Application of Dutch Water Resources Processes within the North American Market

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Where's the Connection?

- Canadian Based
- Multi-disciplinary
  - Water
  - Transportation
  - Structures
  - Systems (ITS/IWS)
- Global Consulting
- 800+ staff

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- Netherland Based
- Multi-disciplinary
  - Water
  - Environment/Sustainability
  - Buildings/Manufacturing
  - Transportation
- Global Consulting
- 4000+ staff

Where's the Connection?

- Since 2002, partnerships in the following sectors:
  - Transportation Planning & Intelligent Transportation Systems
  - Bridges – Architecture & Structural Design
  - Water Sectors:
    - Water Treatment
    - Wastewater Treatment
    - Flood Management & Analysis

Dutch Processes Explored

- **Adaptive Strategies**
  - **Living with Water**
    - Public Awareness
    - Contingency & Emergency Planning
  - **Coastal Defense**
    - Upgrading Program
    - New System
  - **Space for Water**
    - Internal drainage, retention, and urban planning
    - Flood Plain Management

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Flood Management – the Dutch Way

Flood Management – the Dutch Way

- The Netherlands is built on the delta area of four European rivers
- 70% of GDP is earned on land that would flood if left undefended
- Extended flood-defence networks
- Part of our culture and history
- Prince William of Orange involved in water-management issues

Flood Management – the Dutch Way

Flood Management – the Dutch Way

- **A Holistic Approach to Water Management:**
  - Limits to protection: combining soft measures with hard defences
  - Room for Rivers programme
  - Living with Water programme (knowledge and awareness)
  - Adaptive technology

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Flood Management Program
Fraser River, Lower Mainland, BC

*Municipalities of Surrey, Delta, Richmond, New Westminster and Coquitlam

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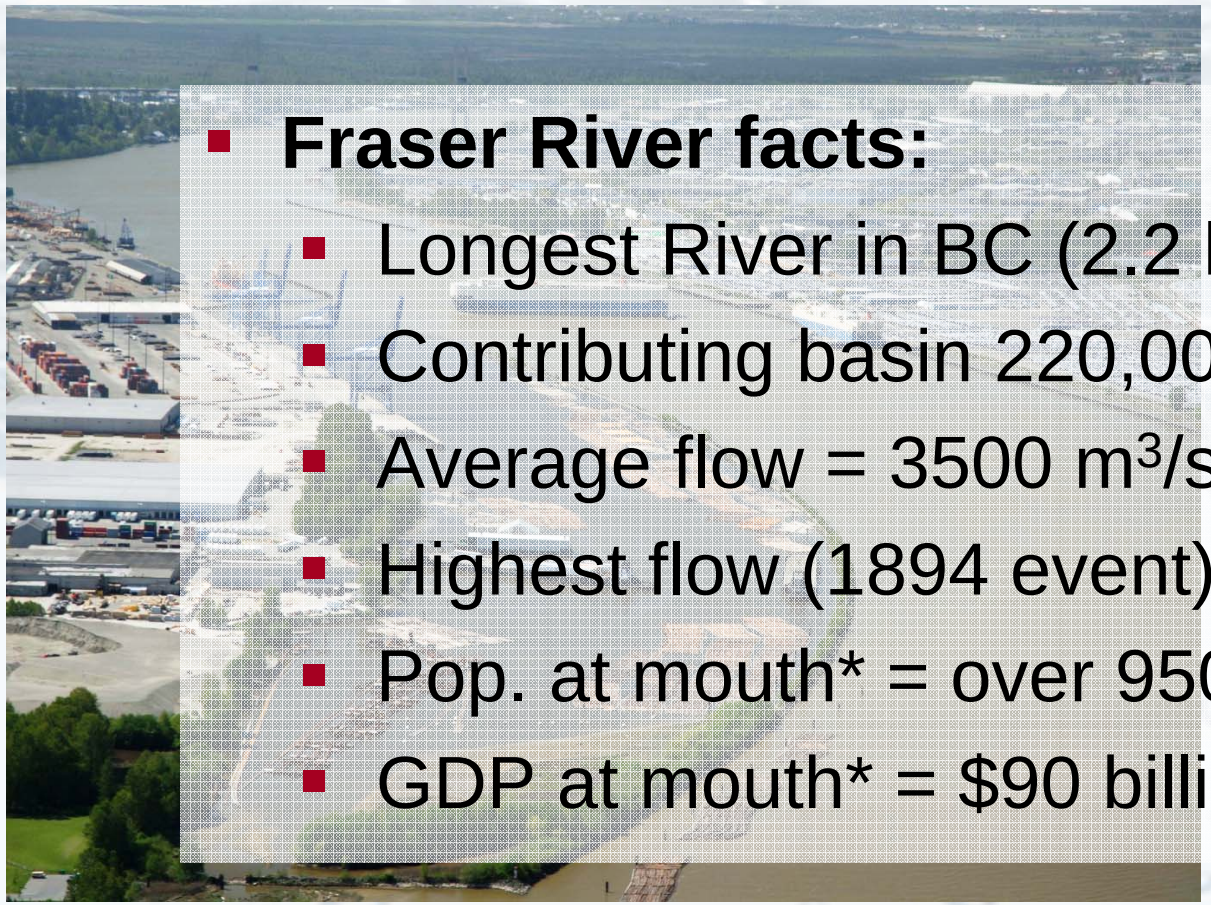
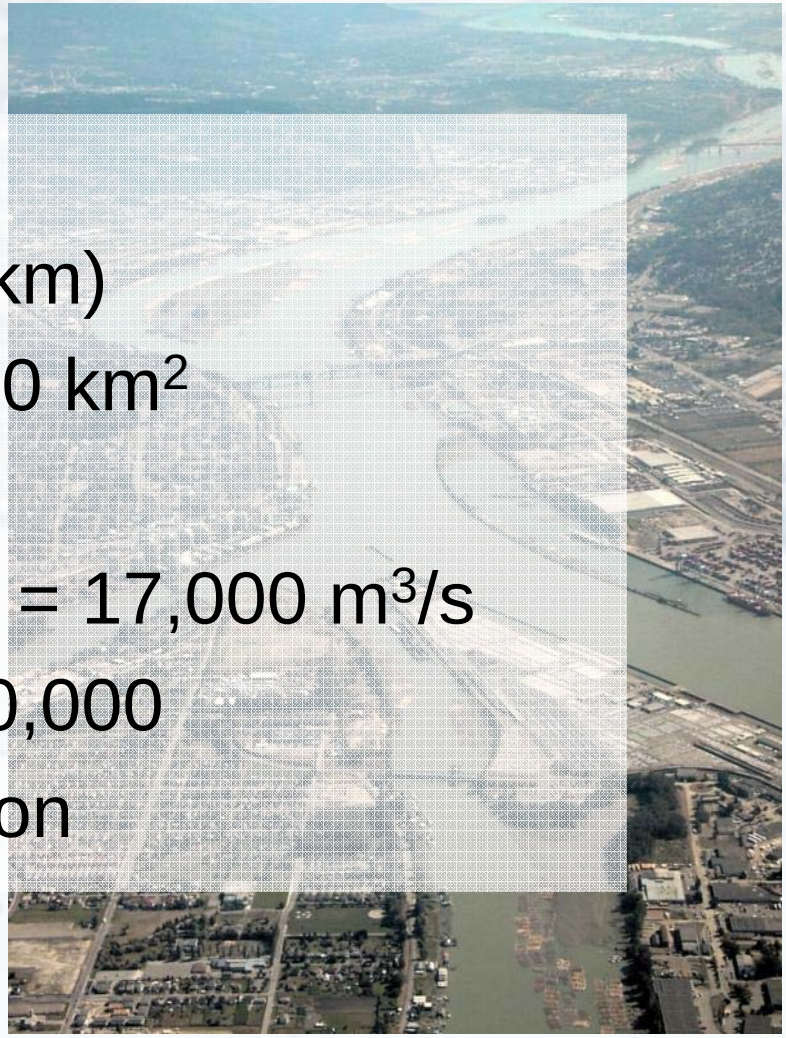
Flood Management Program
Fraser River, Lower Mainland, BC



