VALUE BY DESIGN – ALIGNING APPLICATION OF VALUE ENGINEERING WITH TRIPLE BOTTOM LINE-

– A case Study from a Canadian Crown Corporation.

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SOCIETY OF PM PROFESSIONALS
GREATER VANCOUVER

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VALUE BY DESIGN – ALIGNING APPLICATION OF
VALUE ENGINEERING WITH TRIPLE BOTTOM LINE-

Presentation Outline

Value { Engineering
Analysis
Management

BC Hydro & Sustainable development

Value Engineering 101 {

- What is Triple Bottom Line?
- What is "Value"? What is creativity?
- Why Value Engineering? Is it a 'novel' approach?
- Function Analysis System Technique (FAST)
- Stages in VE process

Case Study {

- VE Experience @ Ruskin
- VE Process undertaken
- VE Proposals developed
- Selected Proposals
- Accomplishments
- Lessons learned

Three Bottom Lines

BC Hydro is accountable to British Columbians to take care of the environment, meet community needs and deliver excellent financial results.

BC Hydro is committed to a path of sustainability whereby we balance, track and measure our performance along environmental, social and economic bottom lines

Three Bottom Lines

The environmental bottom line looks at how we manage impacts from our operations, weigh environmental values with economic ones and plan for a future with more green energy in our system.

The social bottom line includes how we ensure the safety and well-being of people —our employees, customers and the general public—and the health of the communities in which we live and work.

The economic bottom line means making it possible to stay in business forever, by being an efficient, productive and profitable company, and by providing value to our customers and the province.

Reporting on the TBL is keeping BCH to remain the regional Sustainability leader

Our Department is EARG – Engineering Aboriginal Relations and Generation

Motivation to do a VE Study at BC Hydro:

Possible alignment with TBL
Possible further leadership in sustainability
Seek possible synergy with “Safety by Design” initiative

In house VE enthusiast took the ownership

The Ruskin Dam upgrade project is part of the infrastructural renewal* that will enhance the safety and reliability of the system.

*** More than $2 billion Capital work**

What is 'value'?

- ***Value*** is a personal perspective of your willingness to pay for the performance delivered by a product, process or project.

Tata Nano $2000

V.S.

- Good value is achieved when the necessary performance can be accurately defined and delivered at the lowest life cycle cost.

- **Use Value**
- **Cost Value**
- **Exchange Value**
- **Esteem Value**
- **Goodwill**
- **"Feel good" Value**

Both Nano and Jaguar are owned by TATA

What is Creativity?

"Every man with new ideas is a crank until those ideas actually work"

-Mark Twain

What is Value?

$$\text{Value} = \frac{\text{Worth}}{\text{Cost}}$$

VE combines concepts of VALUE with CREATIVITY

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.

Why Value Engineering ?

- **Value Engineering has saved the private industry and governmental agencies many *$Billions* since its inception in 1947.**

- **The VE approach promotes the philosophy of *"Do the Right Thing Right the First Time."* (DTRT RTFT)**

VE aims at achieving the **lowest life cycle cost** meeting or exceeding all the functional requirements and criteria such as quantity, quality, safety, durability and sustainability

Cost: Financial, Social and Environmental.
looking at 3 bottom lines

What is value?

Value = $\frac{\text{Worth}}{\text{Cost}}$

V.E. Objective is to make $\frac{W}{C}$ ~ =1.00

***Best Value is not about cost cutting*, it is about improving the understanding of the business/project needs.**

How is Value Engineering done?

Value Engineering uses a combination of **creative** and **analytical** techniques to identify alternative ways to achieve objectives.

The use of **Function Analysis** differentiates Value Engineering from other problem solving approaches.

Function Analysis Systems Technique

F A S T

How do we determine Value?

The determination of **Value** may be an informal management/design decision process or a rigorously formal review/selection process.

Three key questions regarding the function:

What must it do?	**(primary requirements, basic needs)**
What else will do that?	**(develop alternatives)**
What's the best alternative?	**(select the best, optimum option)**

Larry Mile's 6 questions on a function

What is it?

What does it do?

What must it do?

What does it cost?

What else would do the job?

What does that cost?

VE aims at achieving the **lowest life cycle cost** meeting or exceeding all the functional requirements and criteria such as quantity, quality, safety, durability and **sustainability**

Why Function Analysis?

By identifying the function of a product or procedure with two words, a verb and a noun, we are better able to explore alternatives.

Verb + Noun = Function

(Active)	(Measurable)		(end result)
Makes	marks	**pencil**	enable writing
Conveys	liquid	**pipe**	operate wash room
Projects	light	**projector**	support presentation
Creates	heat	**projector**	*not a needed function !*
Conveys	information	**book**	tell stories

A two-word description for clarity and focus

Removes the problem-solving focus away from the item and towards its function

History of VE

1942 Larry D Miles : Second World war
G.E: $200Million saved at a cost of $1M

1950 – National professional body (later SAVE)

1960 – US Military adopted it as a strategy

1964 - FAST technique – Charley Bytheway

1995 – Federal US govt. saved more than a Billion $

In Canada: Canadian Society of Value Analysis
In US – Society of American Value Engineers

FUNCTION ANALYSIS

1. **Listen to users**
   - **ensure they are present !!**
2. **Identify functions**
   - **Separate functions to basic, secondary and constraints**
3. **Evaluate functions**
4. **Develop function costs**
5. **Develop alternatives**

