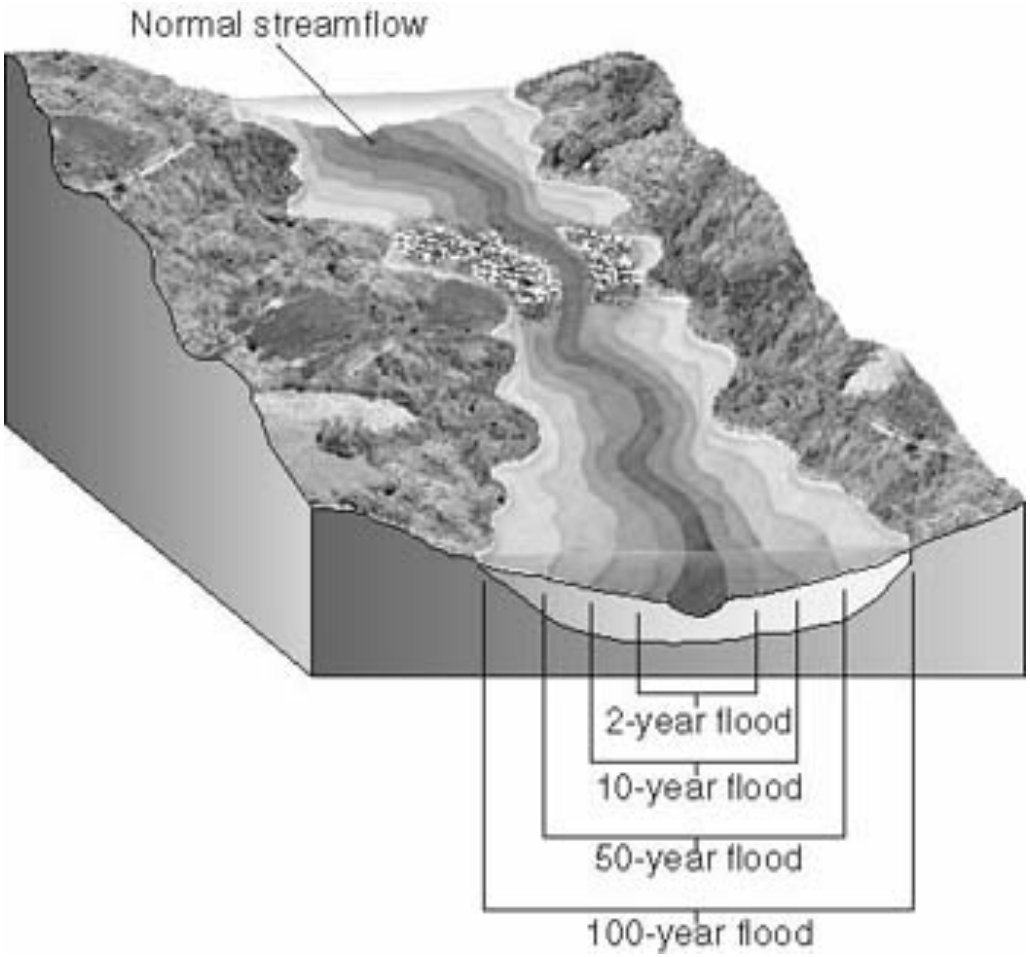
River Hydrographs



A river hydrograph is a graph of discharge over time and can be plotted daily, weekly, monthly or annually. Seasonal variations are evident on an annual hydrograph, whereas flood events are displayed on hourly, daily or weekly hydrographs.

Flood Events

Floods occur when precipitation and run-off exceed the capacity of a river channel to carry the increased volume



re: *Flood Frequency* - The laws of probability state that the chance of an
nt occurring are equal to the number of times it has occurred in the past.

2. Heavy Rain Event:

Thunder Bay , May 28, 2012

Summary of heavy rain event – May 28

Antecedent moisture conditions and overland flow

50 -100-year events (IDF curves)

Weather conditions late evening on May 27

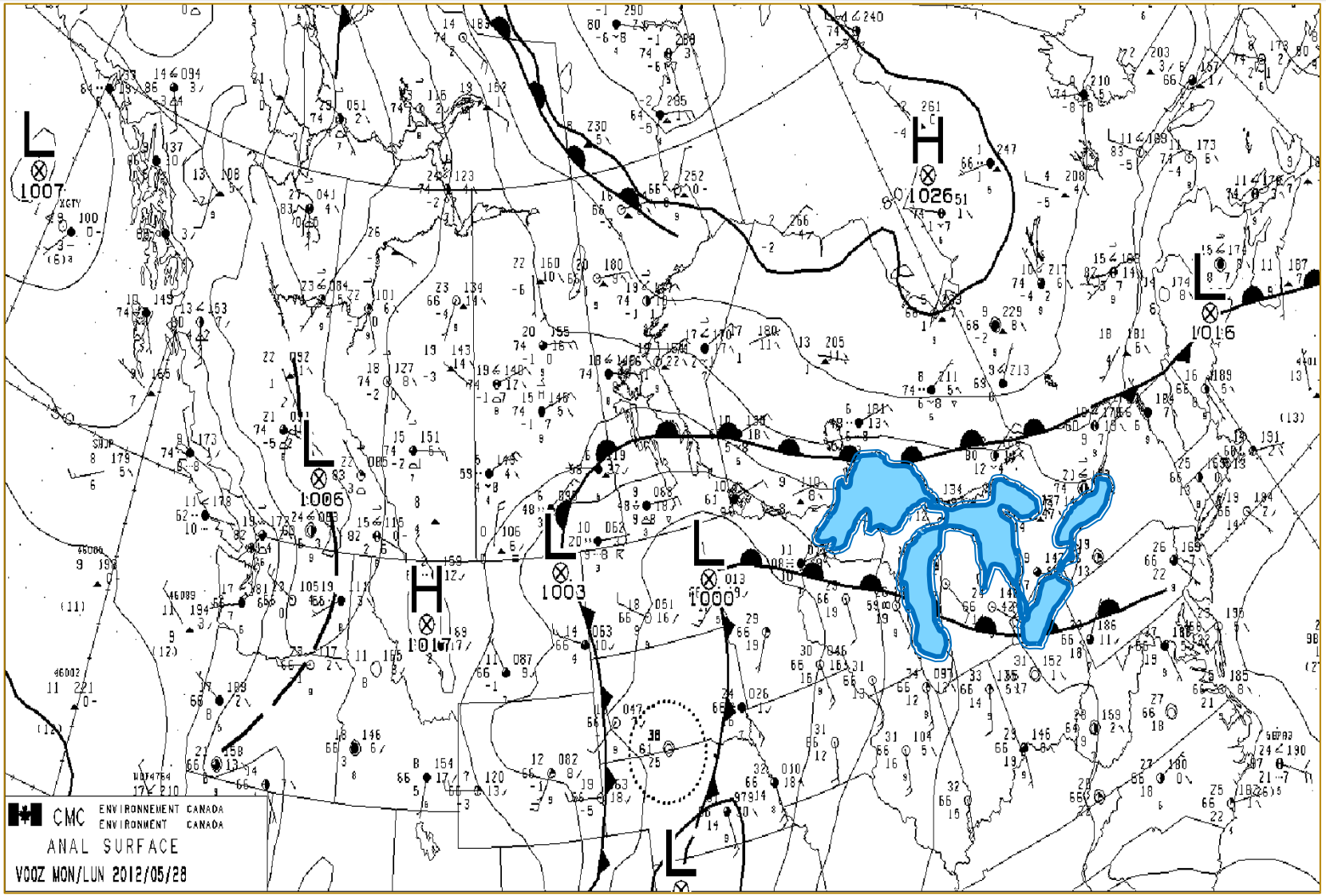
A low-pressure system and associated warm front moved from western Minnesota to southwest of Thunder Bay.