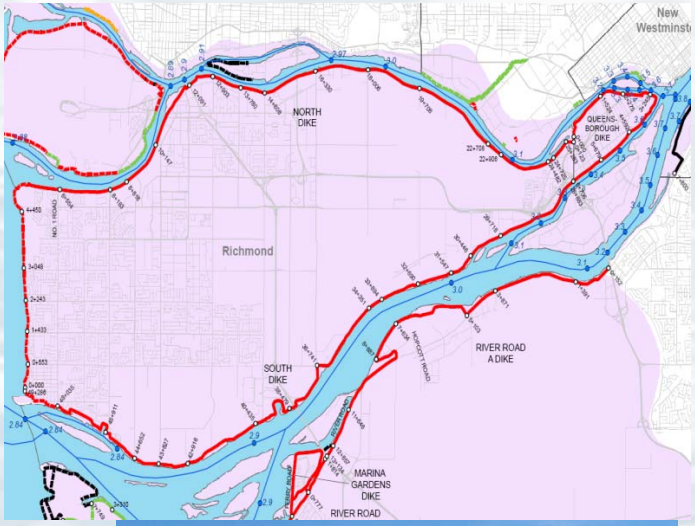
- **Fraser River facts:**
  - Longest River in BC (2.2 km)
  - Contributing basin 220,000 km^2
  - Average flow = 3500 m^3/s
  - Highest flow (1894 event) = 17,000 m^3/s
  - Pop. at mouth* = over 950,000
  - GDP at mouth* = $90 billion

