



# DIABLO DAM SPILL GATE REPAIRS

2016 Northwest Hydropower Forum – Eugene, OR

Kimberly Pate | 17 May 2016

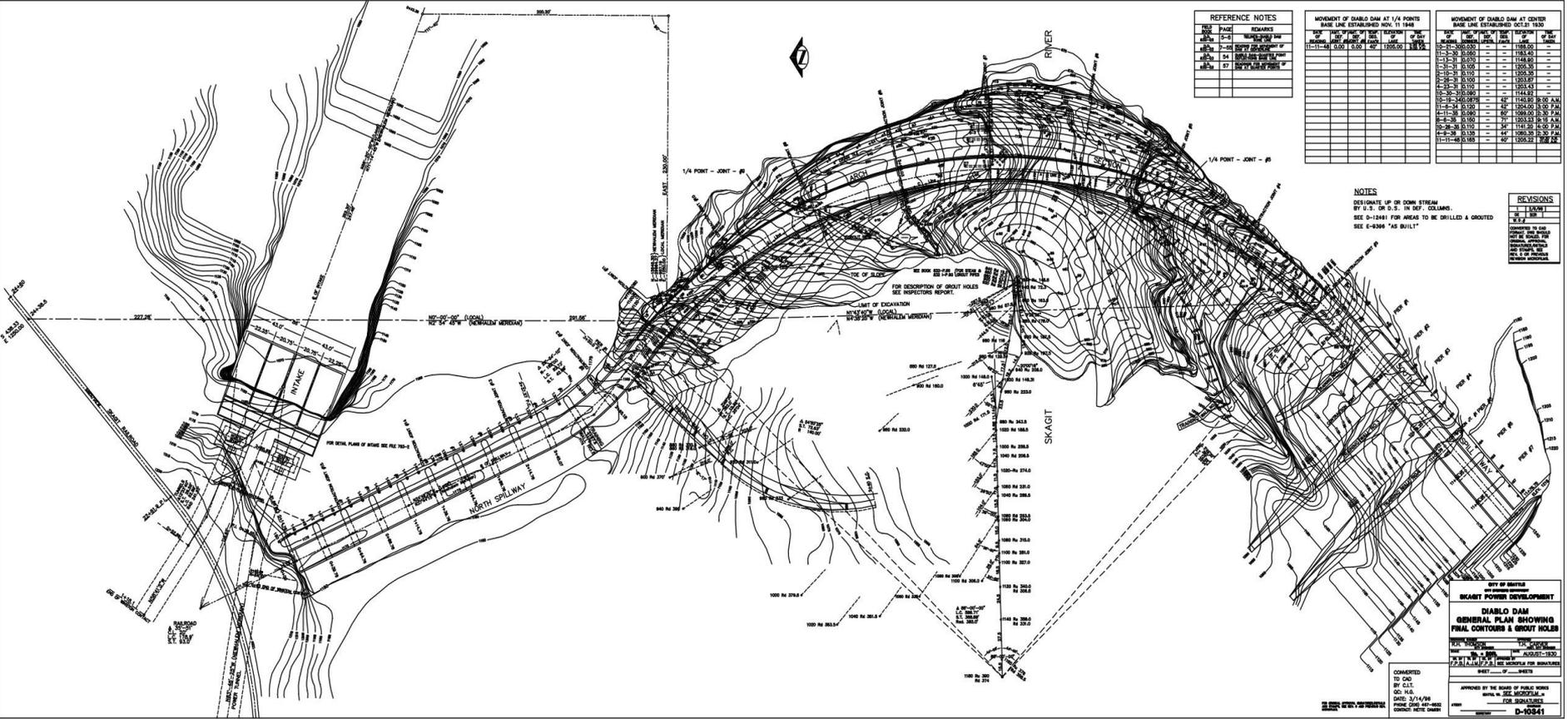




## DIABLO DAM GENERAL INFO

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- Built: 1927-November 1929 by Winston Bros. Company (\$4M)
- Concrete Arch Dam With Gravity Abutments
  - 389 feet high, 1180 feet long at crest, 140 feet thick base
  - 350,000 cubic yards of concrete
  - 19 Tainter Radial Gate 20'-6" wide, 18' to max. Lake
  - Gates 1-3 Automated in ~1980
  - Gates 4-19 Operated by Portable Hoist
  - Normal Usage Sequence is 2, 3, Teens
  - Normal Pool Level, El. 1,205 feet