Environment Canada Forecast at 4 PM

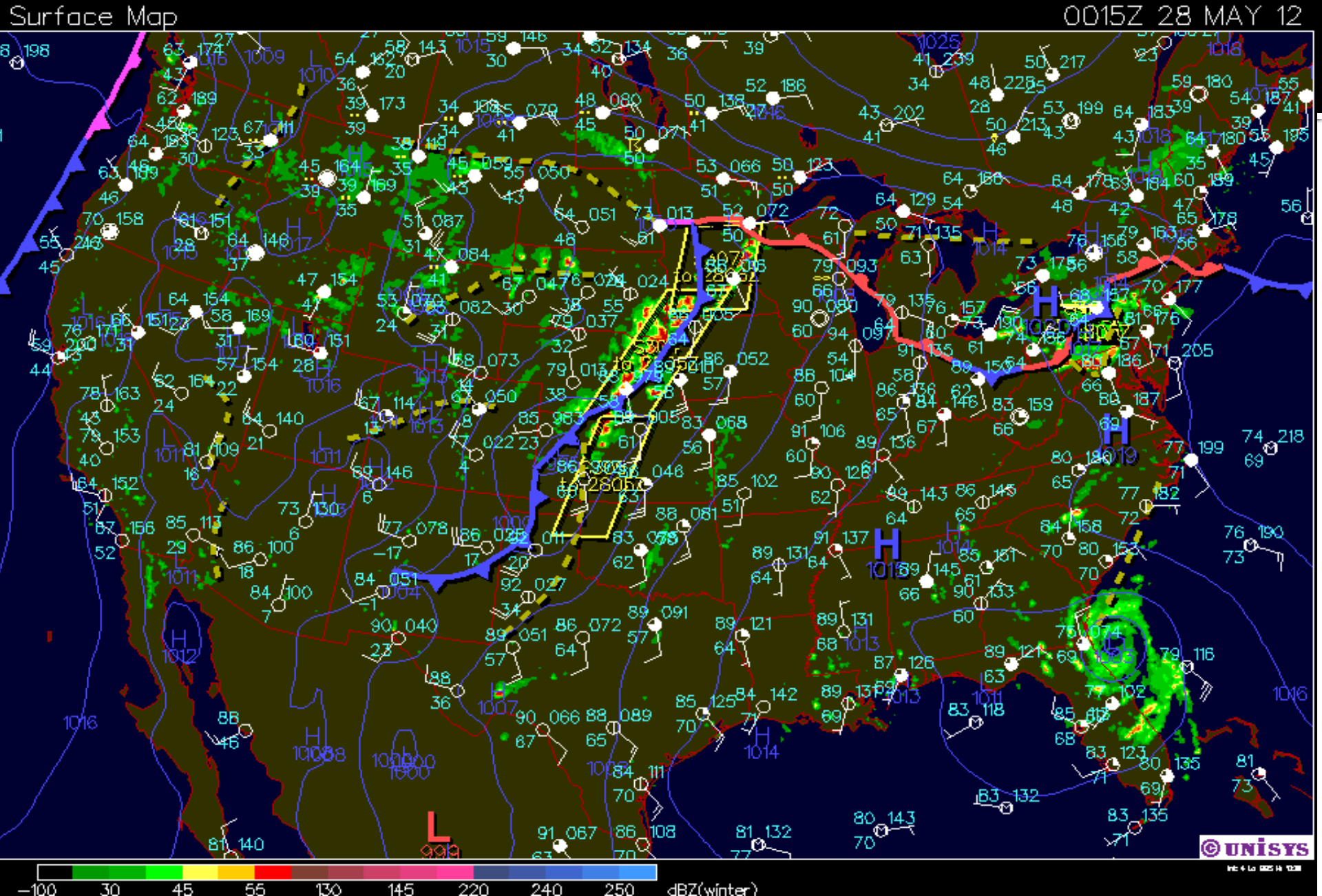
SUNDAY 27 MAY 2012

TONIGHT..SHOWERS WITH RISK OF A THUNDERSTORM. AMOUNT 10 TO 15 MM . . .

Surface analysis: May 27 at 2000 (8 p.m.)



Surface Analysis: May 27 at 2015 (8:15 p.m.)



Defining Rain Events

Light rain: to 2.5 mm per hour

Moderate rain: 2.6 mm to 7.5 mm per hour

Heavy rain: more than 7 mm per hour

≥ 50 mm in 24 hours = a **heavy rain** day

Some Rain Statistics for Thunder Bay – May 28, 2012

Rain began in Thunder Bay on May 28 at midnight

- **50 mm** was recorded between
  00:15 - 01:15 a.m. (1-hour record)
- **70 mm** in two hours (2-hour record)
- **100 mm** in 24-hour

- **65 mm:** average precipitation for the month of May
- May rain total: **201 mm** (monthly record for May)

Radar display of precipitation type

Colour	Precipitation Intensity	Weather Description
Blue	Light	Rain or snow
Cyan	Moderate	Rain or snow
Green	Heavy	Light thunderstorms and/or moderate rain showers
Yellow	Very Heavy	Moderate thunderstorms
Red	Intense	Potential flooding rains and severe thunderstorms
Magenta / Purple	Extreme	Flooding rains with severe thunderstorms