*Municipalities of Surrey, Delta, Richmond, New Westminster and Coquitlam

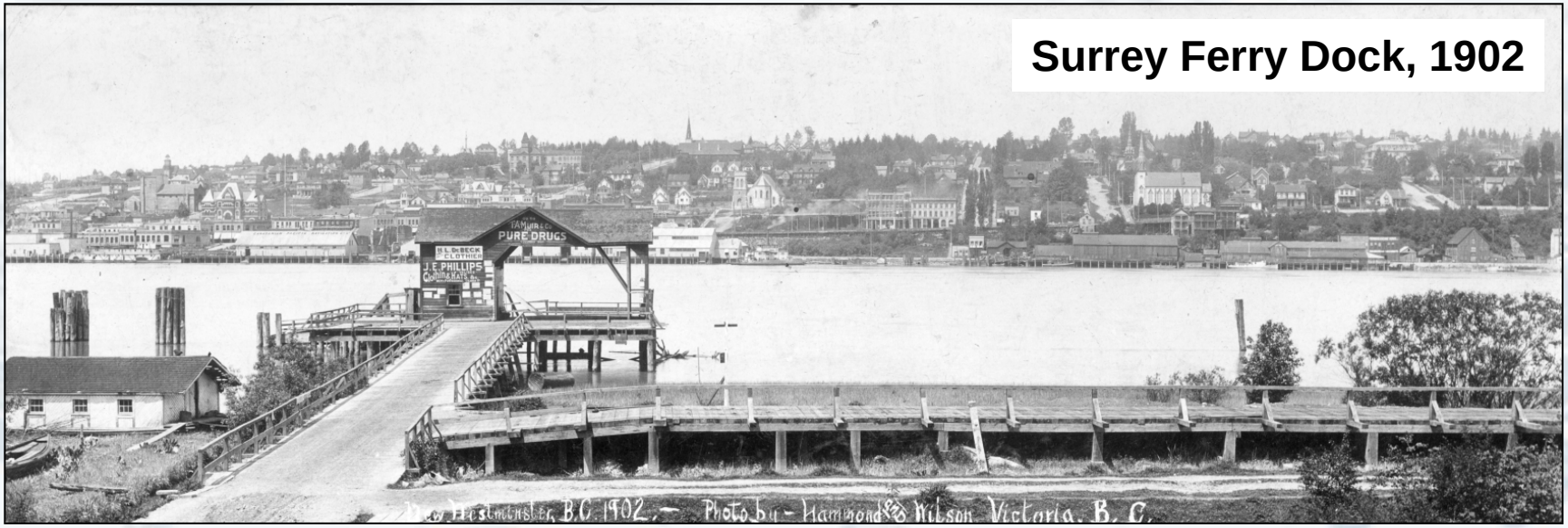


Flood Management Program
Fraser River, Lower Mainland, BC

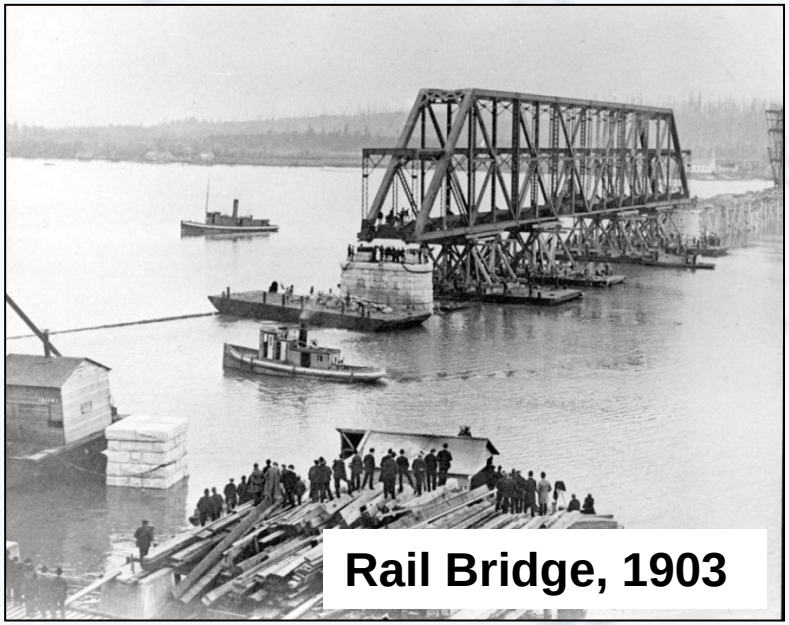
- **Program Components**
  - **City of Surrey**
    - Dike and Pump Station Assessments
  - **City of Richmond**
    - Mid-Island Dike Assessment
  - **Corporation of Delta**
    - Flood Infrastructure Assessments
    - Dike Height Analysis
  - **City of New Westminister**
    - Queensborough Area Flood Assessments



Fraser River Infrastructure



Surrey Ferry Dock, 1902



Rail Bridge, 1903

Patullo Bridge, 1953 (opened 1937)