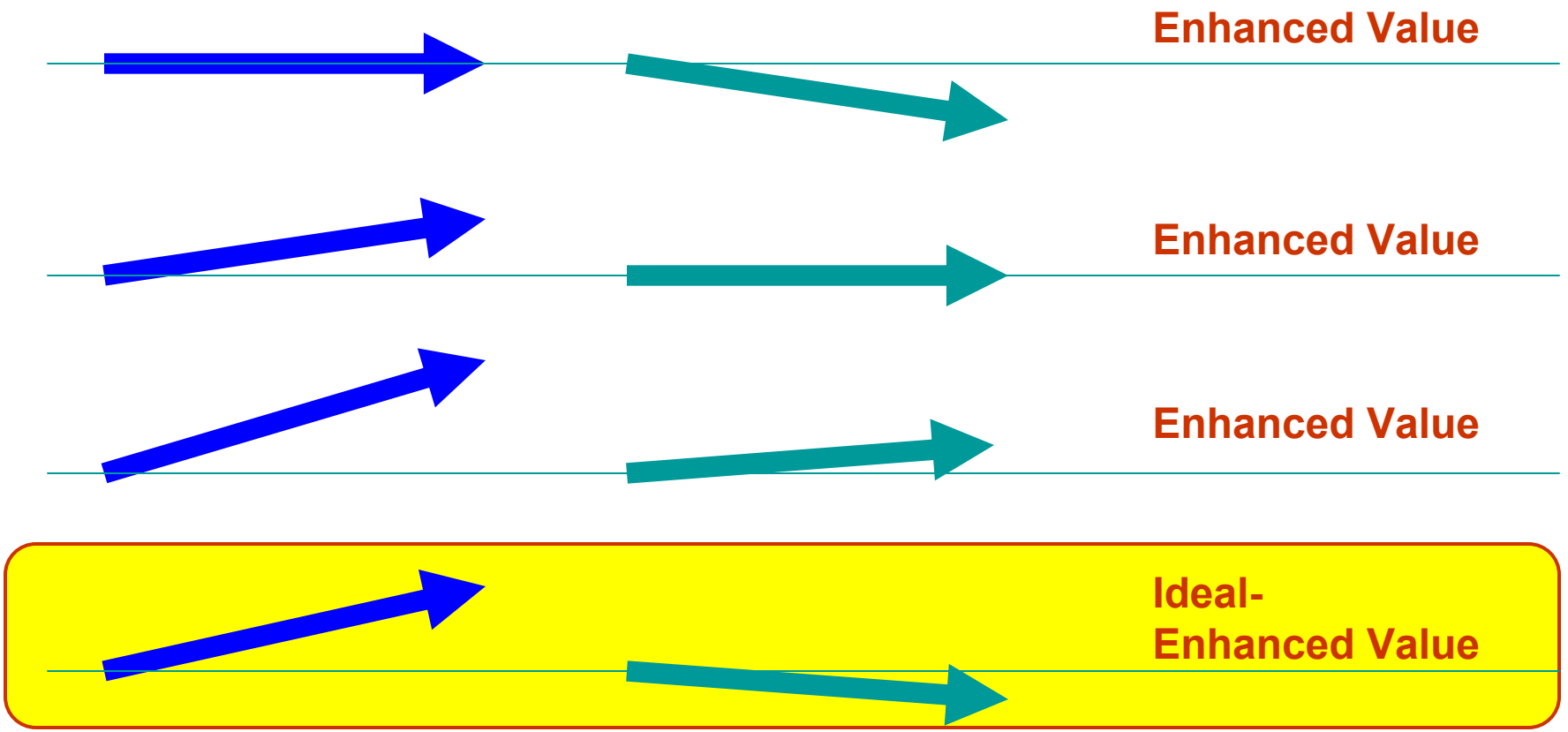
pencil makes marks enable writing

How do we Improve Value of a function?

Function performance
Needed performance

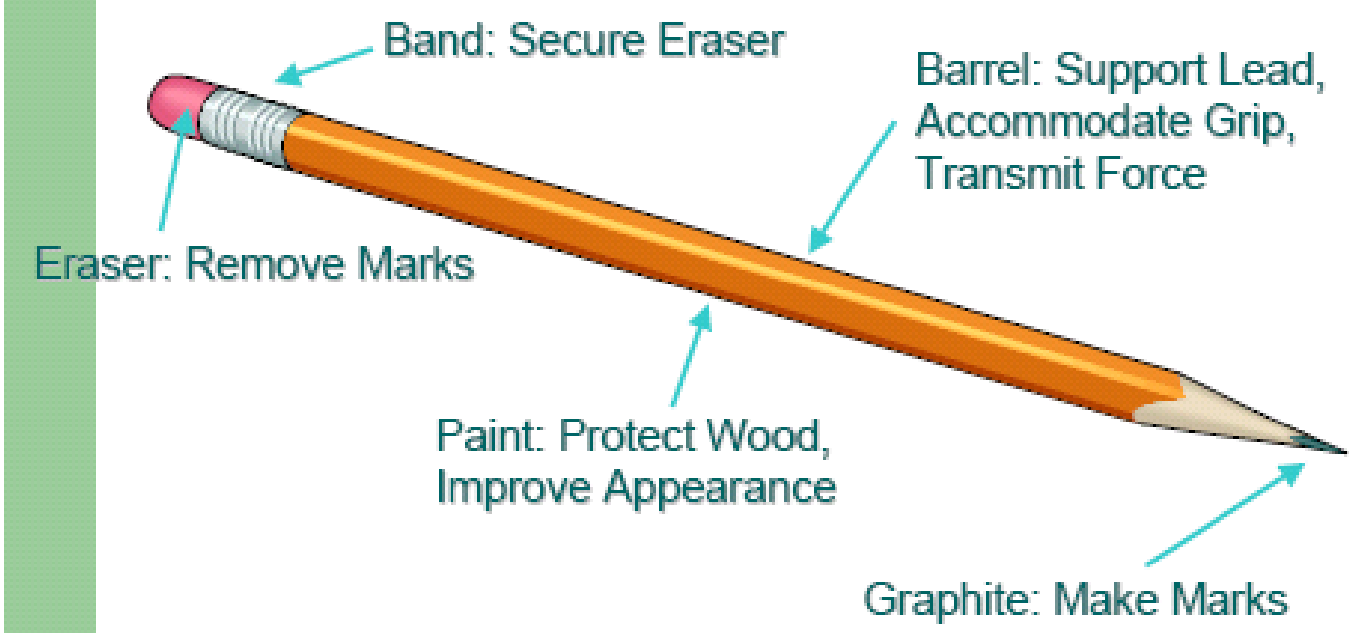
Cost of function?

Resulting Value



What is the function of this pencil?

"make marks"



Consider a Pencil costing 10 cents. What is its value?

Function	Nature of function	component	Cost
Make marks	primary	Lead	1.0 cent
Protect lead & Enable hold	secondary	wood plastic rubber metal?	3.5
Attract buyer	secondary	painting	1.5
Advertise	secondary	engrave? print?	1.5
Motivate seller	secondary	profit?	2.5

Basic value = $\frac{1.0}{10} = 0.1$

Esteem value = $\frac{3.0}{10} = 0.3$ (say *Mont Blanc !*)

Resulted in unmarked pencils, mechanical pencils, etc.

V.E. Objective:

Utilize a systematic approach, to identify the required functions and deliver the project at the lowest possible cost, keeping the design intent unchanged.

Expectations:

1. **Reduction on construction costs**
2. **Lower life cycle costs (Financial, social & environmental)**
3. **Improved operational performance**
4. **Reduced maintenance costs**
5. **Identification of risks and mitigation strategies (Safety by design?)**

What is Value Engineering ?

Value Engineering is a systematic approach for isolating high cost functions in design and arriving at the best balance between cost, performance and quality.

The basic VE job plan consists of the following five stages:

1. **Information Stage**
2. **Creative Stage**
3. **Analysis Stage**
4. **Development Stage**
5. **Presentation Stage**
6. **Implementation Stage**

For a Civil Engineering project, one can expect a savings of 5% to 15%, and a functional design (read improved value) constructible within budget.

Ontario MOT reports that a typical VE study involves a multi-disciplinary team at a workshop lasting 3 to 5 days. The payback from the investment in VE normally exceeds 10:1. **MOT saved about 100million since 1998**

How is VE different from conventional methods?

Conventional Approach

Item oriented

Analytical, based on habits

Cost visibility by components
(material, labor etc.)

Individually oriented
(cost engineer
peer reviewer?)