Making Sense of Radar Charts

Rainfall intensity

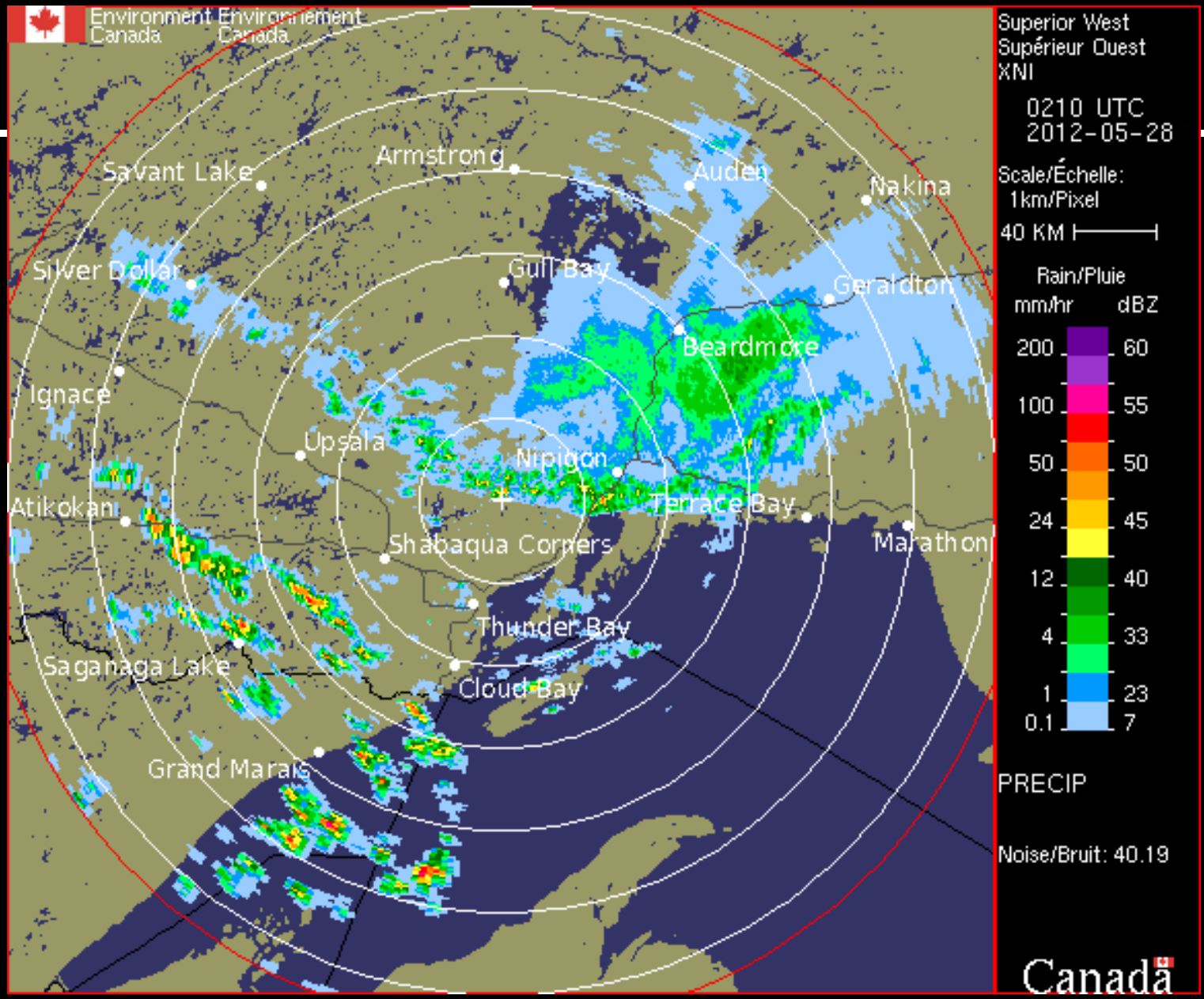
Radar displays spot estimates of rain amounts per hour
Example: Red has a range of 75 to 100 mm/hr

- Isolated thunderstorms
- Lines of thunderstorms

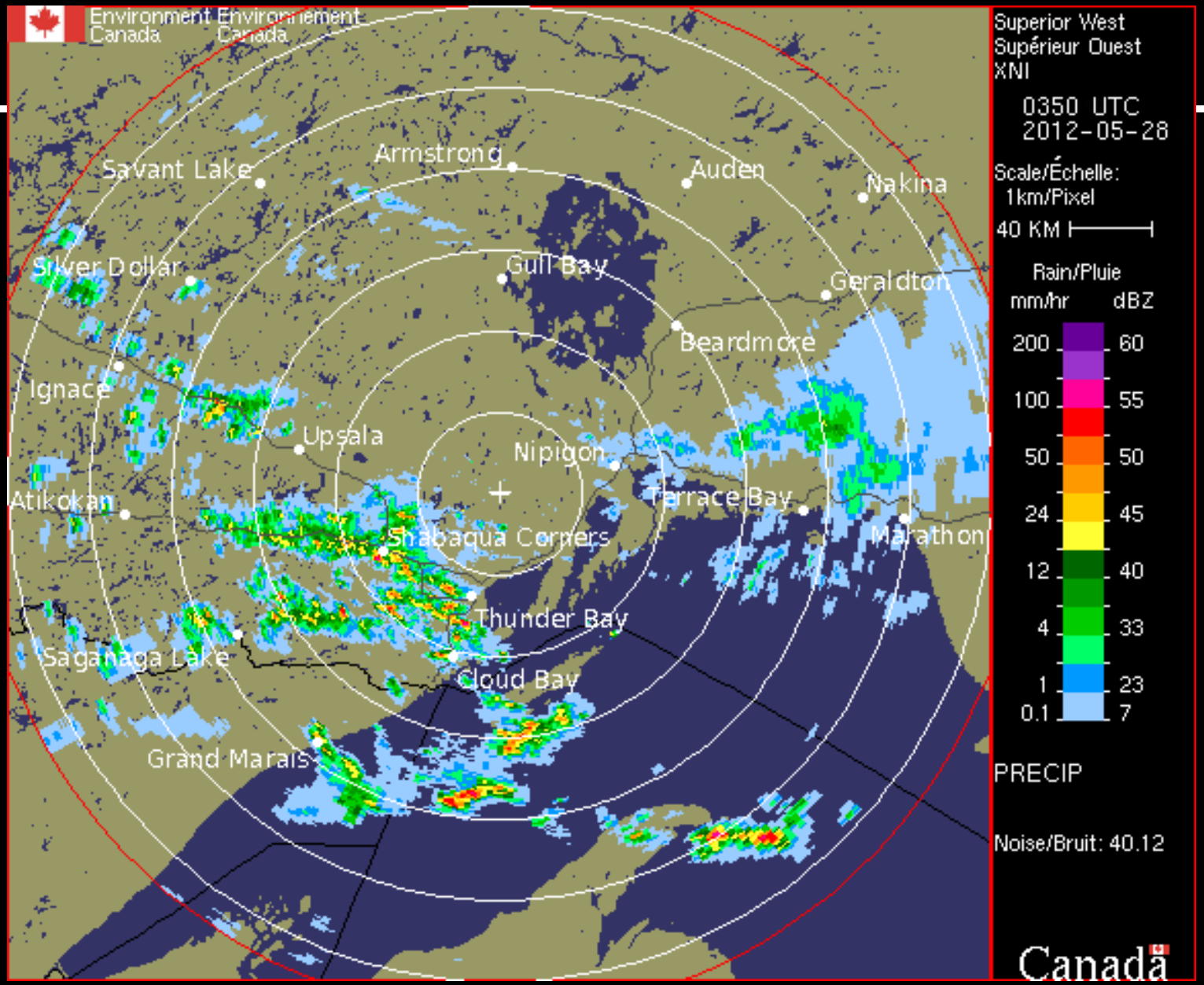
Typically, these pass over a location moderately quickly

In the following we see this feature, also thunderstorms that are stationary or re-form

