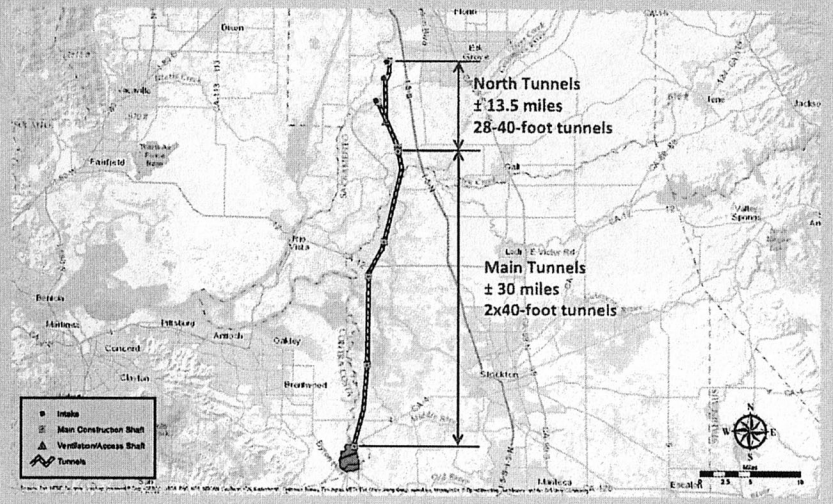
CALIFORNIA WATER FIX
RELIABLE CLEAN WATER

PROJECT IMPLEMENTATION CONSIDERATIONS FOR THE CALIFORNIA WATERFIX

Westlands Water District
August 9, 2017

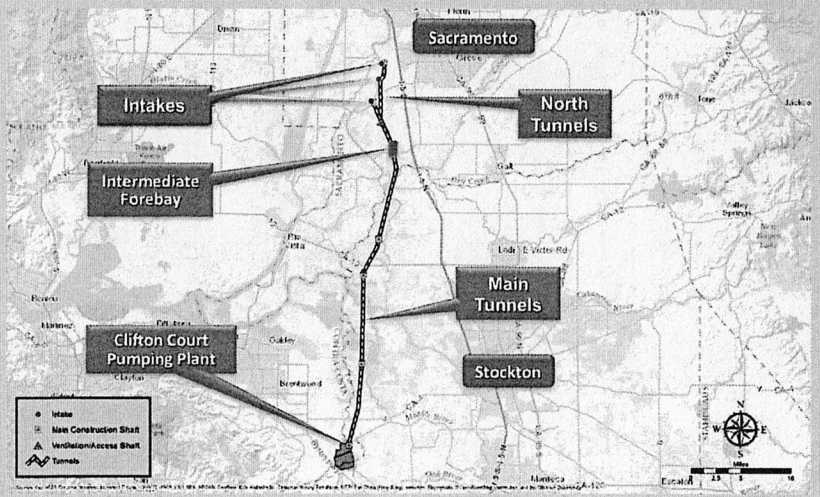
Presented by Chuck Gardner ①
on August 22, also.

TUNNEL PORTIONS OF PROGRAM



3

CALIFORNIA WATER FIX- OVERALL PROGRAM



2

MAIN TUNNELS

- 100 year life
- Twin bore main tunnels
- 150 ft below grade
- Concrete segmental liner
- Pressurized face Tunnel Boring Machine construction
- 45 ft excavated diameter
- 40 ft finished internal diameter