**REFERENCE NOTES**

REF. PAGE	REMARKS
REF. 1-1	GENERAL PLAN
REF. 2-1	GENERAL PLAN
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**MOVEMENT OF DIABLO DAM AT 1/4 POINTS**  
 BANK LINE ESTABLISHED NOV. 11, 1946

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**NOTES**  
 DESIGNATE UP OR DOWN STREAM BY U.S. OR S.S. OR S.F. COLLARS.  
 SEE D-13461 FOR AREAS TO BE DRILLED & GROUTED.  
 SEE D-13468 "AS BUILT"

**REVISIONS**

NO.	DATE	DESCRIPTION
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**CITY OF SEATTLE**  
**SKAGIT POWER DEVELOPMENT**  
**DIABLO DAM**  
**GENERAL PLAN SHOWING**  
**FINAL CONTOURS & CREST HOLES**

DESIGNED BY: [Name]  
 DRAWN BY: [Name]  
 CHECKED BY: [Name]  
 APPROVED BY: [Name]

DATE: 11-11-46  
 PROJECT NO.: [Number]

CONVERTED TO: [Scale]  
 BY: [Name]

APPROVED BY THE BOARD OF PUBLIC WORKS: [Name]  
 DATE: [Date]

FOR SKAGIT: [Name]

**D-10541**



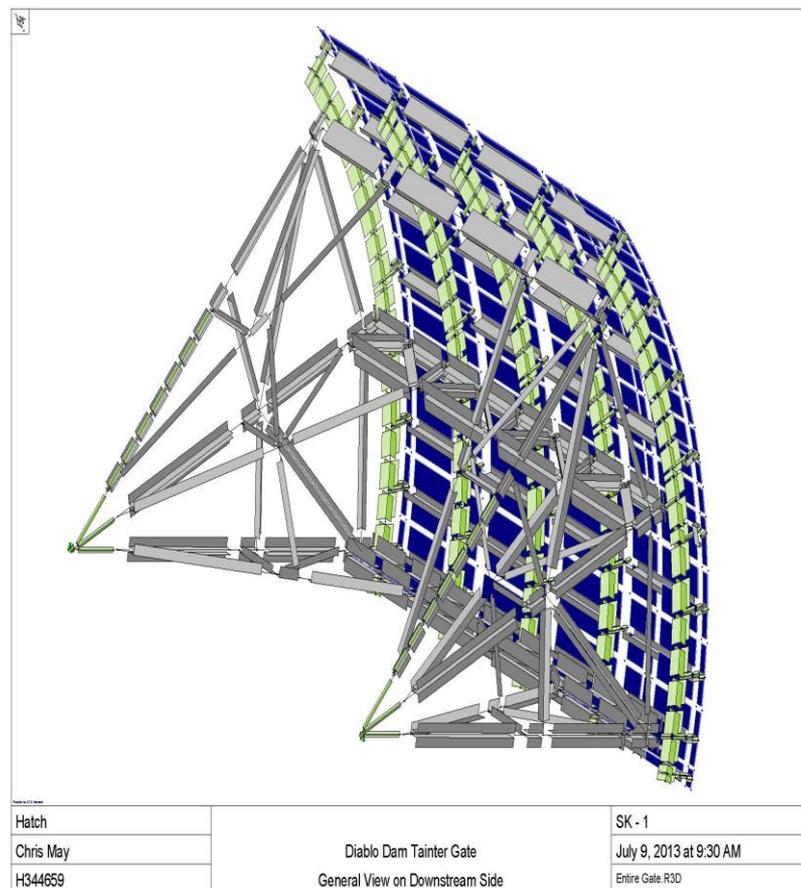
# SUMMARY OF RECENT HISTORY – LOOK SIMILAR?