VE Approach

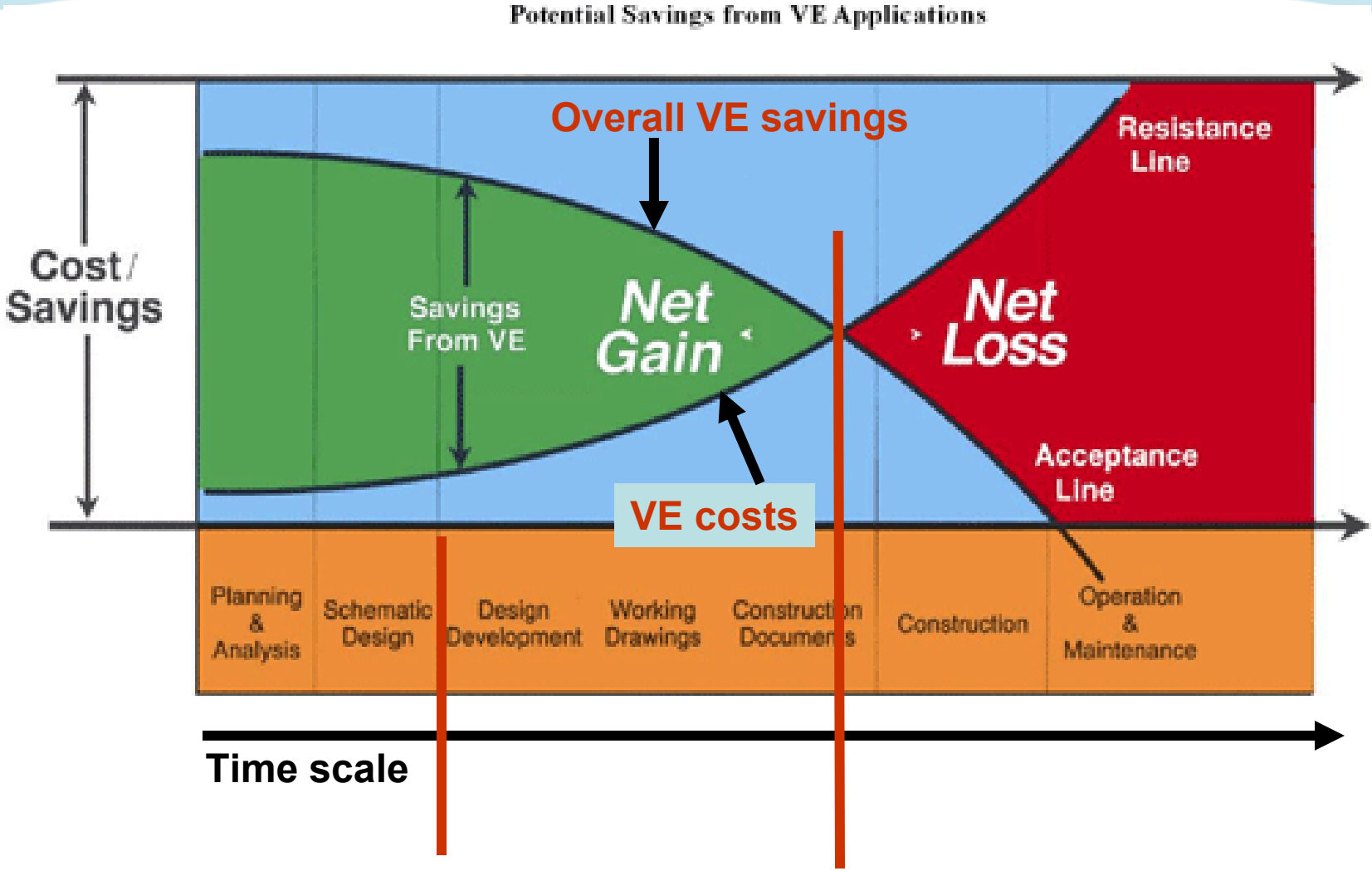
Function oriented

**Creative and Innovative
not based on habits**

**Cost visibility by function
(primary, secondary, etc.)**

**Team oriented
(brain storming)**

Is there a good time to do VE?



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VE Workshops

(3-5 days depending on project scope)

- •Multi-disciplined team approach
- •Include all professionals
  (arch., struct., civil, mech. and elec., etc.)
- •Involve the Owner, Consultants and Construction Manager.
- •Must be done by a trained facilitator, CVS

The team approach used for VE studies are comprised of three specific phases:

I Pre-Study Preparation Phase

- develop rapport among team members, gather data

II VE Study Phase

- detailed study, analysis, create & develop ideas

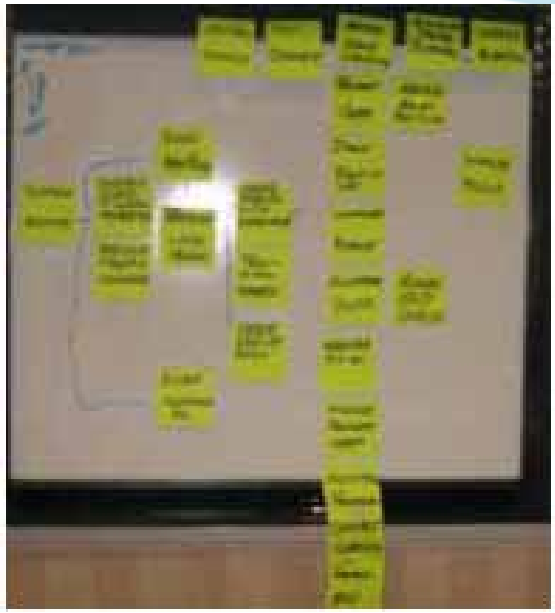
III Post VE Study Phase

- review the processes and lessons learnt

Information & Study Phase

Information Procedure

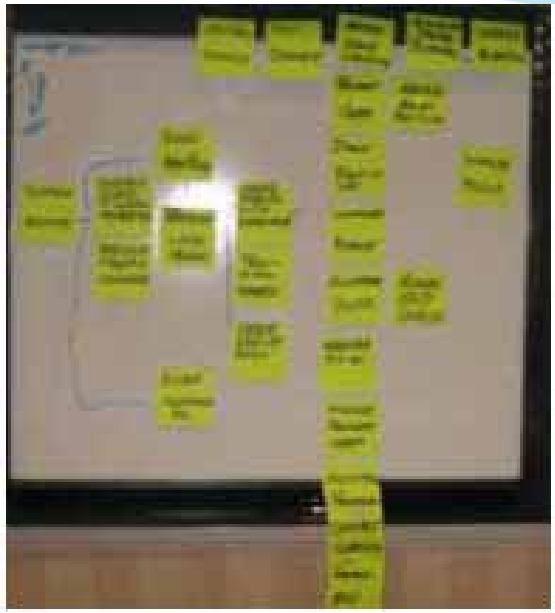
Component Identification
Component Costing
Criteria and Limits Analysis
Function Analysis
Function Costing
Function-logic Diagramming (FAST)



Creative Phase

The Creative Workshop

- Record creative ideas on a flip chart
- Begin with high cost functions
- Structured & facilitated brainstorming
- Number ideas for cross-referencing
- List every idea no matter how unconventional
- No ridicule or judgment
- Enjoy!!



Functions → Ideas

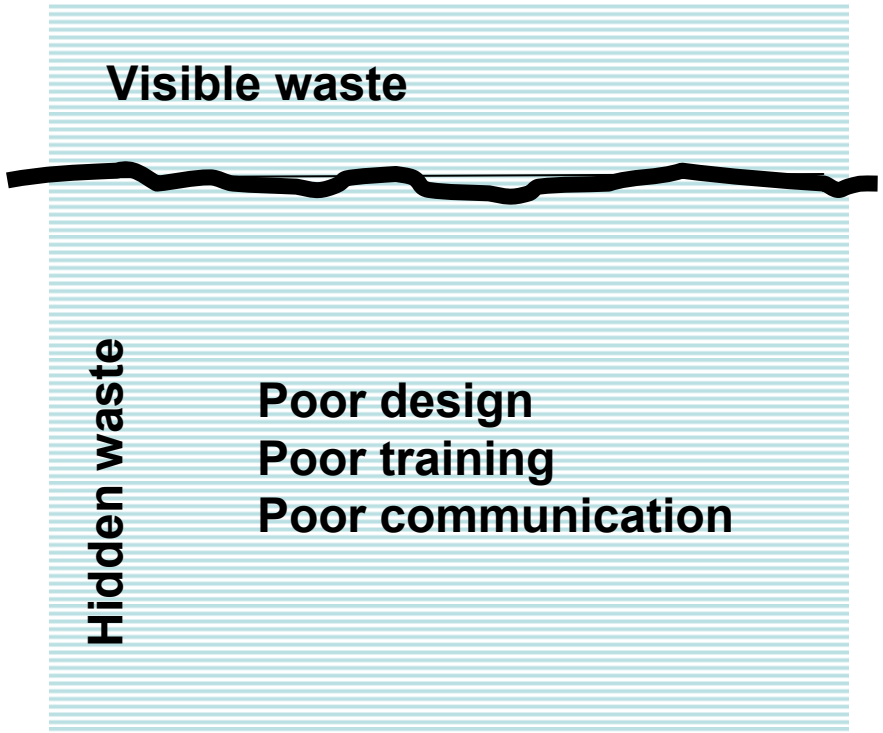
Mind is like a parachute:
It works best when open!