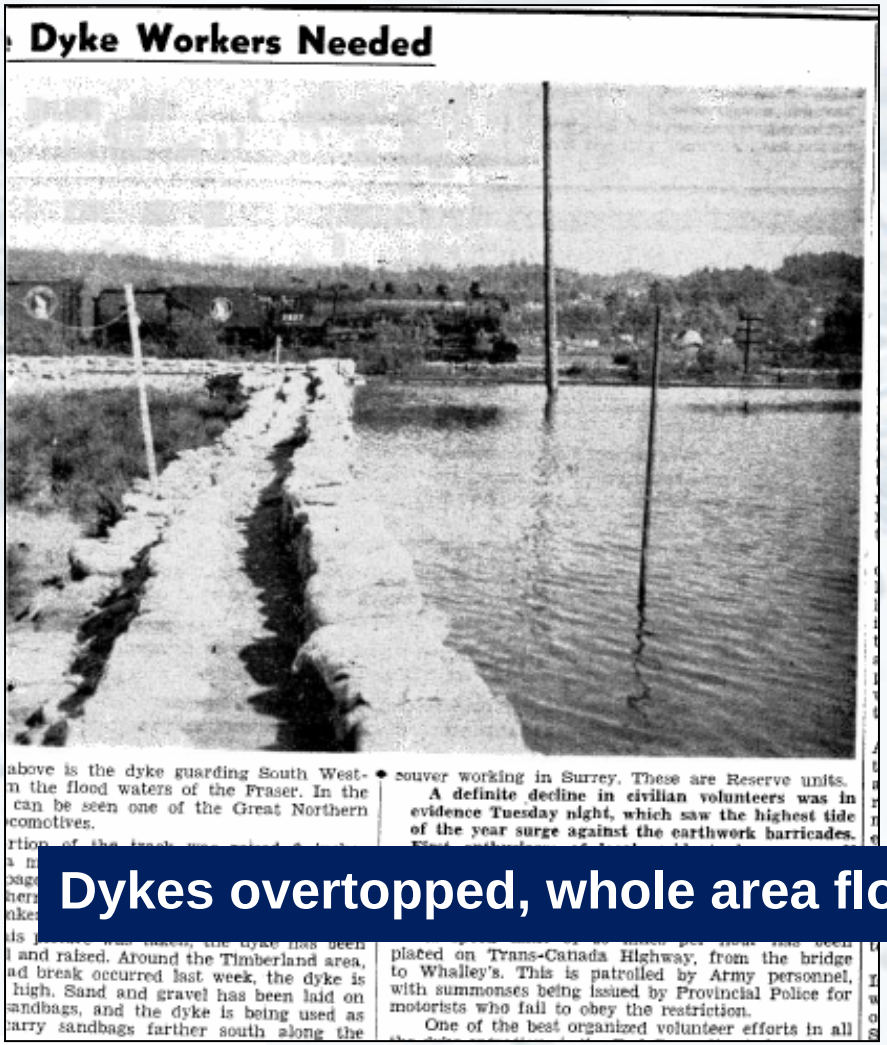
Fraser River Flooding

- By 1890 area had a general store, hotel, saloon and livery stables
- **Floods 1894 (largest flood on record) – some deaths in the area**
- 1920 south Westminster Dyking District (WDD) was formed
- **2.6 miles of dykes, 7 flood boxes, 4.3 miles of interior ditches**
- 1930's Provincial Dyking Commissioner
- **1936 Fraser River flooded the area**
- 1940 Provincial Program – new floodboxes, pump stations, ditches
- **1948 Second largest flood on record**
- **1972 Flooding again**
- 1975 South Westminister Dyking District transferred to Surrey with agreement for Province to improve existing dyking & flood protection systems
- After works started, Federal government pulls additional funding for Fraser River Flood Control Program in 1979 – ***dykes never fully completed***
- 2000 & 2007 Surrey upgrades some of the dyke "holes" with Provincial funding

Fraser River – 1894 Flood of Record

- Development was still sparse and relatively little damage
- Diking Districts formed (ex. South Richmond 1905-1950).

Fraser River – 1948 Flood



Dyke Workers Needed

above is the dyke guarding South West-
m the flood waters of the Fraser. In the
can be seen one of the Great Northern
comotives.

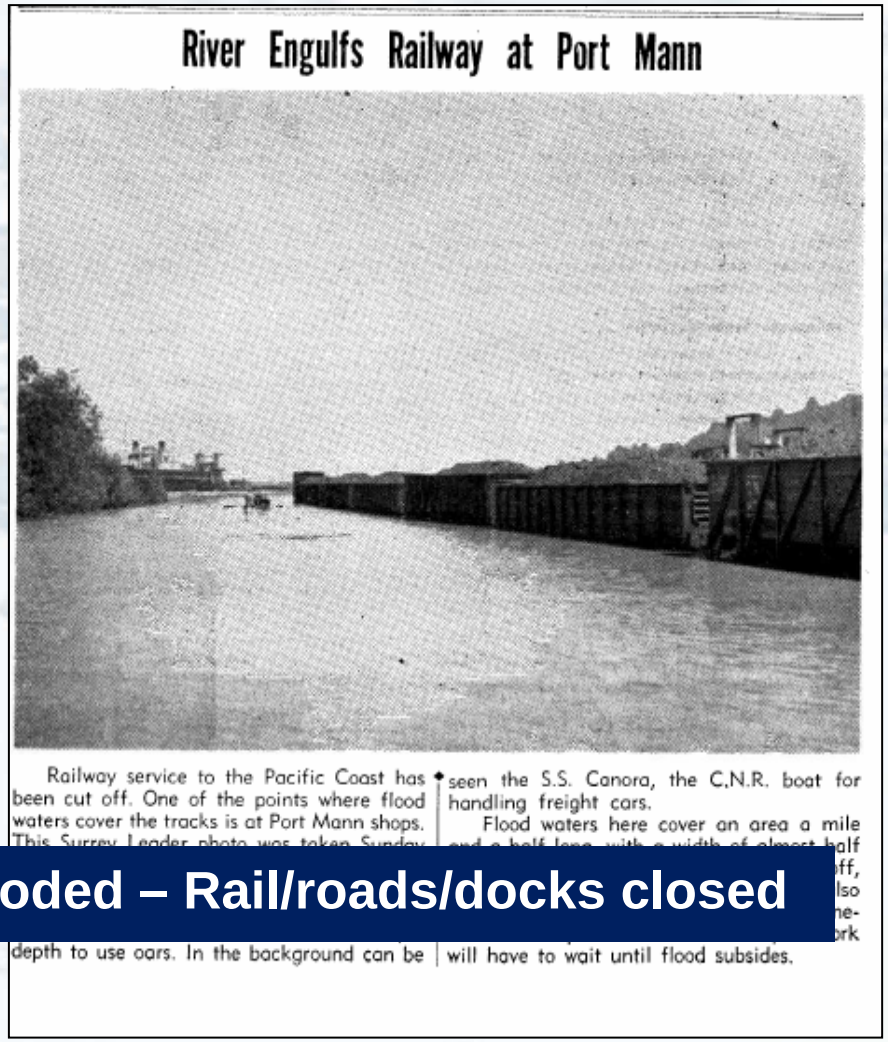
and raised. Around the Timberland area,
ad break occurred last week, the dyke is
high. Sand and gravel has been laid on
sandbags, and the dyke is being used as
arry sandbags farther south along the