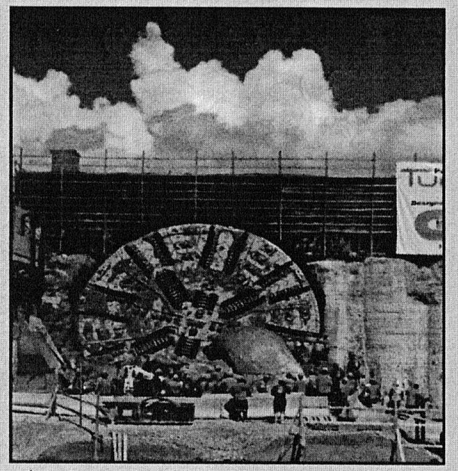
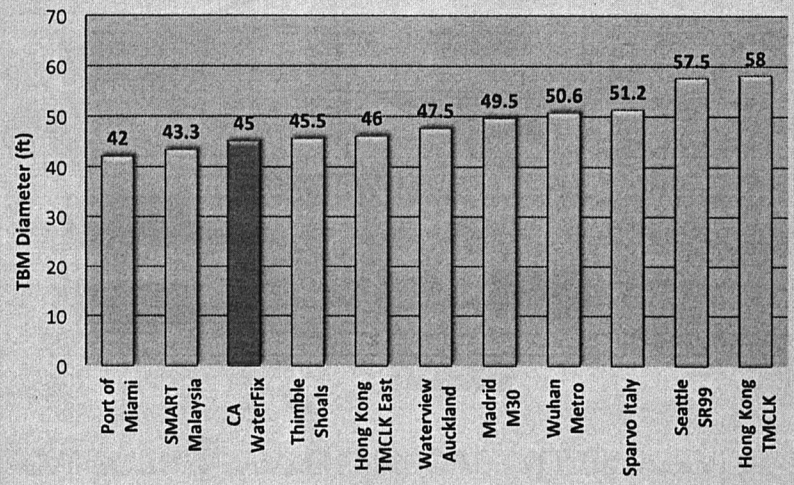


Photo Courtesy: Port of Miami Tunnel

4

LARGE DIAMETER TUNNEL BORING MACHINE PROJECTS



PROGRAM FACTS

- 700,000 tunnel segments
- 23 million cubic yards of excavated tunnel material
- 10-12 Tunnel Boring Machines operating simultaneously
- 195 Mega Watts of power required for Tunnel Boring Machines
- Existing levees protect project sites
- Limited highway access in Delta

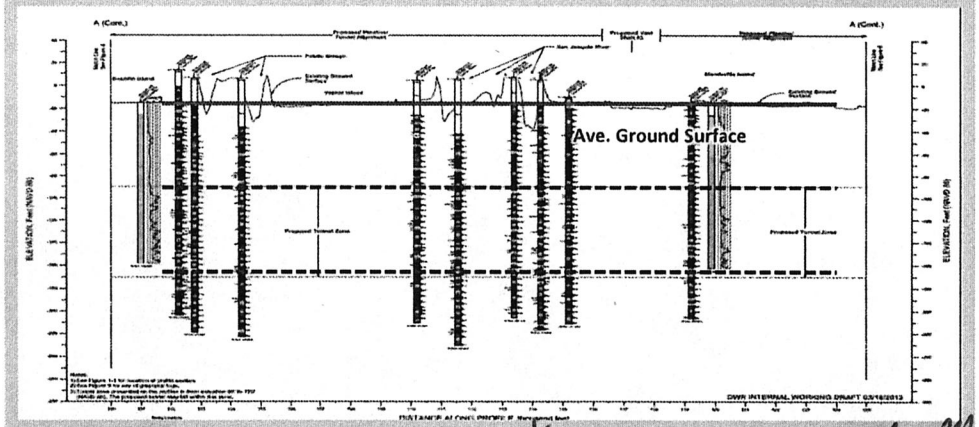
an more reliable power source for North Delta residents

need to get power to remote parts of Delta

barge traffic & landing sites

SMWD to supply power in North
WAPA " " " South
once done, power lines will come down.