Evaluation phase

- Developing & ranking ideas against performance criteria
  - Pass / fail test
- Eliminating ideas that don't have champions.
  - Feasible / realistic / lack of champions
- Voting on ideas through 'Gut Feel Criteria'
  - Consensus / Wisdom
- Majority Decision

- *Waste*
  - Make it visible
  - Make it tangible
  - Seek / Identify opportunities to eliminate/modify
    - Small / large ideas, build on others ideas..

Unnecessary & secondary functions are like waste that may be eliminated by creativity



Development Phase

Objectives:

Review Customer's values and objectives

Expand Ideas

Develop the chosen ideas into written recommendations that include:

- **Sketches**
- **Calculations**
- **Cost Analysis**
- **Advantages and Disadvantages**
- **Risks (cost and time) if possible.**

Presentation Phase

Objectives:

Present workshop team recommendations

Welcome questions

Demonstrate depth, knowledge and thoroughness

Inspire confidence

Identify the Targets (Who)

Review the Study Objectives (Why)

Present the Conclusions (What)

Critical Success Factors for VE

Methodology

VE job plan must be followed systematically

Attitude of Participants

Right attitude, appropriate stakeholders, awareness of process

Executive support

VE workshops, sponsorship, implementation of results

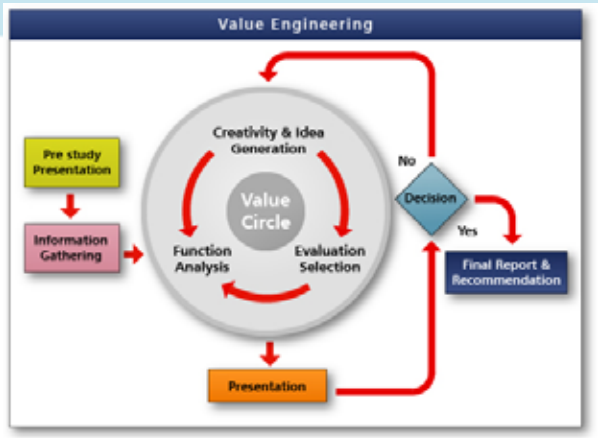
Management of Process

Clear objectives, timelines, follow-up actions, review and feedback

Professional Workshop Facilitation

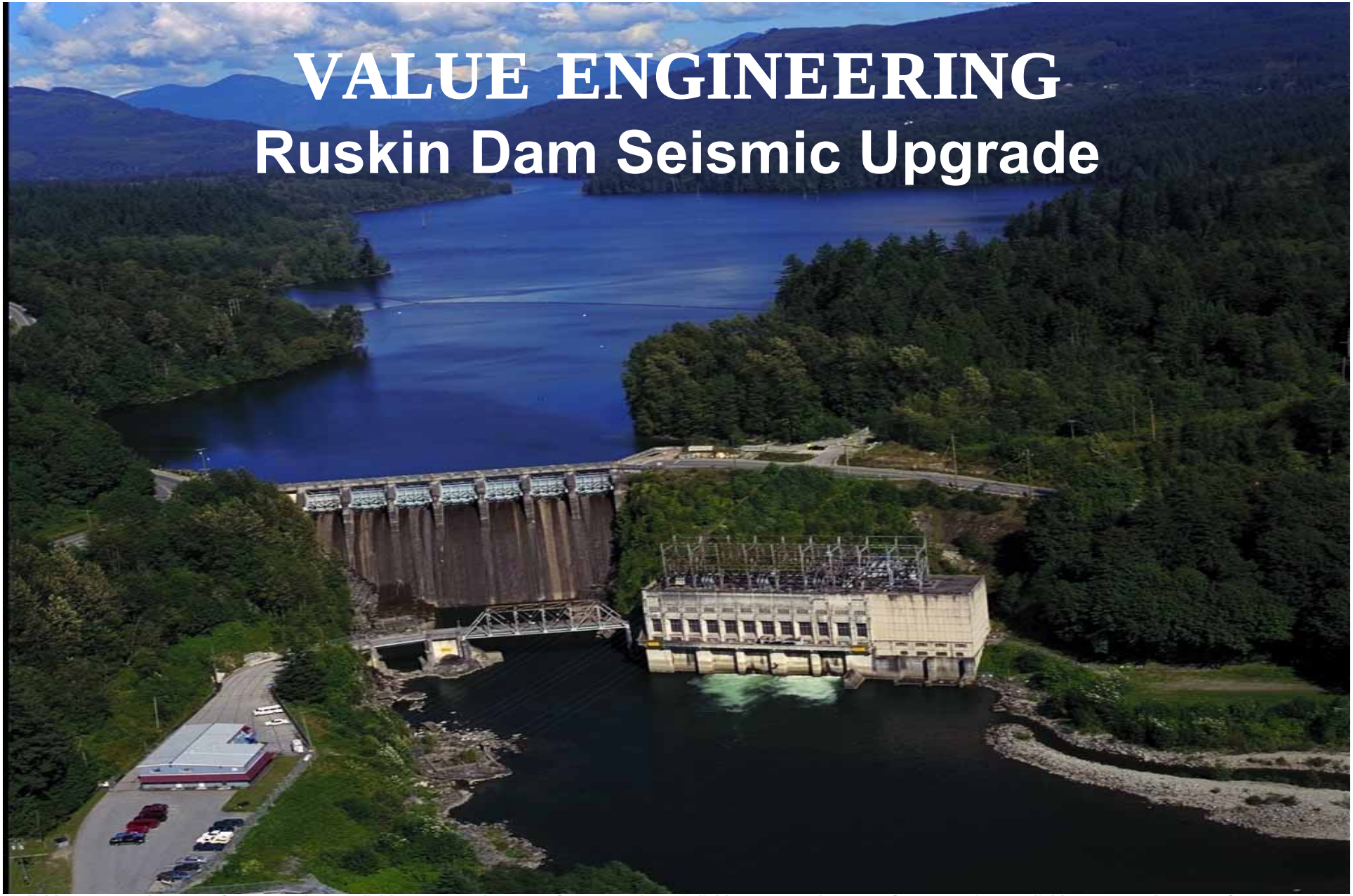
Probing with right questions, using appropriate tools, managing the process, maintaining momentum of team, etc. etc.

VALUE BY DESIGN !