couver working in Surrey. These are Reserve units.

A definite decline in civilian volunteers was in evidence Tuesday night, which saw the highest tide of the year surge against the earthwork barricades.

placed on Trans-Canada Highway, from the bridge to Whalley's. This is patrolled by Army personnel, with summonses being issued by Provincial Police for motorists who fail to obey the restriction.

One of the best organized volunteer efforts in all



River Engulfs Railway at Port Mann

Railway service to the Pacific Coast has been cut off. One of the points where flood waters cover the tracks is at Port Mann shops.

depth to use oars. In the background can be

seen the S.S. Canora, the C.N.R. boat for handling freight cars.

Flood waters here cover an area a mile

will have to wait until flood subsides.

Dykes overtopped, whole area flooded – Rail/roads/docks closed

Fraser River – 1964 Flood

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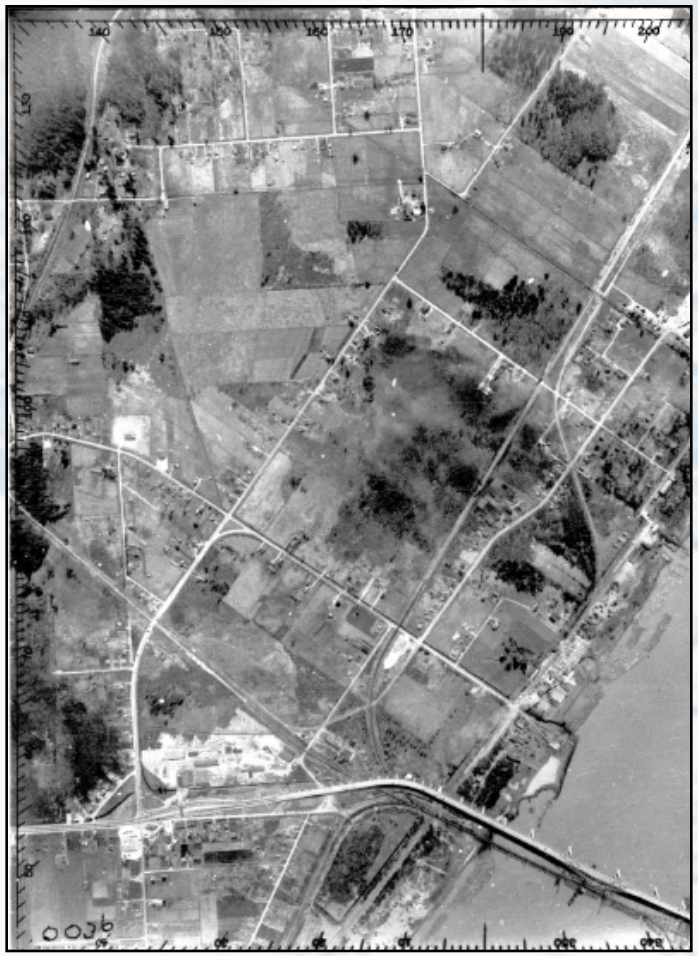
Fraser River – Land Use Changes