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- Folsom Tainter Gate Failure, 1995
- FERC Letter to City Light, 1998 (e.g. Folsom Forensic Report)
- FERC Tainter Gate Initiative, 2002 (Category 1 or 2?)
- Part 12 Inspection Plan and Schedule, 2002
  - Seismic / extreme flood structural retrofit of all Gates starts in 2003
  - Extension of Time request from 12/31/2004 to 07/31/2005
- Part 12 Inspection Plan and Schedule, 2012
  - Model and Determine Maximum Acceptable Friction
  - Friction Test Gates and Determine Current Condition
  - RISA model developed and Friction Testing starts in June 2013

# 2013 TO 2014 GATE #2 TESTING AND REPAIRS

- SCL Assisted Hatch with 2013 Testing
- Cantilevered Beam (73" long) Temporarily Mounted at Each Trunnion
- Digital Dial Indicator Mounted at the End Beam
- Serial Connection Between Indicator and PC
- Data Collected Using PC Running LabVIEW
- Collect Continuous Data at 10 Hz
- Raise Gate 1 Foot and 2 Foot



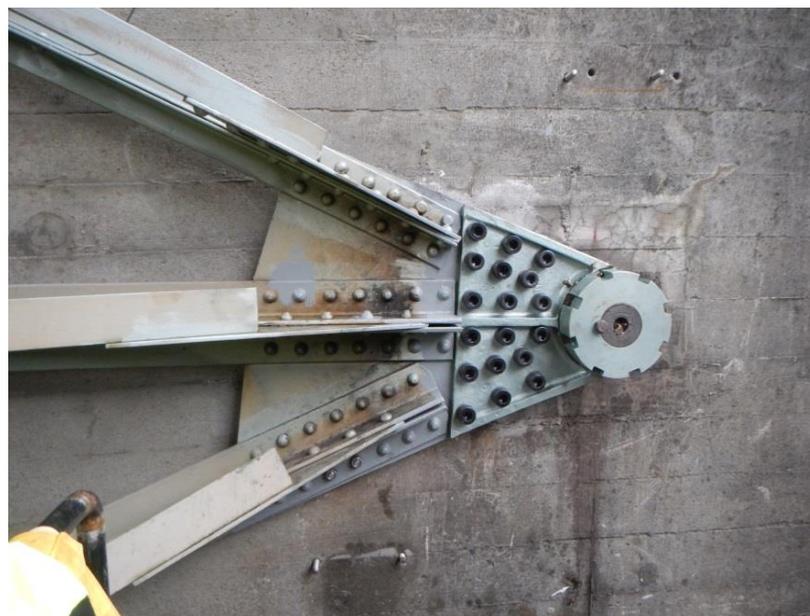
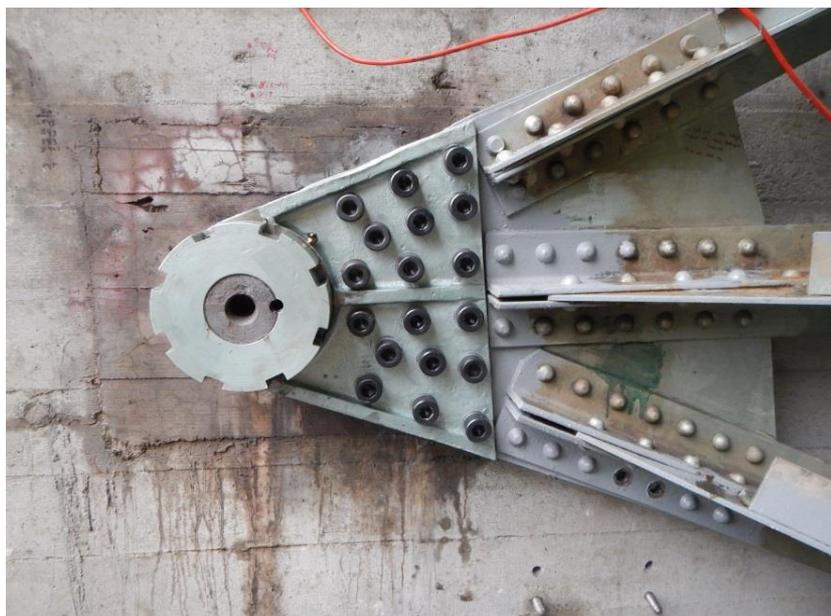
# GATE NO. 2 FRICTION TEST AND REPLACE BUSHINGS