- SYSTEMATIC APPROACH
- FULL USE OF CREATIVITY & TEAM WORK
- PRE DETERMINED CRITERIA FOR VALUE
- EVALUATION AND ASSESSMENT BY TEAM
- LIFE CYCLE – COST, MAINTENANCE, SUSTAINABILITY
  - FINANCIAL, ENVIRONMENTAL & SOCIAL (TBL)
- WORKS WELL WITH SAFETY BY DESIGN STRATEGY
- KNOWLEDGE TRANSFER AND ORGANIZATIONAL LEARNING

VALUE ENGINEERING
Ruskin Dam Seismic Upgrade



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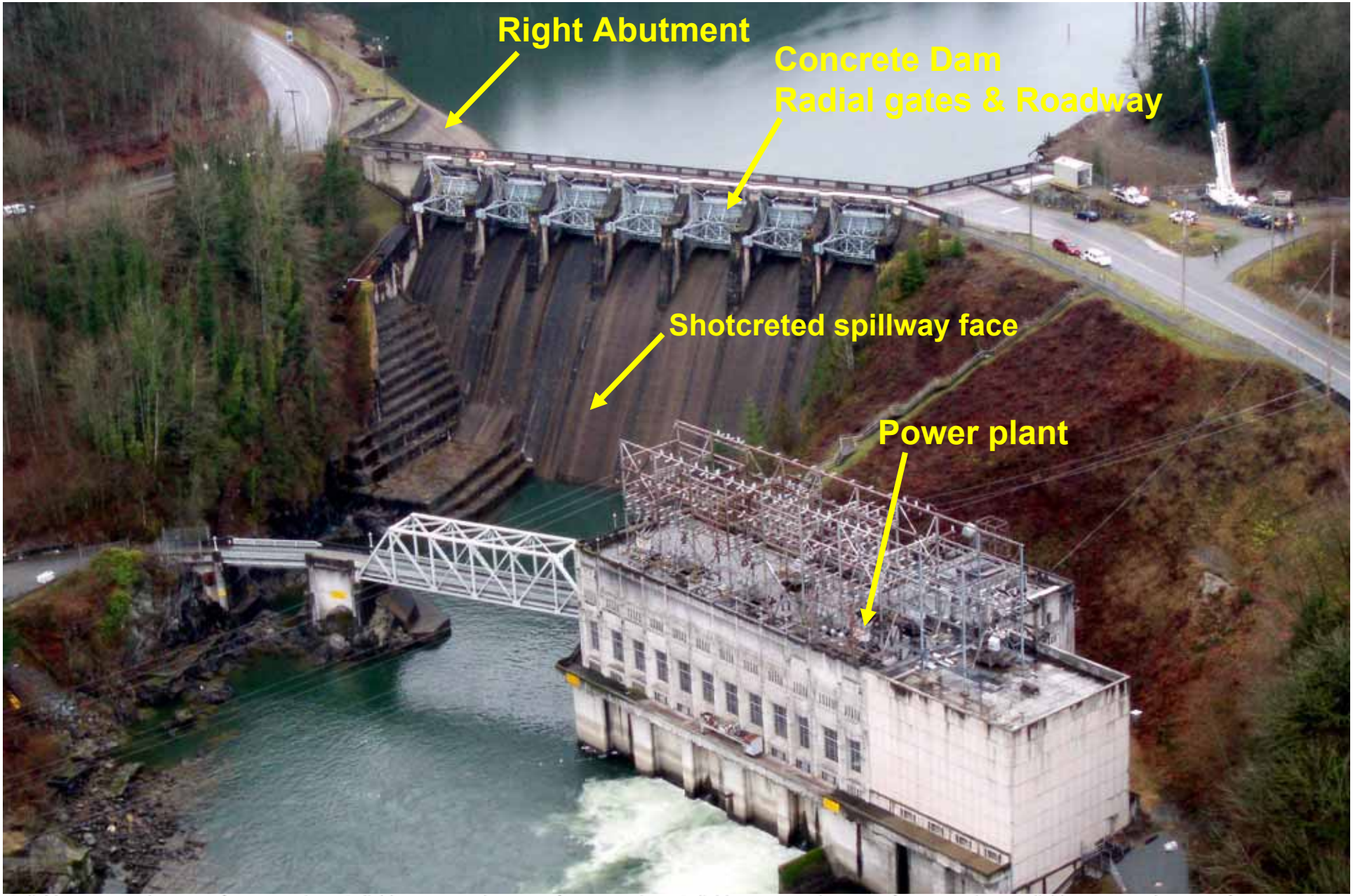

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Ruskin Dam Seismic Upgrade

VALUE ENGINEERING

BC hydro


Dam Upgrade Project
In-house design
•Upgrade the Right Abutment
•Demolish & Rebuild Upper Dam
•New Elect. & Mech. Systems
•ALARP – Safety by Design
•$171 mil (-15%,+50%)
•2009-2014
Powerhouse PROJECT
MWH design
$500 million
•2009-2014

Dam Upgrade Project

The project is to upgrade the dam structure – upper concrete dam and the right abutment.

The Maximum Design Earthquake with an average Return Period of 10,000 years (7.5 on the Richter scale for that location)

Ruskin Dam VE Study is the first formal VE study in recent years within BC Hydro

Why seismic upgrade is important?

Key Objectives and WDB for Dam Upgrade Project

- **Address Dam Safety Issues**
  - Seepage and piping risk at right abutment
  - Seismic stability of right abutment
  - Seismic stability of concrete dam
- **Incorporate other User Requirements such as:**
  - Gate reliability
  - Physical security
  - Safety by Design principles