1949

1966

2007

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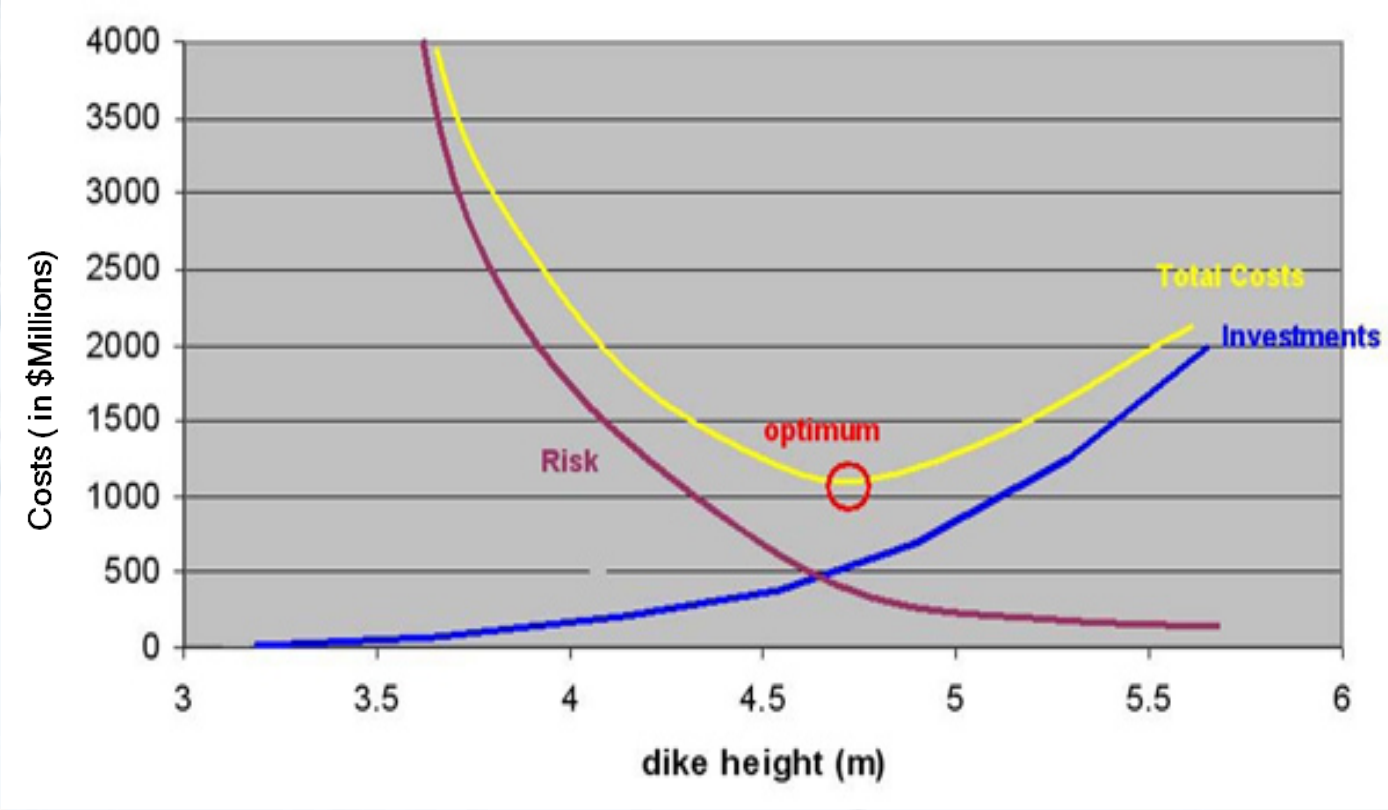
Level of Protection & Prioritization

- **Risk Approach Method**
  - By Netherlands Ministry of Transport, Public Works, and Water Management
  - Investment Cost vs. Risk
  - Optimum level of protection
  - Dike heights for higher levels of protection