- Gate 2 Friction in 2013
  - 0.9 Right, 0.6 Left
  - Original Bushing had 1 Port with "X" Groove ~ +/- 30 Degree of Coverage
- New Bushings in 2014 (Improve Grease Distribution)
  - Outer Circumferential Groove
  - 4 ports OD to ID
  - 4 Distribution Bars



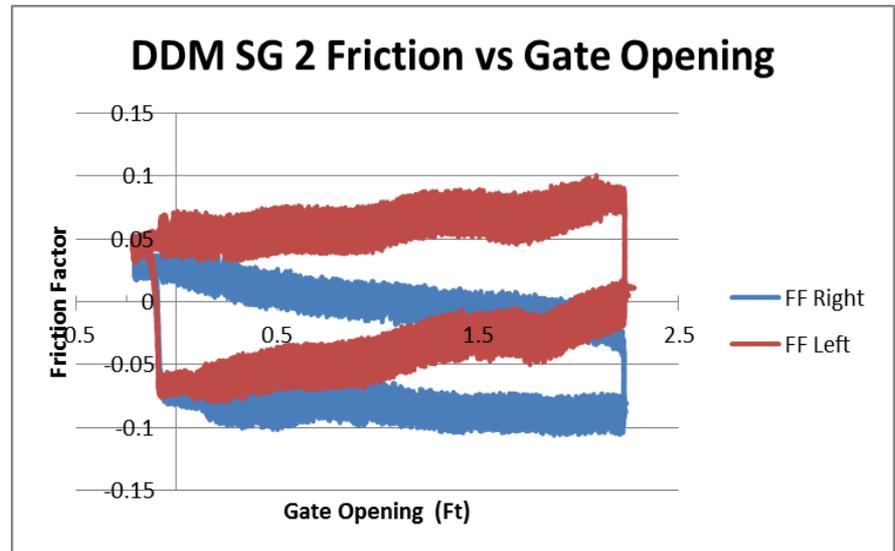
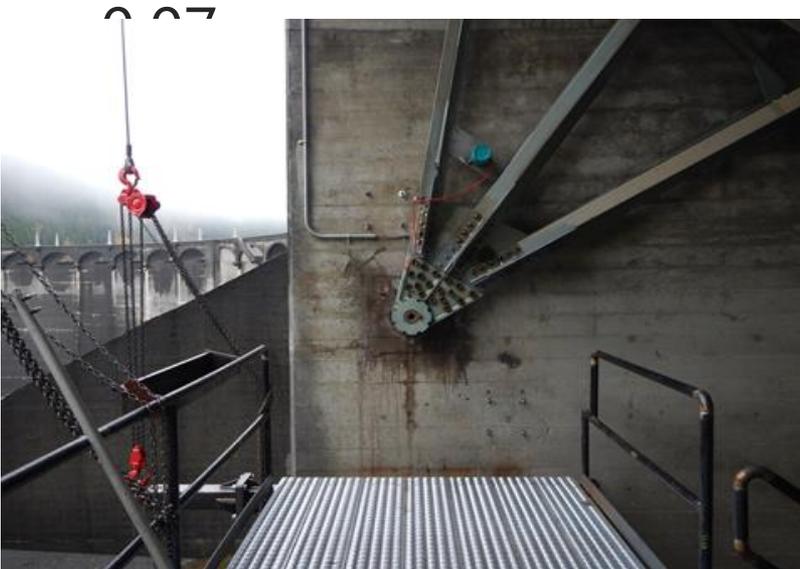
# REASSEMBLY OF TRUNNION