- Design Flood PMF: 3,650 m3/s
- Design Earthquake MDE: 0.71 g, M7.5

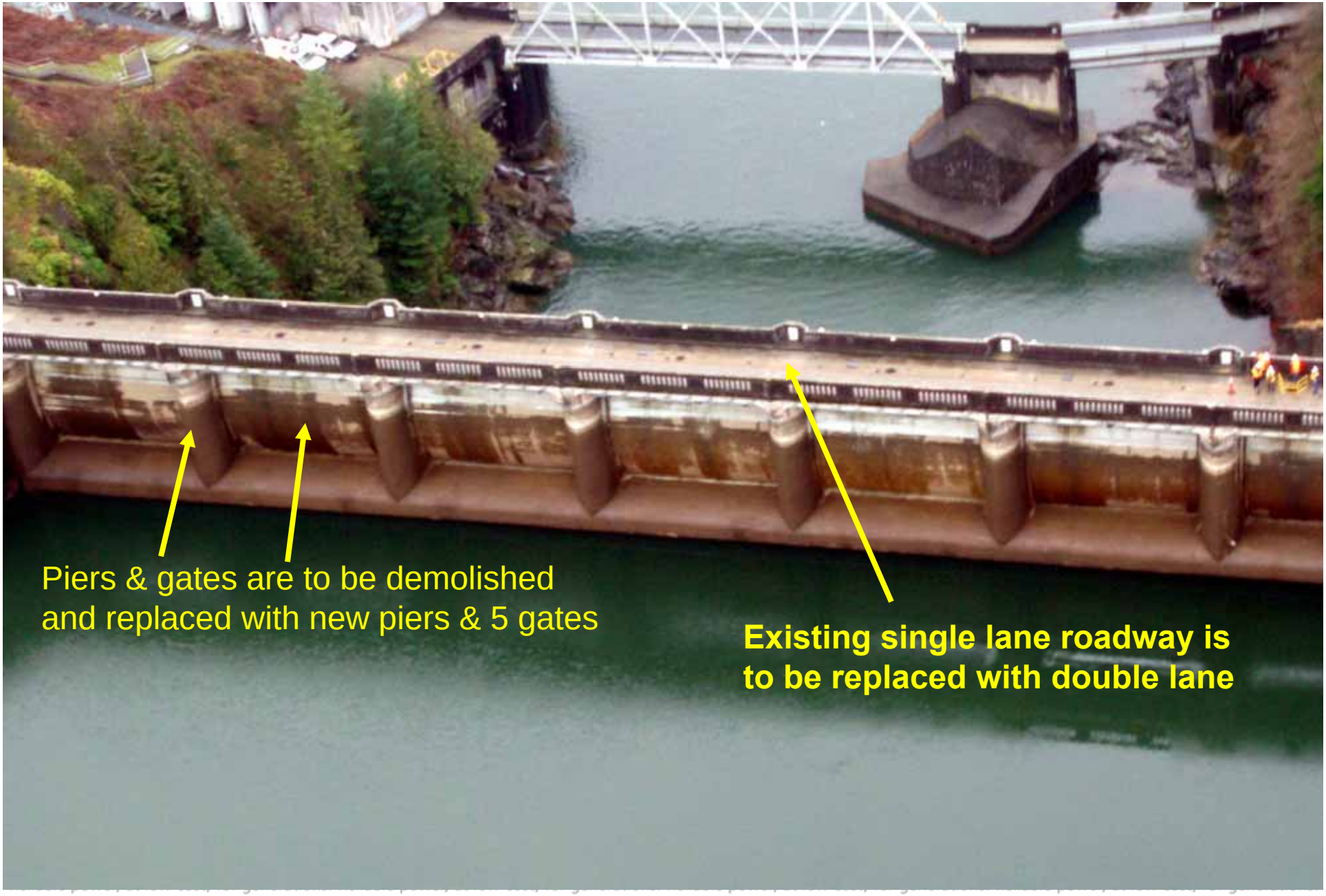
Purpose of the Ruskin VE Study *

Review and evaluate the methods and approaches specified in the feasibility design documents developed to-date.

Study the effectiveness of the proposed design solutions, including scheduling and phasing

Develop and/or refine concepts or components to improve performance and/or reduce cost, while maintaining design standards and codes, safety and reliability.