Level of Protection & Prioritization

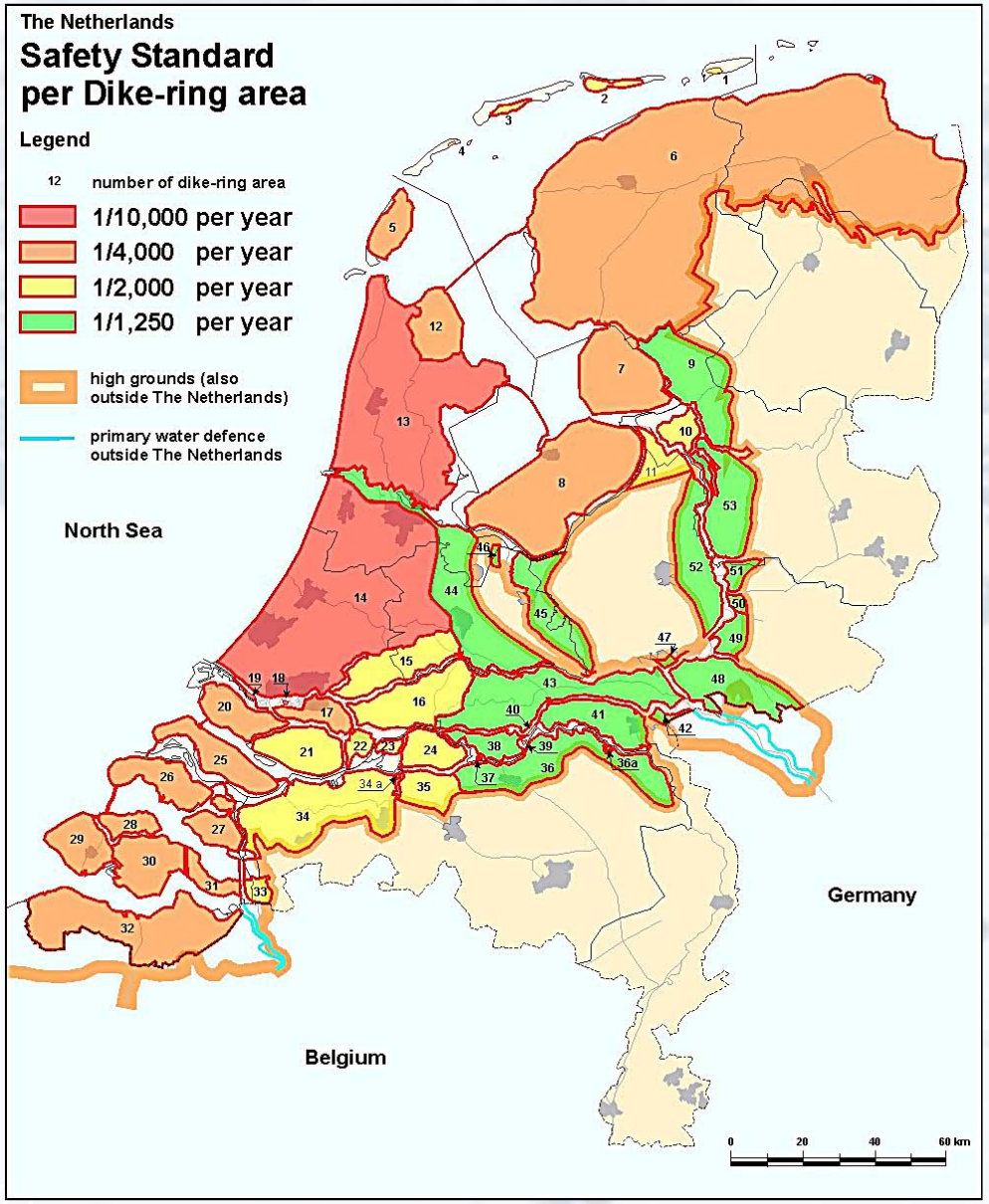
- **Risk Approach Method**

Risk ($) =

Probability of Failure *(return period)*

x Economic Consequences *(damage ($))*

Level of Protection & Prioritization



Fraser River / Lower Mainland

Freshet:	15%	(1:500)
Sea:	37.5%	(1:200)
Total:	52.5%	(1:143)

The Netherlands

Green:	6%	(1:1,250)
Yellow:	3.75%	(1:2,000)
Orange:	2%	(1:4,000)
Red:	0.75%	(1:10,000)

Economic Consequences (Damage)

Tangible Damage

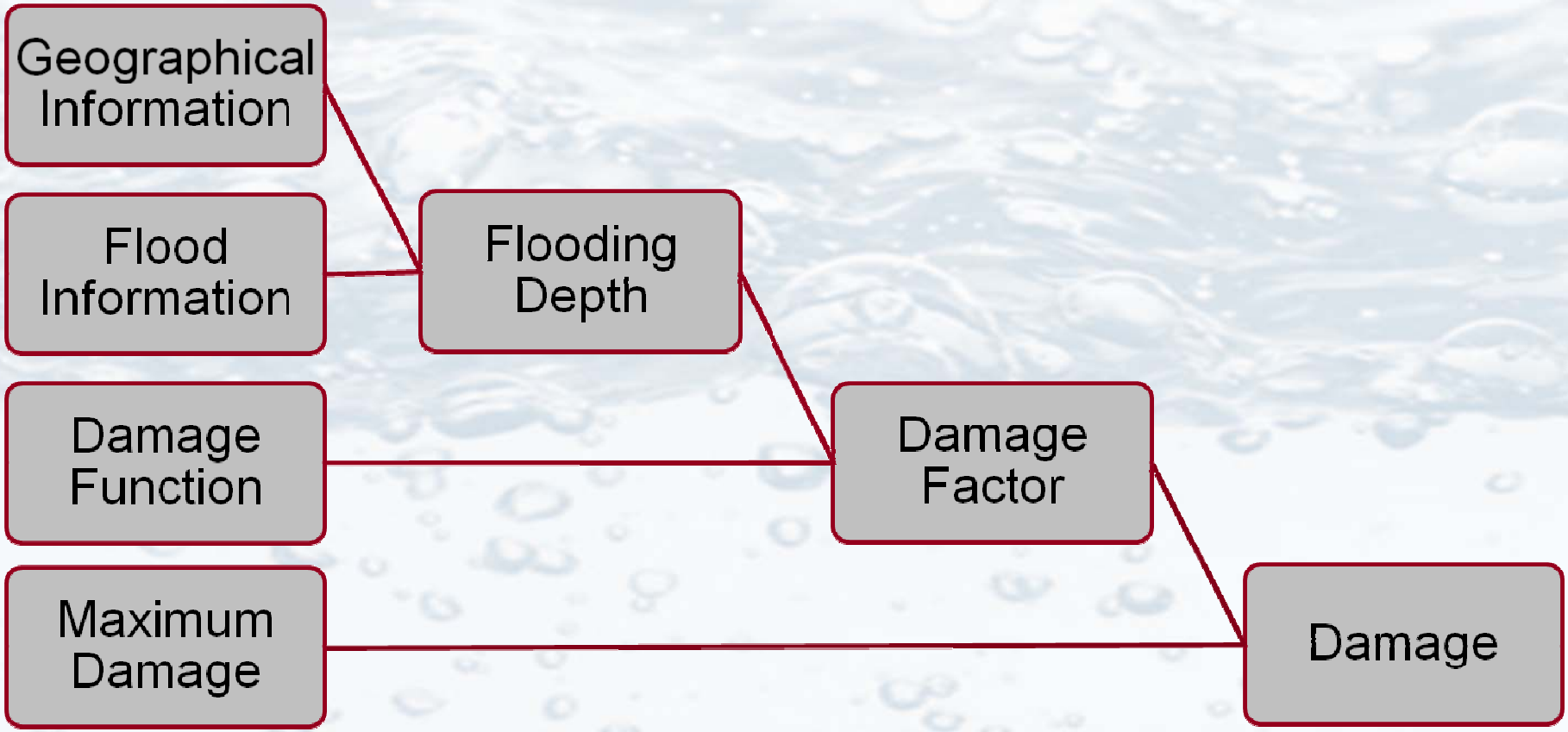
- Direct damage
  - property, infrastructure
- Indirect damage
  - loss of business