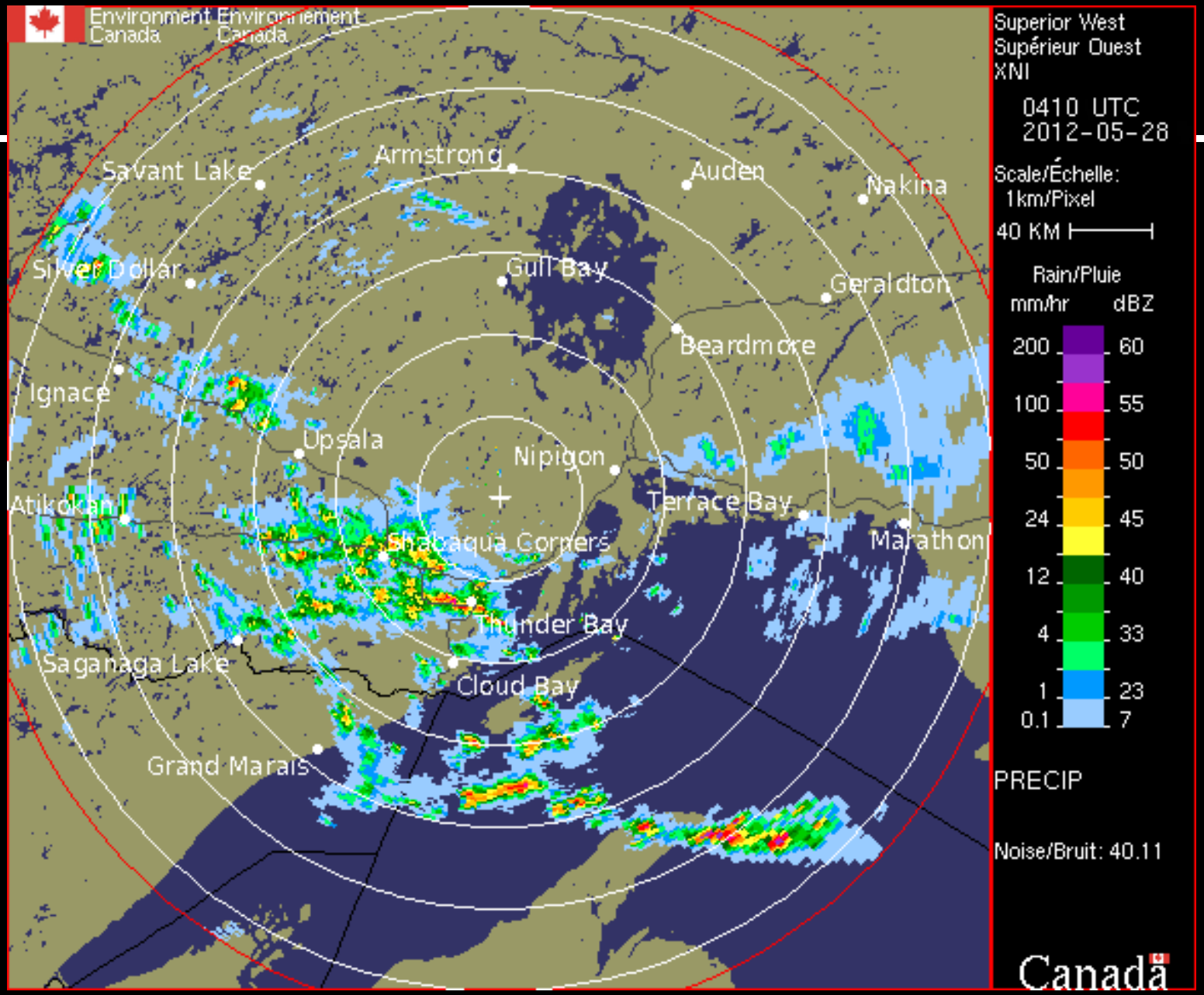
Radar: May 27 at 2210 (10:10 p.m.) Thunder Bay and area



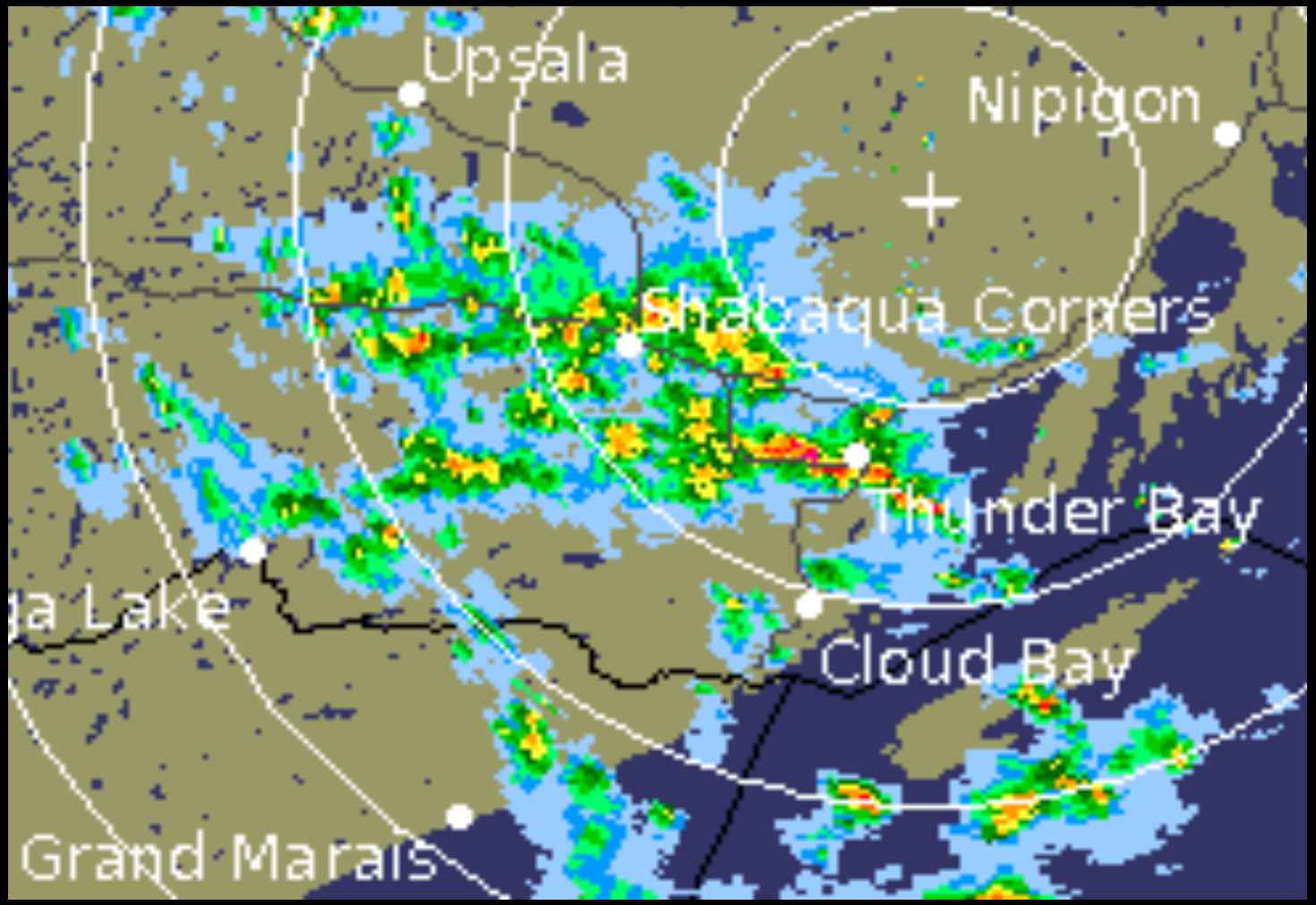
Radar May 27 at 2350 (11:50 p.m.)