- Bolted Both Sides Together
  - Socket Head Cap Screws
  - Nordlock Lock Washers



# FINAL TESTING ON GATE 2

- Dry Gate Opening Test With Beam/Indicator
- Conduct Full Gate Opening
- Wet Gate Opening Test With Beam/Indicator
- Wet Gate Friction Testing - Repaired Trunnion Friction



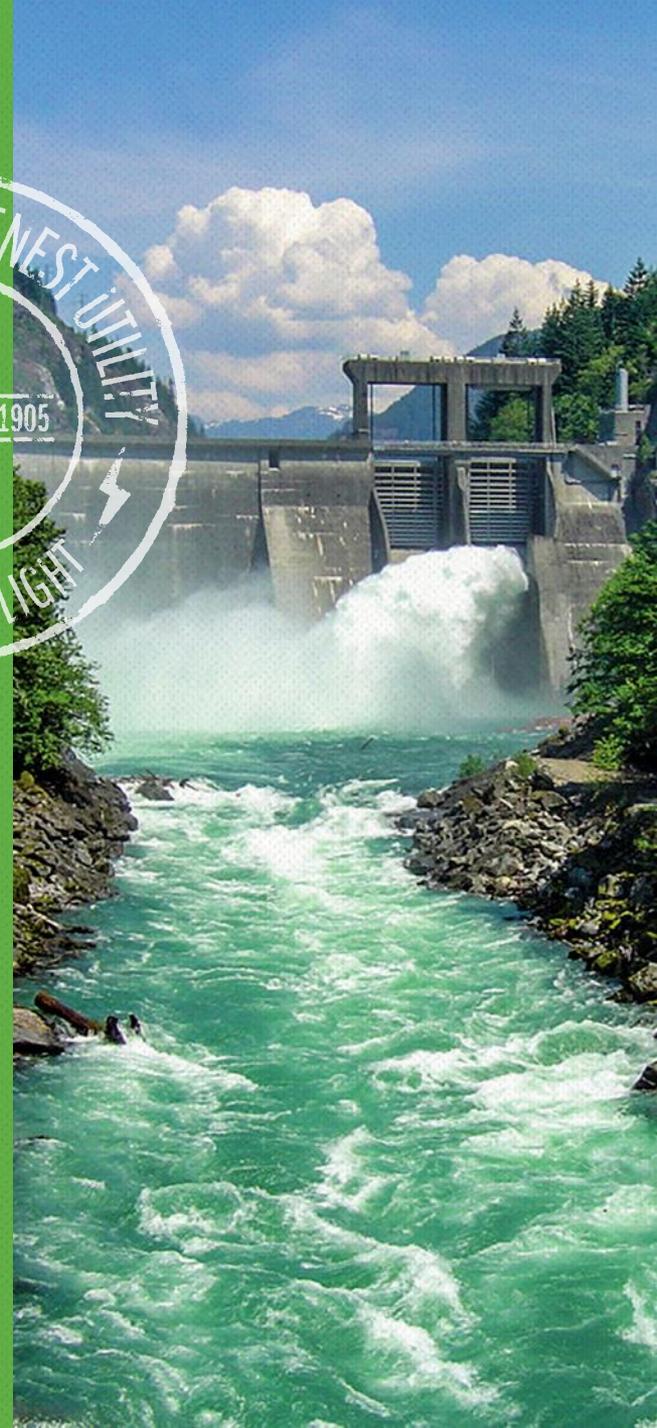
# GATE REPAIR STATUS

Gate #1 – 2015 Bent Left Arm  
Daily Visual Operator Inspection  
Bushings replaced in early 2016  
Greaseless / Karon V bushing assemblies