*** As per RFP to select a CVS**



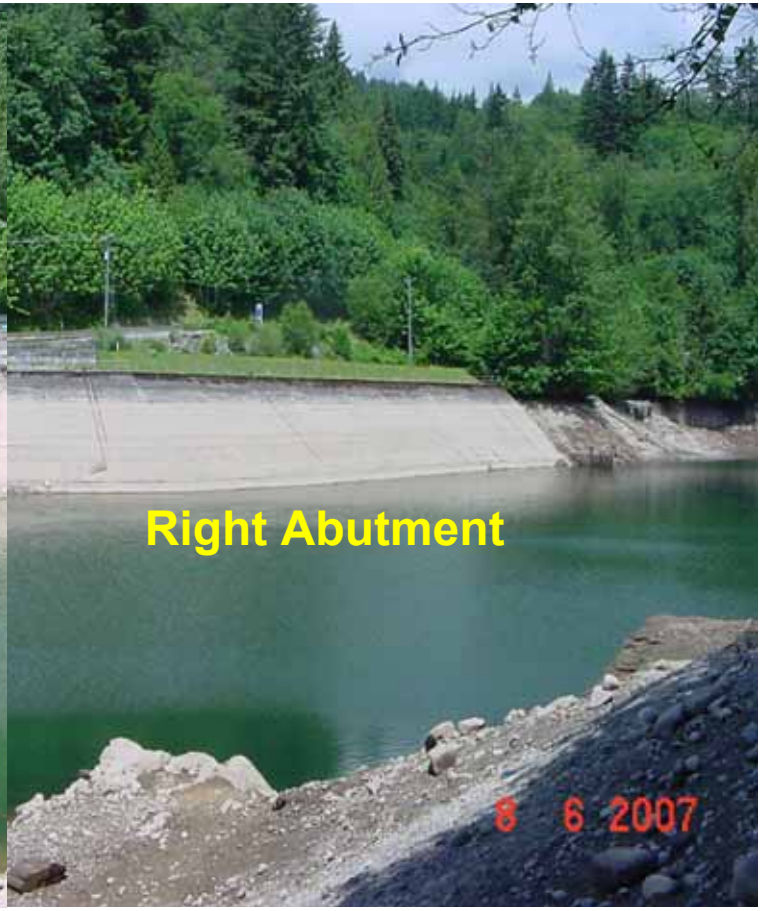
Ruskin Dam Seismic Upgrade

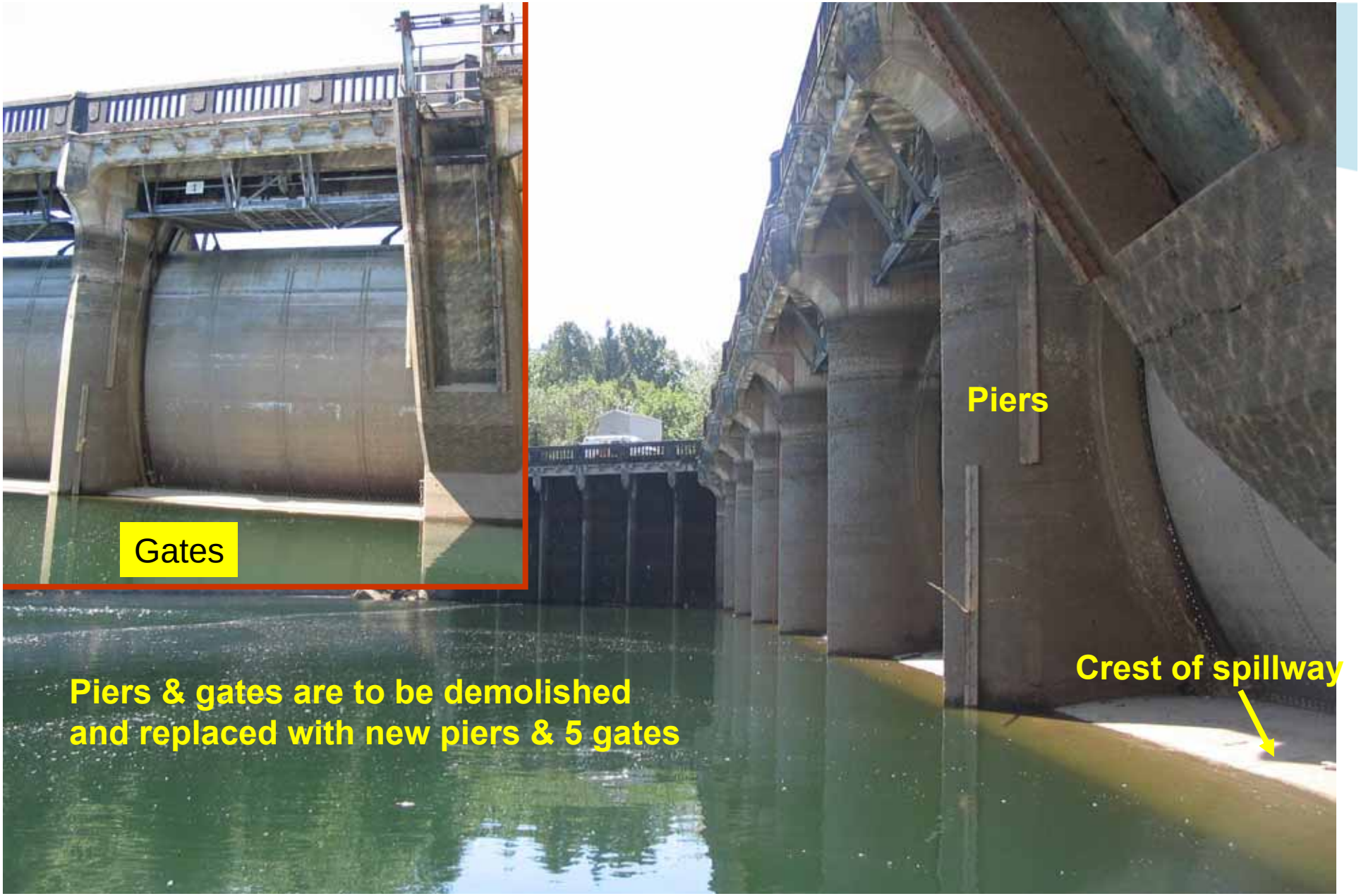
VALUE ENGINEERING

BC hydro

Project Site

Upstream





Ruskin Dam Seismic Upgrade

VALUE ENGINEERING

BC hydro

Conceptual Design - key features:

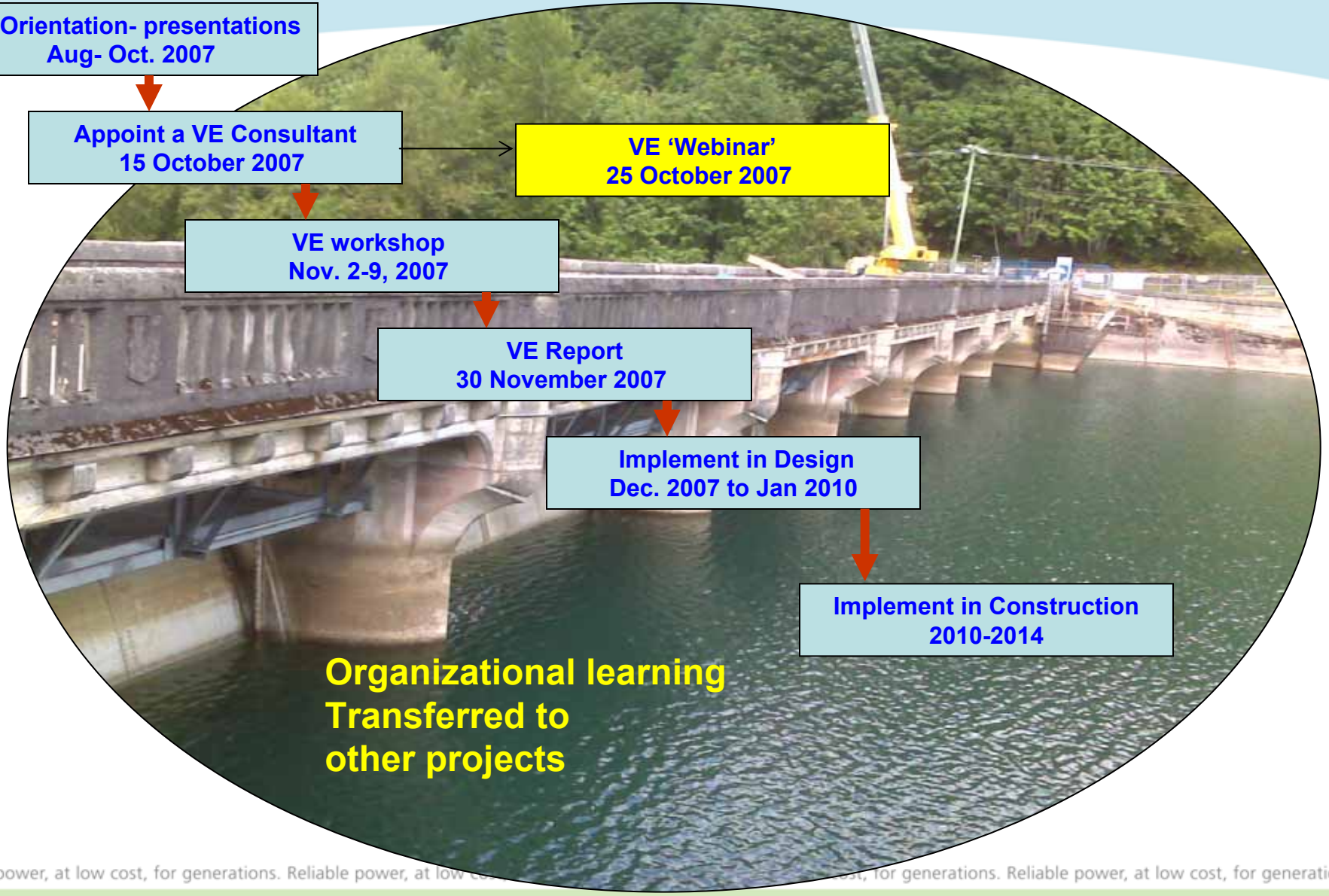
1. Remediation work on the Right Abutment that provides a downstream reverse-filter blanket, installation of a jet grout cut off wall in the area of the downstream drainage adit, and strengthening of the soils beneath the upstream concrete slab by jet grouting

2. For the Upper Dam, the upgrade program involves demolition and replacement of the 6 existing concrete piers, 7 radial (steel) gates, and the bridge deck with new piers, 5 larger gates, and a wider roadway bridge

3. Construction of new electrical, mechanical and hydraulic operational systems, and corresponding control rooms to operate the gates.

4. The project is guided by principles of "Safety by Design" and the entire project is being designed accordingly.

Ruskin Dam SEISMIC UPGRADE PROJECT
VALUE ENGINEERING STUDY



VE Phase	Agenda
Information Phase	•Webinar •Detailed Project Presentations •Defining Problem/Opportunities
Function Analysis	• Identifying Project Functions/FAST
Creativity	•Defining Targets •Creative Brainstorming
Evaluation	•Screening of Ideas to be Championed •Detailed Evaluation
Development	•Mid-Workshop Review Meeting with Owner/Agency •Technical Write-ups of VE Proposals
Presentation	• Team Presentation of VE Proposal

VE Workshop Agenda

VE Study Summary

- **VE Ideas Summary:**
  - **176 Ideas Generated**
  - **60 Ideas Shortlisted**
  - **26 Ideas Developed in to VE Proposals**

Value Targets (functions)		
Ref. Function	**Basic Functions**	**No. of Ideas Selected for proposals**
CF	Control Flow	8 Ideas
CS	Control Seepage	3 Ideas
EC	Estimate Correction	1 Idea
FC	Facilitate Construction	3 Ideas
MG	Maintain Gates	1 Idea
OG	Operate Gates	7 Ideas
PW	Protect Workers	1 Idea
SG	Support Gates	2 Ideas
Total VE proposals developed		**26 Ideas**

Summary of VE Proposals & Recommendations:

Rejected VE Proposals due to increased costs & not commensurate with benefits	2
VE Proposals considered for Design improvements (9 accepted)	12
Rejected VE Proposals after general considerations	7
Accepted VE Proposals for further consideration*	2
Accepted VE Proposals at the Preliminary Design*	3

Note: 1 proposal has been since modified and adopted

Three major proposals with high impact

Following have been adopted and are currently being pursued with detailed assessment and cost estimation.