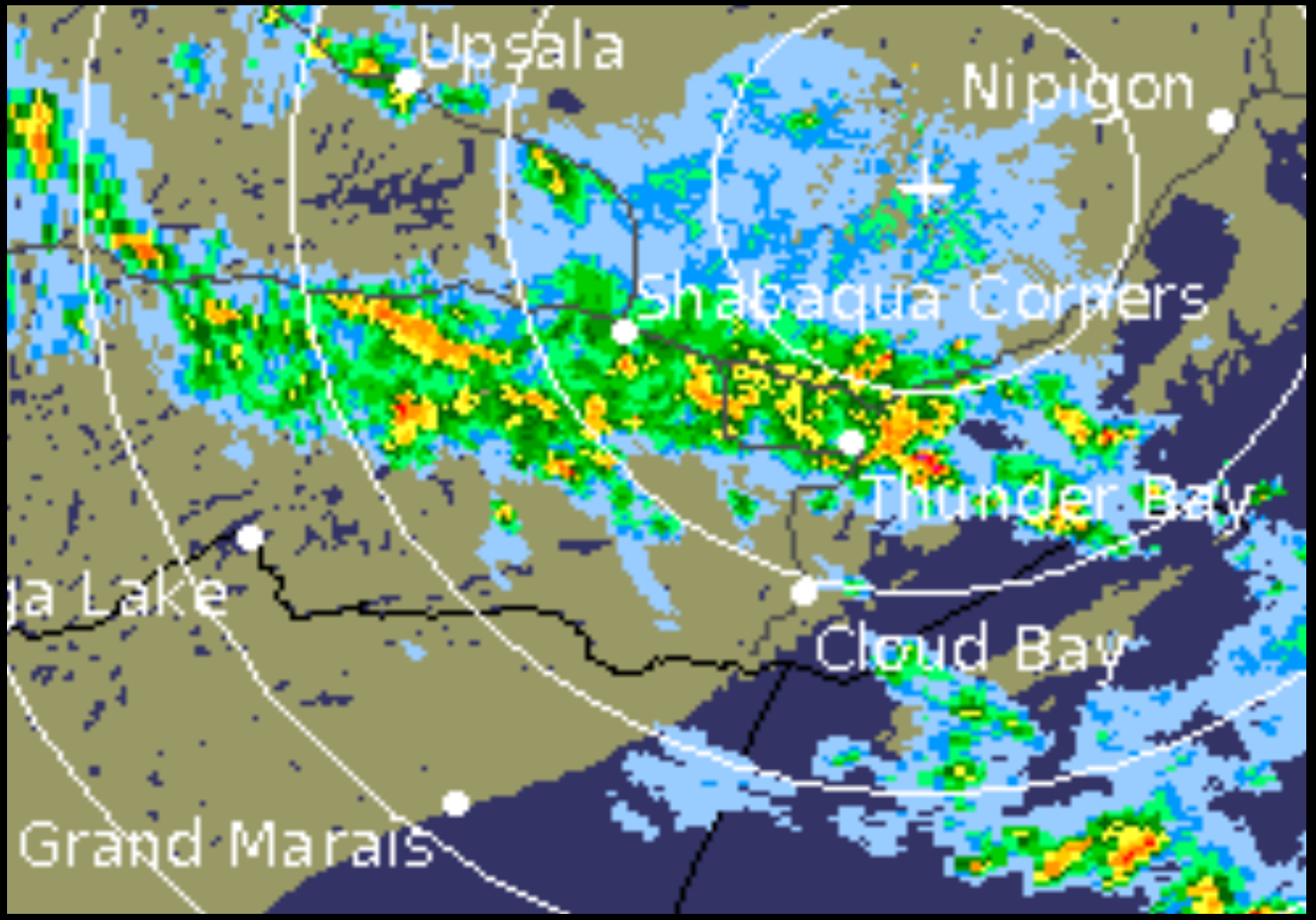
Radar: May 28 at 0010 (00:10 a.m.)

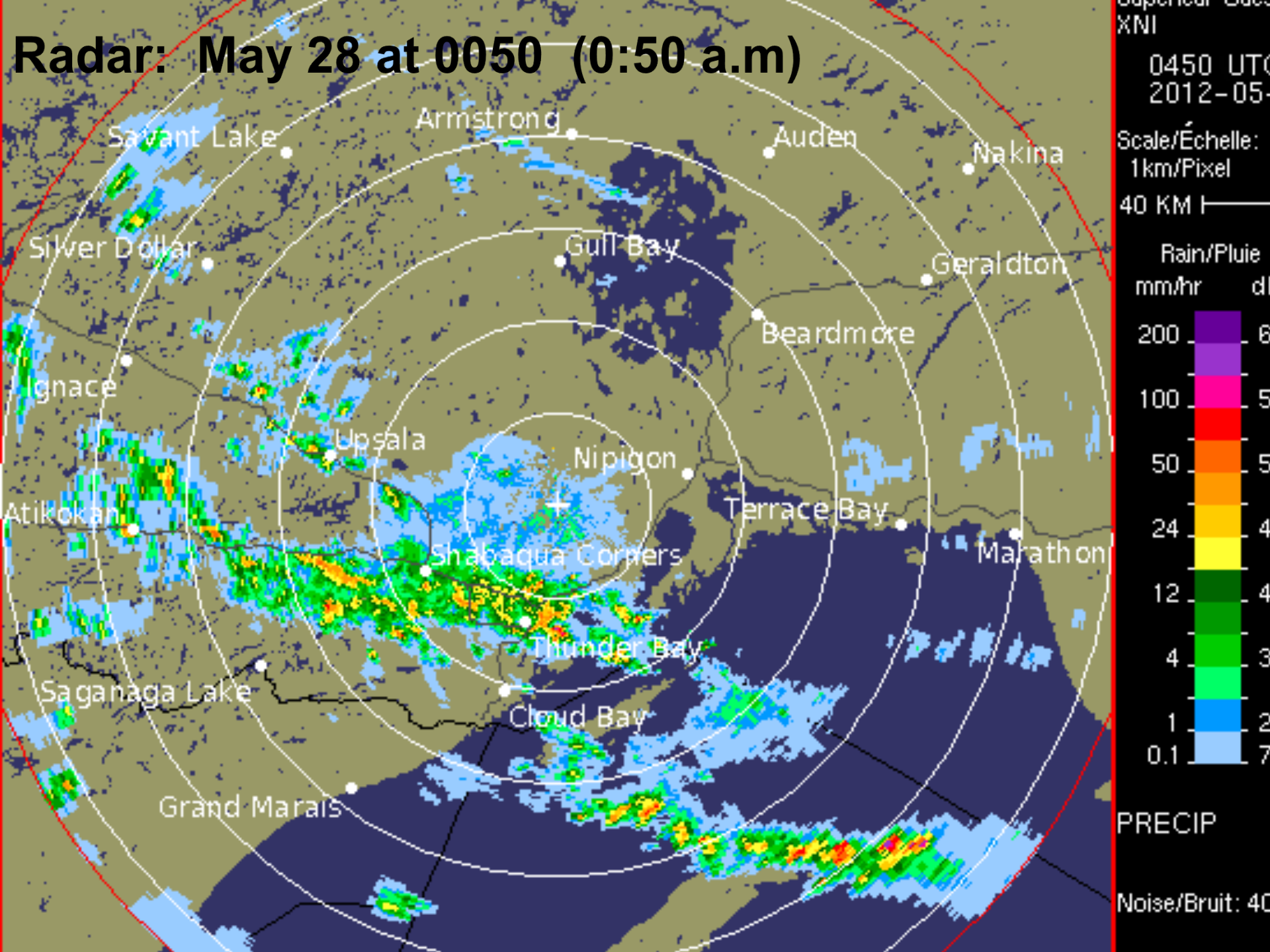


Radar: May 28 at 0010 (00:10 a.m.)



Radar: May 28 at 0030 (00:30 a.m.)