Gates #4 through #12 and #16 through  
#18 Acceptable Friction Values

Gates #13 through #15 – 2016 Friction  
Tests

Gate #19 pending 2016 plan and  
schedule



# WHAT'S NEXT?

## REFURBISH 18 GATES TO GREASELESS DESIGN

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- Started with Gate 3, next is Gate 2 (remote gates)
- Turn Existing Trunnion to Round and Smooth
- Thermally Shrink Fit Stainless Steel Sleeve to Trunnion Shaft
- Bore Out Cast Bushing Carrier for New Greaseless Bushing
- Add Two Energized O-ring Seals on Trunnion/Bushing End



# ACKNOWLEDGEMENTS

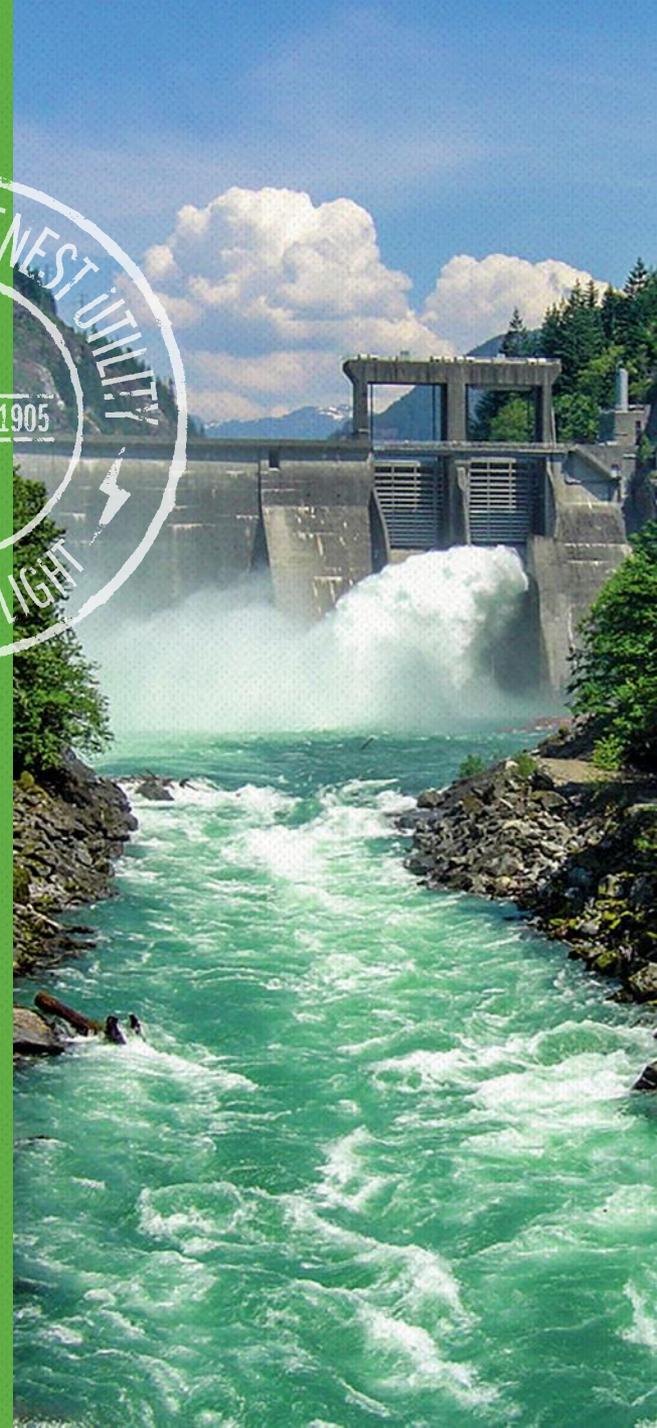
Robert Gordon, P.E.

Senior Mechanical Engineer

Daniel Kirschbaum, P.E.

Supervising Mechanical Engineer

Skagit Staff and Steel Crews





# CITY LIGHT

## OUR VISION

To set the standard—to deliver the best customer service experience of any utility in the nation.

## OUR MISSION

Seattle City Light is dedicated to exceeding our customers' expectations in producing and delivering environmentally responsible, safe, low-cost and reliable power.

## OUR VALUES

Excellence, Accountability, Trust and Stewardship.