1. Install a plastic concrete cut off wall
VE Proposal CS-10 –savings of $ 8.00 million – adopted additional environmental benefits.

2. Use parts of temp bulkhead to form perm. Bulkhead in lieu of stop logs
VE Proposal MG-16 – potential savings of $ 7.0 million
Project Management is still undecided on this.

3. Maintain existing pier designs and use a design for the new gates so as to accommodate potential deformation of the skin plates.
VE Proposal SG-02 (modified)- design and cost impact is being studied for a hybrid idea. i.e., new gates with ductile behaviour

Photo Representation Of the Proposed work

Design Suggestions / Improvements selected for further consideration

1.	Locate Electrical rooms in such a way that the seismic loads are less than 1.0g)	VE Proposal OG-01	Adopted
2.	Dampen the electrical room	VE Proposal OG-02	Discarded
3.	Use armoured cabling for all dam runs	VE Proposal OG-05	Adopted
4.	Automatic control of emergency generator	VE Proposal OG-11	Adopted
5.	Locate the circuit breakers inside electrical room, not on piers	VE Proposal OG-12	Adopted
6.	Provide hydraulic by-pass for oil for gate control system	VE Proposal OG-14	Adopted
7.	Minimize the hydraulic cylinder size	VE Proposal OG-18	Adopted
8.	Seismic dampening of gate skin plates	VE Proposal CF-11	Further study
9.	Use a self-balanced bulkhead with no support from piers	VE Proposal FC-10	Discarded
10.	Include a fuse-able bulkhead for emergency flood relief	VE Proposal FC-17	Discarded
11.	Provide access for slab inspection at right abutment	VE Proposal PW-12	Adopted
12.	Include the lost power revenue in calculations	VE Proposal EC-01	Adopted

The rejected major proposals were:

1.	Install a fuse gate in one bay with new pier configuration	VE Proposal CF-01 A
2.	Install 2 fuse gates with the old pier configuration	VE Proposal CF-01B
3.	Install 3 fuse gates in the exiting bays	VE Proposal CF-01C
4.	Use flap gates replacing all the 7 existing gates	VE Proposal CF-15
5.	Use radial gates on the sides and flap gates in the centre	VE Proposal CF-24
6.	Use strong back system to secure right abutment slabs	VE Proposal CS-29
7.	Distribute the loads from the centre piers to end piers by using bridge deck	VE Proposal SG-12

Accomplishments – Ruskin VE Study.

1. VE proposals resulted in significant design decisions with impact on cost estimate. **Cost savings of a minimum of $8 million achieved with a potential for additional savings**.

2. Several VE proposals adopted in design with no significant impact on cost, but **improved the quality of design**.

3. VE study resulted in **confirming that most of the design decisions thus far have been appropriate and thereby validating them**.

4. Established the **VE study as a tool for the management to ascertain that almost all possible design options have been studied** before making major design decisions.

5. Created **enhanced trust and reliance on the classic VE study** which will potentially be applied to all major projects in BC Hydro. This will hopefully result in a shift in culture of project delivery within the organization.

Lessons Learned

1. Gained valuable insight and an appreciation of the benefits of performing formal Value studies on major project initiatives.

2. VE study done at an earlier stage of the Ruskin Project would have been much more effective as more broader options could have been entertained in the creativity sessions.

3. Many of the design decisions had already been in place (sacred cows-don't touch) and it was too late to make major changes at the time of VE study.

4. During the workshop, many salient aspects beyond the scope of VE study emerged impacting the final product. They include the safety aspects, environmental issues, public consultation, etc.

5. Provided another opportunity to be due diligent in the design process

6. Several design improvements have been identified and adopted adding value to the project.

Lessons Learned contd.

7. Cost estimates developed in the VE workshop are only 'order of magnitude'

8. More design development and rigorous cost estimates are required to ascertain idea feasibility and acceptability.

9. Detailed follow-up study is required to meaningfully capture the impact of VE proposals.

10. Due diligence and detailed study are expected to take place after the VE proposals are developed at the workshop before accepting or rejecting them.

11. 'Safety by Design' - VE workshop gave ample insights into the safety aspects.

12. A Safety by Design workshop followed the VE study workshop and the team members observed that the VE study & SbD have many common themes.

Lessons Learned contd.

14. Management / Executive support is critical to success of a VE Study.

15. A champion to the cause of Value Engineering is critical to create an interest and sense of importance of the process amongst the team members.

16. The 'webinar' conducted for the study was well appreciated by all- saved time and was very effective.

17. For significant engineering projects, success of the Value Engineering study depends on the effectiveness of the facilitator and He/she must be a Value Engineering professional, a Certified Value Specialist.

18. By undertaking the VE study, the Corporation has saved a minimum of $8 million with a potential for additional savings. This represents a significant rate of return as the Value Engineering task cost had been only about $150,000.

VE study is in line with BC Hydro's Triple Bottom Line approach.

$2 billion+ worth of construction is on the books!

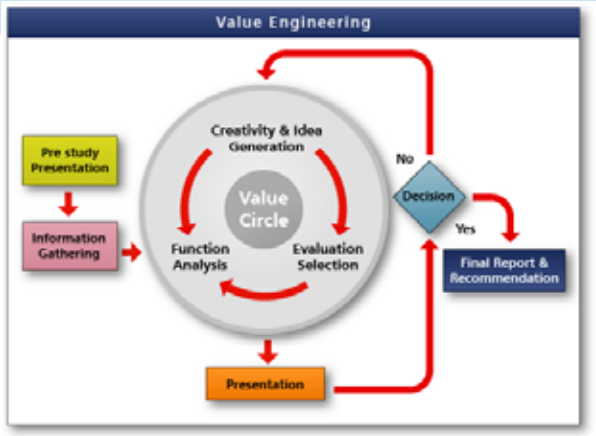
Value Engineering and Safety by Design share common principles.

VE as a practice will result in

Value Engineering Study- a vehicle to bring triple bottom line and sustainability in practice.

- ***Significant revisions with cost impact***
- ***Cost neutral revisions.***
- ***Validation of design decisions***
- ***Management tool for due diligence***
- ***Cultural shift towards project delivery***

VALUE BY DESIGN !



- SYSTEMATIC APPROACH
- FULL USE OF CREATIVITY & TEAM WORK
- PRE DETERMINED CRITERIA FOR VALUE
- EVALUATION AND ASSESSMENT BY TEAM
- LIFE CYCLE – COST, MAINTENANCE, SUSTAINABILITY
- WORKS WELL WITH SAFETY BY DESIGN STRATEGY
- KNOWLEDGE TRANSFER AND ORGANIZATIONAL LEARNING
- GOOD SYNERGY WITH SAFETY BY DESIGN
- TRIPLE BOTTOM LINE CONSIDERATIONS (NOT JUST $$)

Value engineering

Strengths

- Optimization of Quality / Performance
- Overall Cost Optimization
- Appropriate Technology
- Sustainable (Reduce, Reuse and Recycle) Approach
- Enhanced Reliability & Safety
- Risk Mitigation (bad news upfront)

Limitations

- VE team should be involved right from the beginning
- Reliance on creativity and lateral thinking
- Team work is a must
- Can result in many intangibles
- Initial cost (time and effort)

Ruskin Dam VE Study

Winner of Outstanding Accomplishment

2009 SAVE Annual Conference – Detroit 29 June to 2 July 2009