Radar: May 28 at 0050 (0:50 a.m)
Savant Lake
Armstrong
Auden
Nakina
Silver Dollar
Gull Bay
Geraldton
Beardmore
Ignace
Upsala
Nipigon
Atikokan
Terrace Bay
Marathon
Shabaqua Corners
Thunder Bay
Saganaga Lake
Cloud Bay
Grand Marais
XNI
0450 UTC
2012-05-
Scale/Échelle:
1km/Pixel
40 KM
Rain/Pluie
mm/hr
200
100
50
24
12
4
1
0.1
PRECIP
Noise/Bruit: 40

Environment Canada Warning: Severe Thunderstorms

EVERE THUNDERSTORM WARNING, ISSUED BY ENVIRONMENT CANADA
T 1:27 AM EDT MONDAY 28 MAY 2012.

EVERE THUNDERSTORM WARNING FOR:
NEW= CITY OF THUNDER BAY
NEW= ATIKOKAN - SHEBANDOWAN - QUETICO PARK =NEW= SUPERIOR
EST.

=DISCUSSION==
LINE OF NEARLY STATIONARY THUNDERSTORMS STRETCHES ALONG
GHWAY 11 TO THE WEST TO THUNDER BAY INTO THE CITY OF THUNDER
AY ITSELF.
OCAL RAINFALL AMOUNTS OVER 50 MM ARE EXPECTED BEFORE THE
EAVIEST RAIN TAPERS OFF IN THE NEXT HOUR OR TWO. HOWEVER, MORE
AIN IS STILL EXPECTED DURING THE NIGHT AND MONDAY. …

Antecedent Moisture Conditions

May 1 to 22: featured average rainfall

May 24: Heavy rain day
(50 to 60 mm measured)

May 25 to 27: 5 to 25 mm

Overland (surface) water flow

Overland Flow

Formula:

$$Q = KiA$$

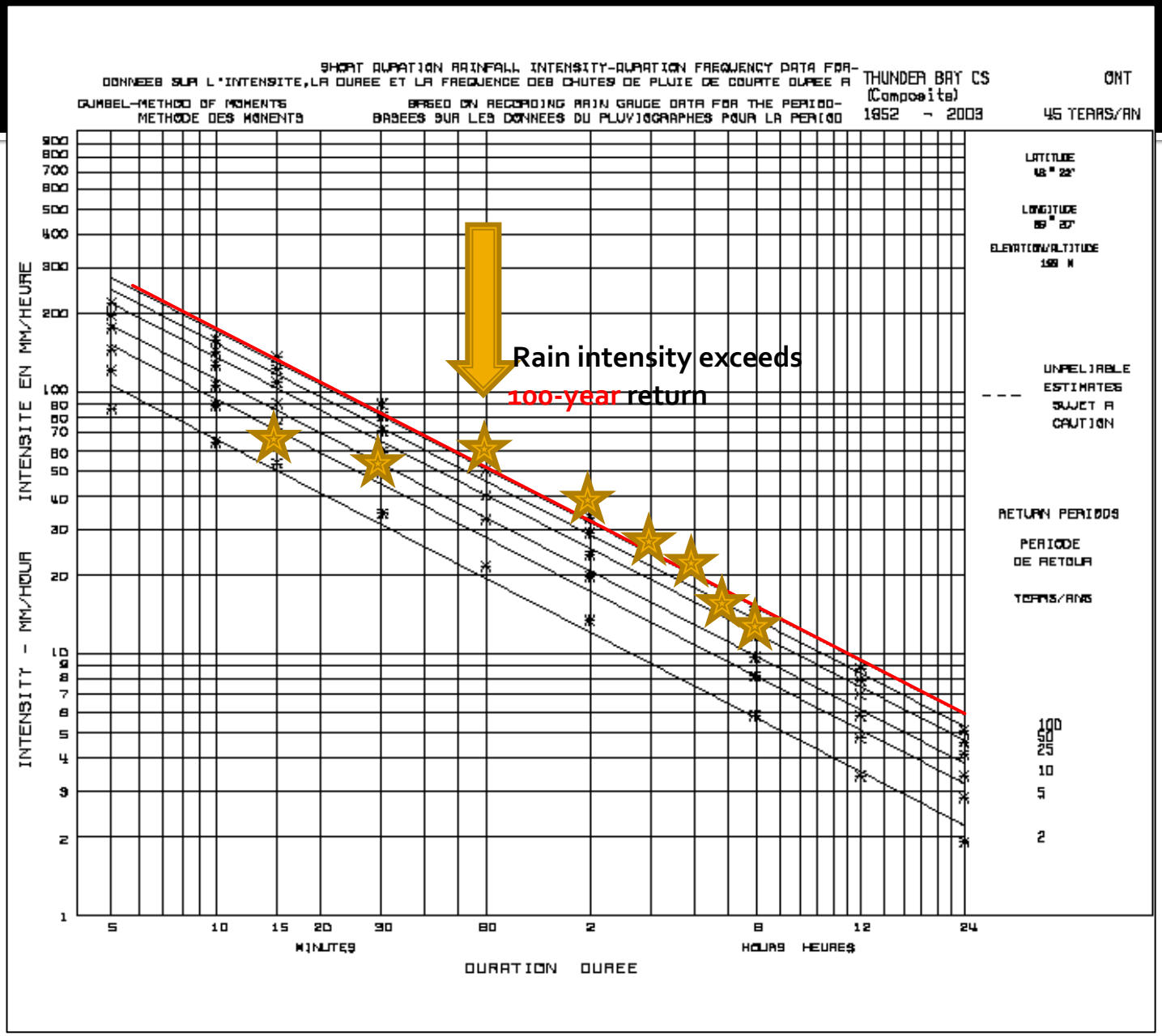
Where: Q = peak rate of runoff in m3/sec

K = runoff coefficient

i = intensity of rainfall (cm/hr)

A = watershed area in ha

Thunder Bay Airport Intensity Duration Frequency



Rainfall Measurements

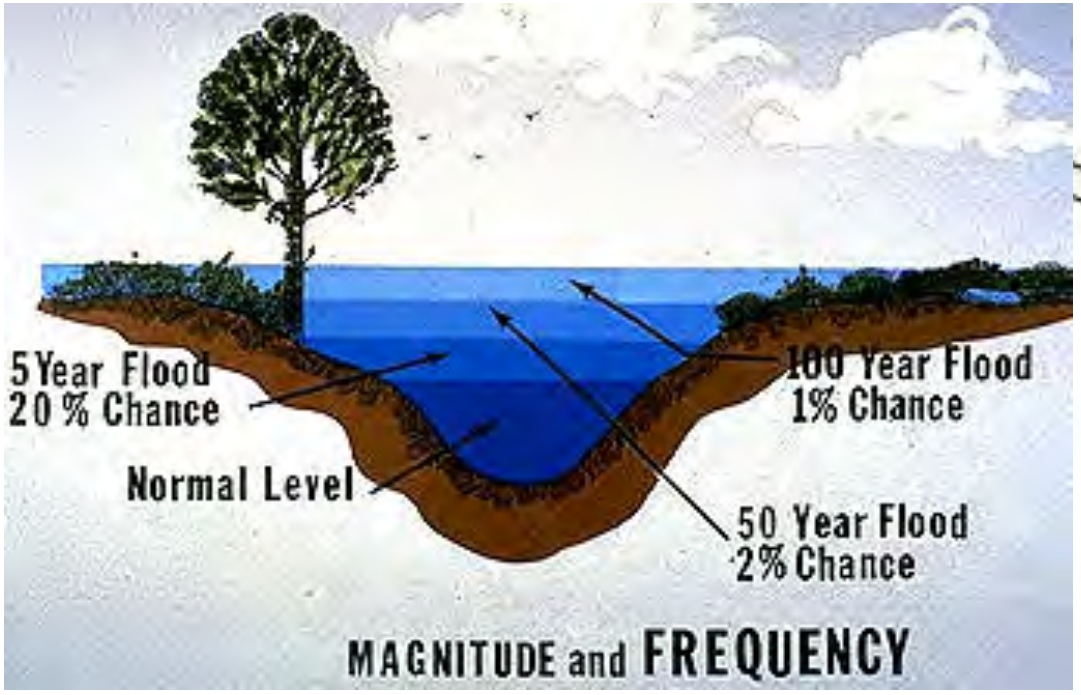
Problems and potential errors especially with heavy rain events equal to or greater than 75 millimetres.