Intangible

- Number of casualties

Determine Maximum Damage

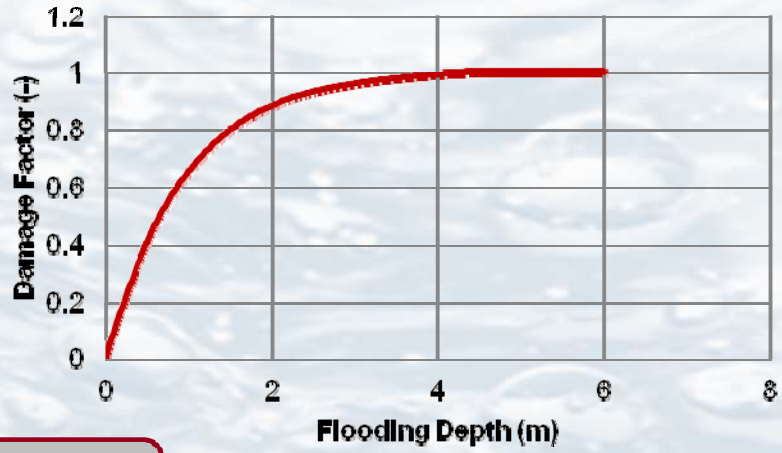
Economic Consequences (Damage)



Economic Consequences (Damage)

Geographical Information (topography)

Flood Information → Flooding Depth (1.1m)



Damage Function → Damage Factor (70% at 1.1m)

Maximum Damage ($40B) → Damage

Damage with 1.1m Flood = $40B x 70%
= $28B

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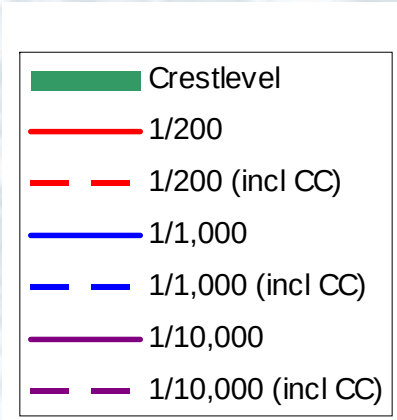
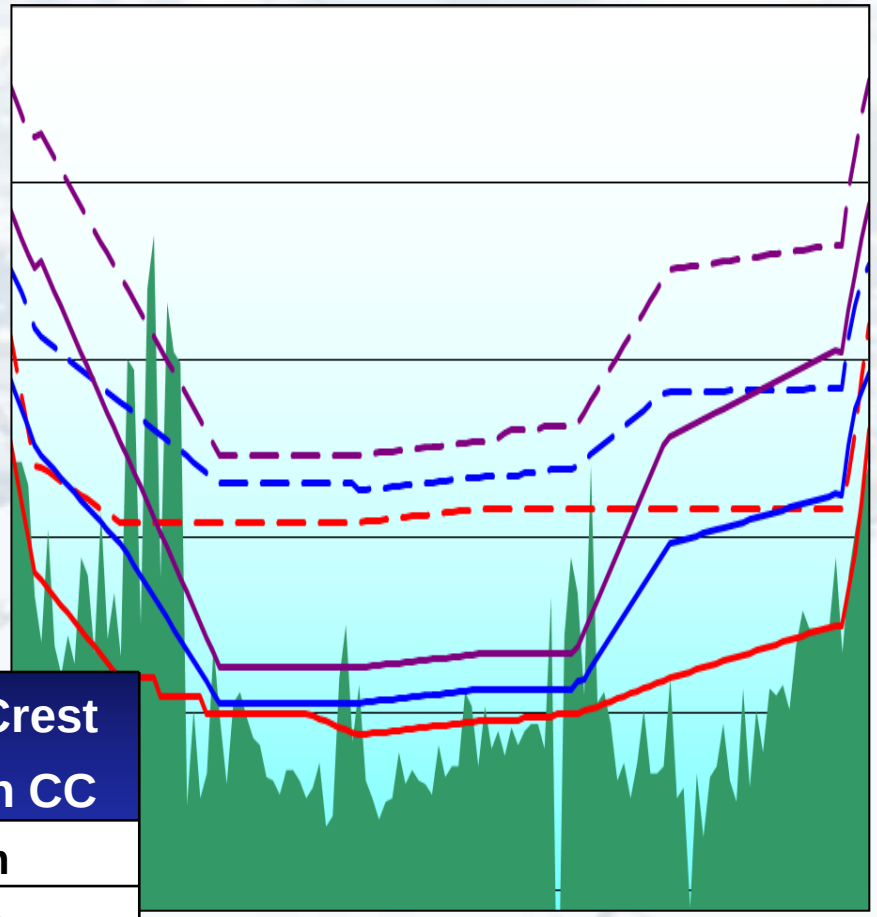
How High?

- What does a 1:10,000 design level mean in terms of elevation?
- What about climate change and sea level rise?





Design Height	Average Crest Level	Average Crest Level With CC
Provincial Standard	3.6 m	+ 0.5 m
1:1,000	+ 0.2 m	+ 0.7 m
1:10,000	+ 0.4 m	+ 0.9 m

Acknowledgements

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- Colin Kristiansen, P.Eng., Delcan

Questions…