Engineering
with a Conscience
& a Consciousness

Leo F. Gohier, P. Eng.
University of Waterloo, 2nd year Civil
2005 May 26

Asset Management

- Sustainability
- Play with bubbles
- Cost/pricing
- Your future
- Your role
WALKERTON

WATER IS THE MOST UNIQUE ASSET

- Universal
- Individual
- Personal
History of Expressions

- Throw baby out with bathwater
- It’s raining cats and dogs
- Bringing home the bacon
- Wake
- Saved by the bell

QUESTIONS

- What is infrastructure/Examples?
- What does it do
- What is an infra deficit
- What is sustainability/life-cycle
- What is a Civil Engineer?
Asset Management

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What is sustainability?

- Next Generation (s)
- Borrow Earth from grandchildren
- Forever!
Elements of Sustainability

- Social
- Environmental
- Financial

Engineering is the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race.

Henry G. Stott, 1907
CIVIL ENGINEER

● Civil
  ● Latin: civis
  ● citizen

● Engineer
  ● Latin: ingenium
  ● spirit (resourceful, ingenious)
  ● intelligence

Waterloo Fast Facts

  Water Sold 11,400,000 m³
  Sewage Collected 14,100,000 m³
  Valves 3,920
  Manholes 4,820
  Sanitary Sewers 332km
  Watermains 350km
  Pumping Stations 6
  Water and Sewer Services 26,636
  Hydrants 2,126
HISTORY OF PIPE MATERIALS

- 1850’s: oak trees (wired and tarred)
- 1880’s: pit cast cast iron (lead joints)
- Early 1900’s: steel (tarred)
- 1920’s: spun (grey) cast iron (lead joints)
### HISTORY OF PIPE MATERIALS, Cont'd. . . .

- **1950’s +:**
  - Ductile iron
  - Asbestos-Cement
  - PVC
  - HDPE
  - Reinforced Concrete

### HISTORY OF SERVICE MATERIALS

- **1850’s:** Lead
- **1930’s:** Lead alloy
- **1940’s:** Galvanized iron
- **1950’s:** Copper/brass/PE/PB
**BI-METAL CORROSION**

- Watermains and services not of same material
- Results? Need to replace prematurely watermain and/or services
- Why? Solved one problem, created another

**PLANTS VS PIPES**

Plants = 20%
Of Total Replacement Value

Pipes = 75%
Of Total Replacement Value
Somebody tell me what to do!
“No code, no formula, no decimal points, no factor of safety, what do I do?????”

AVAILABLE OPTIONS

• Do Nothing
• Crisis Management
• Planned Management
LIFE-CYCLE ANALYSIS:
SIX SIMPLE QUESTIONS!

- What Do We Have?
- What Is It Worth?
- What Condition Is It In?
- What Do We Need To Do To It?
- When Do We Need To Do It?
- How Much Money Do We Need?

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### 2005

<table>
<thead>
<tr>
<th>Time Period</th>
<th>% of Infra Sust.</th>
<th>Factor</th>
<th>Sust.</th>
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<td>0 - 25 years Minor Mtce.</td>
<td>26%</td>
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<td>26</td>
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<tr>
<td>25 - 50 years Major Mtce.</td>
<td>37%</td>
<td>4</td>
<td>148</td>
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<tr>
<td>50 - 75 years Rehabilitation</td>
<td>14%</td>
<td>50</td>
<td>700</td>
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<tr>
<td>75 - 100 years Replacement</td>
<td>23%</td>
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Total: 5474/Year

### 2004

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<tr>
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<td>37%</td>
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<tr>
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<td>37%</td>
</tr>
<tr>
<td>75 - 100 years Replacement</td>
<td>23%</td>
<td>14%</td>
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### 2030

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<td>0 - 25 years</td>
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<td>23</td>
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<td>50</td>
<td>1850</td>
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<tr>
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<tr>
<td>75 - 100 years</td>
<td>14%</td>
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<tr>
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Total: 4777/Year

### 2055

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Total: 2800/Year
Sustainable Water Costs
(in relative and constant units)

- 2005: 5474 → 1.0
- 2030: 4777 → 0.9
- 2050: 8806 → 1.6

What does this tell you?
The real problem is NOT the accumulated deficit or the 75 to 100-year old infrastructure.

It’s the 25 to 50-year old infrastructure bubble, that will burst in the next 25-50 years + how we value water.
11-100 years
1-10

11-100 years
1-10
Asset Management

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PROBLEM TERMS

- User-Pay
- Pay-As-You-Go
- Full Cost Recovery
- Infrastructure Deficit
## Cost of Water
Compared to other utilities

- **Heating:** $150/mo
- **Hydro:** $100
- **Telephone:** $60
- **Cell Phone:** $50
- **Internet:** $50
- **Cable TV:** $45
- **Water:** $22

## Cost of Water
Compared to other drinks

- **25L of Wine:** $500
- **25L of Beer:** $85
- **25L of Pop:** $30
- **25L of Milk:** $25
- **25L of Bottled Water:** $25
- **25L of Water:** 2¢
Other Comparisons

- Car $600/month
- Water $22/month
- Gas 85 cents/litre
- Water 0.08 cents/litre

DIFFICULTIES

- Political
- Financial
- Social
- Environmental
- Engineering Focus
- Institutional
- Lunacy
LUNACY

Doing Things The Same Way
And
Expecting A Different Result

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REALITY #1

REALITY #2

\[ x + y = z \]
REALITY #3

“No code, no formula, no decimal points, no factor of safety, what do I do?????”

HARLAN CLEVELAND WAS RIGHT!

We know in our hearts that we are in the world for keeps; yet we are still tracking 20-year problems with 5-year plans, staffed by 2-year personnel working with 1-year appropriations. It’s simply not good enough.
“PROBLEMS” OF THE FUTURE

- Accumulated deficit
- Ongoing deficit
- Infrastructure “bubbles”
- How we value water

If We Don’t Change Direction Soon,
We Will End Up Where We Are Going.

Professor Irwin Corey
Asset Management

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Three of You

- The Professional
- The Resident
- The Human Being
WHY?

Why? → A:
Why? → A:
Why? → No A:

Kepner-Trego
"PUBLIC GOOD" APPROACH

- Invest in public good, don’t just spend
- Manage the deficit, don’t create another one
LIFE-CYCLE ENGINEERING

7 RULES OF SUSTAINABLE ENGINEERING:

- Design it better
- Build it better
- Maintain it better
- Monitor it better
- Rehabilitate it better
- Rebuild it better
- MIP! Understand it better
Understand the past, shape the future

Léo F. Gohier
Feb 2004

SUSTAINABLE INFRASTRUCTURE
= SUSTAINABLE COMMUNITIES
InfraGuide available at:

National Guide Office – 1-866-330-3350
Email – infraguide@nrc-cnrc.gc.ca
Internet – www.infraguide.ca
Thank You