- Rain gauge location
- Wind
- Mechanical errors

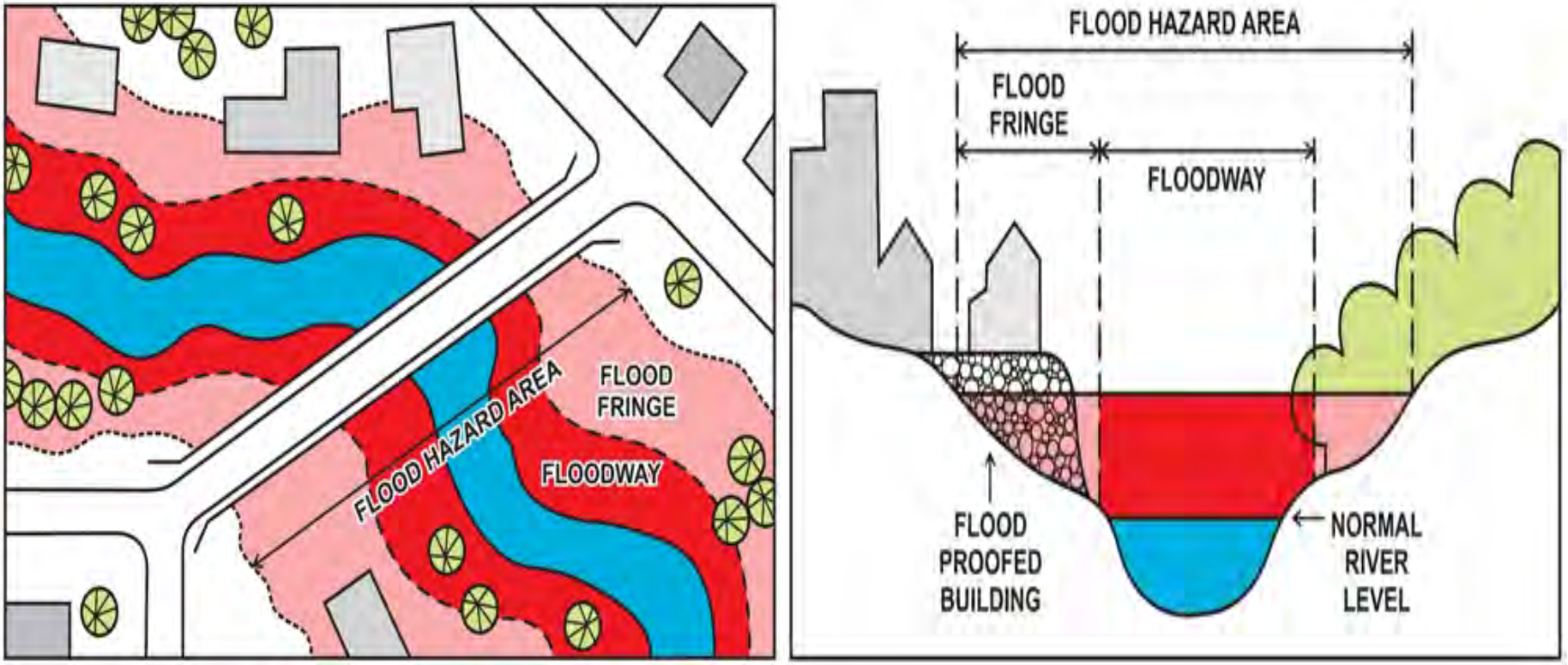
Rain totals tend to under report actual amounts.

3. Floodplain Management

Floodplain management strives to maximize benefits of living on the floodplain by minimizing flood damage potential (Structural and Non-Structural Mitigation)



- Fertile alluvial plains
- River-based recreation and tourism
- Transport corridor for commerce and industries
- Urban convenience of level land for construction



Source: http://environment.alberta.ca/

COMMON MITIGATION MEASURES

Structural Measures

- Flood mitigation storage
- Channel Modification
- By-pass floodways
- Levees and floodwalls

Non-Structural Measures

- Planning and zoning controls
- Relocation
- Economic incentives
- Flood insurance
- Flood information
- Flood adaptation

What is Being Done About Flood Damage?

In an effort to reverse the trend of rising flood damage, various agencies have undertaken programs that can be grouped into three general categories:

A. Keeping flood waters away from people & buildings by:

- Constructing dams, levees, & floodwalls
- Enlarging or altering stream channels
- Decreasing runoff through land treatment measures

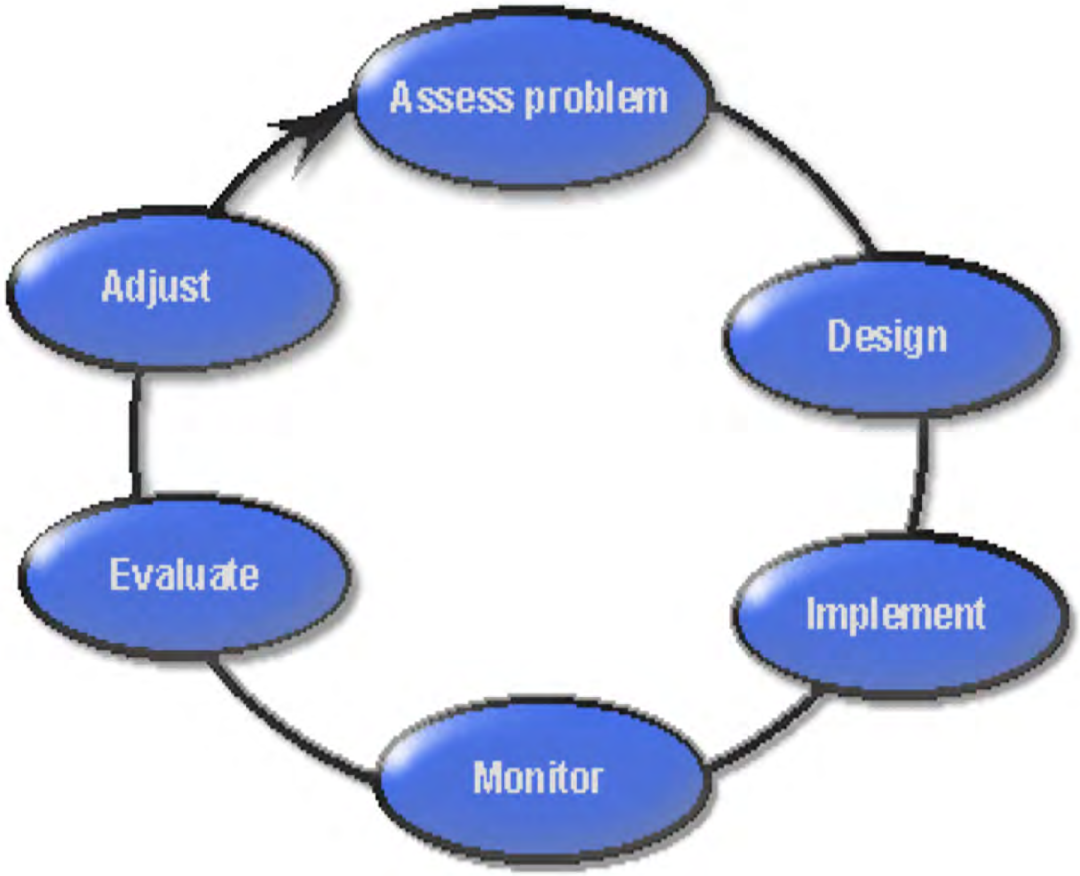
B. Keeping people & buildings away from flood waters by:

- Floodplain regulations
- Purchasing floodplains to maintain flood capacity
- Flood Warning systems & preparedness planning

C. Reducing the cost of flooding to individuals through:

- Flood Insurance
- Flood Disaster Relief
- Tax Incentives

Basic Concept of Adaptive Management in Policy



(Source: B.C. Forest Service http://www.for.gov.bc.ca/hfp/amhome/Amdefs.htm)

4. Floodplain Management and IWRM

"Living With Water":

The Need For An Adaptive Ecosystem Approach

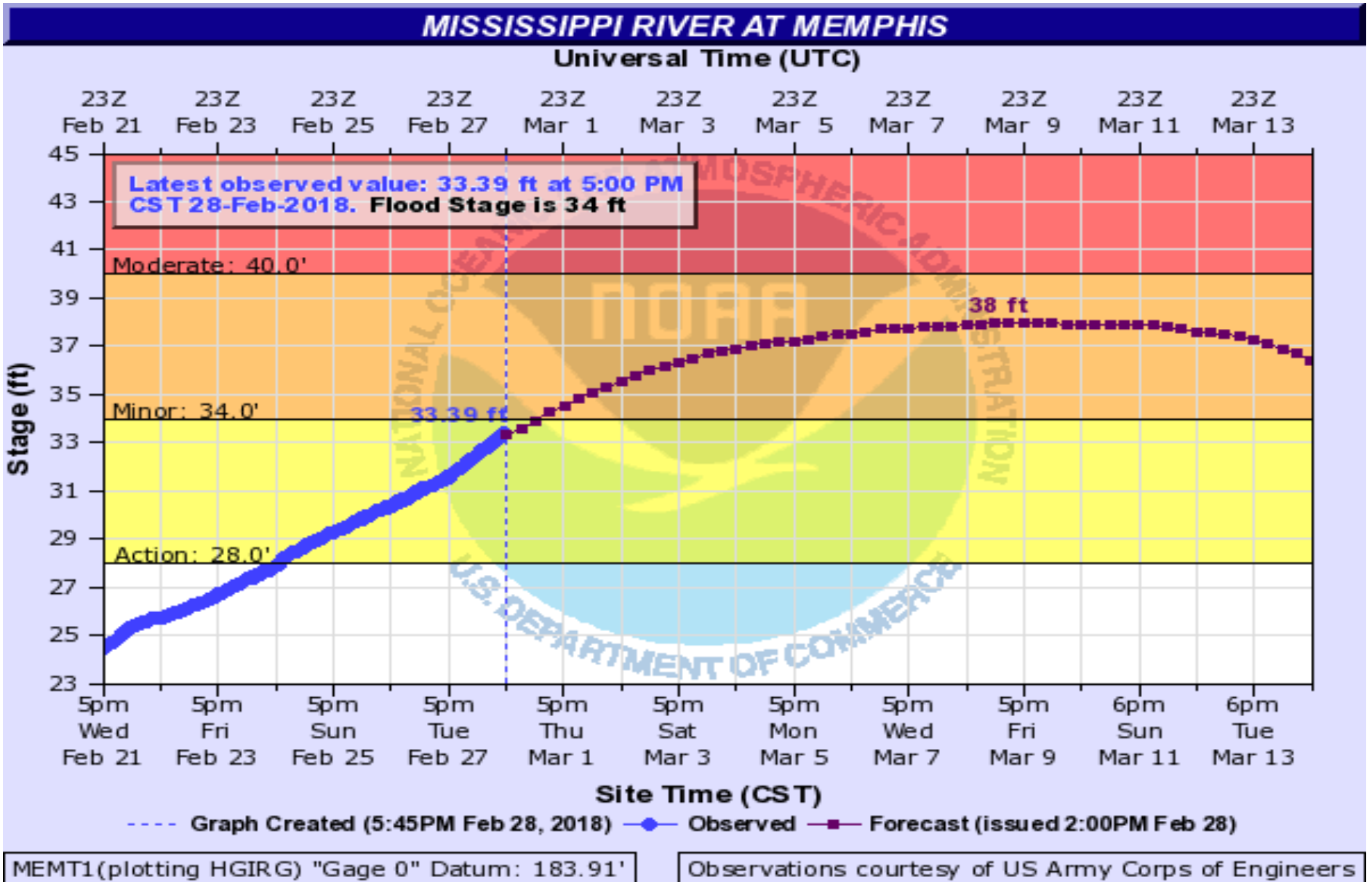
Despite recent efforts at a watershed approach, communities in floodplains are susceptible to a range of long-term water quality and quantity impacts

Theory and Practice

- A Shift in Water Resource Management
- Adaptive Management Solutions through an Ecosystem Approach
- Adaptive Ecosystem Management on a River Basin Scale

Lower Tolt River
Floodplain Restoration Project (Seattle)

Photos show both old and new levee locations. The new levee provides flood protection, but allows the river to meander with a variety of habitat conditions, including for Chinook salmon populations.


MISSISSIPPI RIVER AT MEMPHIS
Universal Time (UTC)
23Z Feb 21
23Z Feb 23
23Z Feb 25
23Z Feb 27
23Z Mar 1
23Z Mar 3
23Z Mar 5
23Z Mar 7
23Z Mar 9
23Z Mar 11
23Z Mar 13
Latest observed value: 33.39 ft at 5:00 PM CST 28-Feb-2018. Flood Stage is 34 ft
Moderate: 40.0'
Minor: 34.0'
Action: 28.0'
33.39 ft
38 ft
Stage (ft)
45
43
41
39
37
35
33
31
29
27
25
23
5pm Wed Feb 21
5pm Fri Feb 23
5pm Sun Feb 25
5pm Tue Feb 27
5pm Thu Mar 1
5pm Sat Mar 3
5pm Mon Mar 5
5pm Wed Mar 7
5pm Fri Mar 9
6pm Sun Mar 11
6pm Tue Mar 13
Site Time (CST)
Graph Created (5:45PM Feb 28, 2018)
Observed
Forecast (issued 2:00PM Feb 28)
MEMT1(plotting HGIRG) "Gage 0" Datum: 183.91'
Observations courtesy of US Army Corps of Engineers