GEOTECHNICAL PROFILE AT TUNNEL DEPTH



Note: Over 200 borings/CPTs completed

CG: "soil is inconsistently inconsistent"

want ~ 1500 borings before designing the TBM

TYPICAL TUNNEL SEGMENTS AND LINED TUNNEL

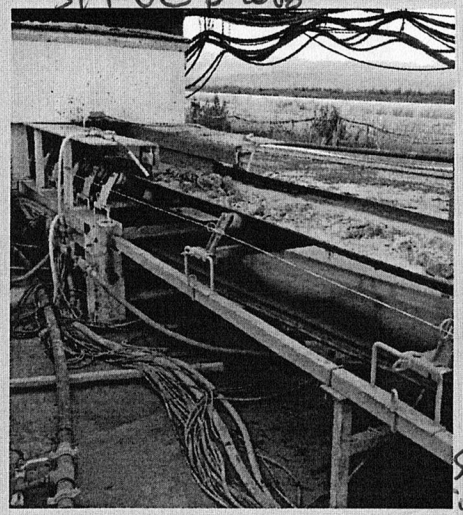
Seattle tunnel segments with gaskets

Shafts have to be protected by levees for launch sites & for TBMs.

Hong Kong tunnel

REUSABLE TUNNEL MATERIAL ("Tunnel Muck")

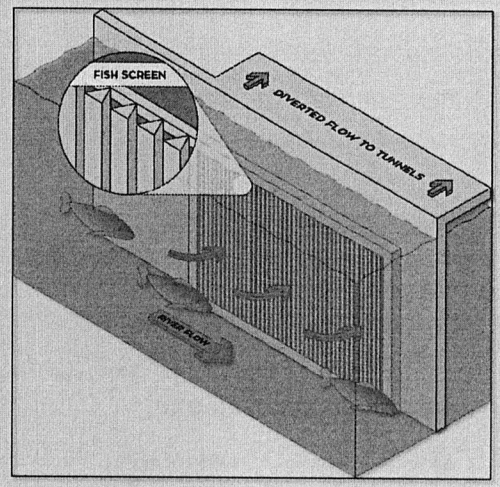
SFPUC shaft

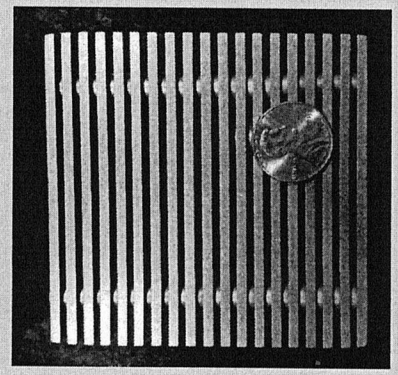


- Preliminary level of testing (DWR Report)
  - Sterile material
  - Suitable for engineering fill
- Stockpiles at 6-14 ft
- Existing restoration uses
  - SFPUC Bay Tunnel Bair Island
  - London Crossrail Wallasea Island

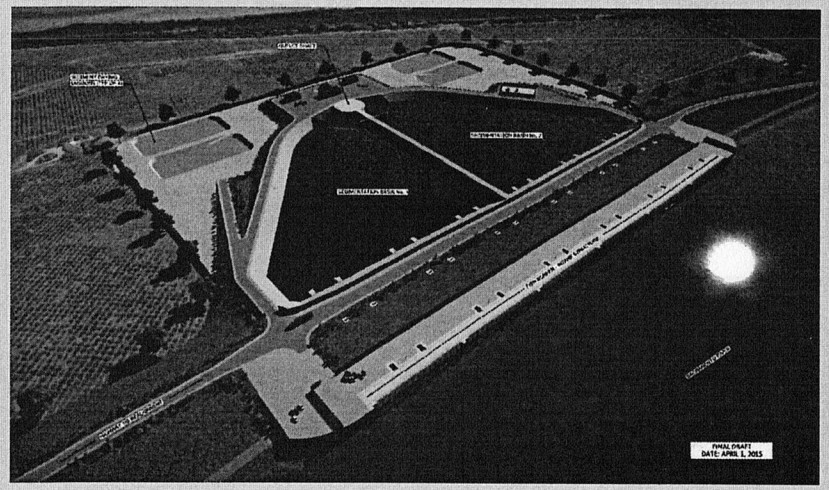
Some Delta landowners are interested in using for levees. Used in SF Bay's Bair Island restoration project.

PROTECTING FISH



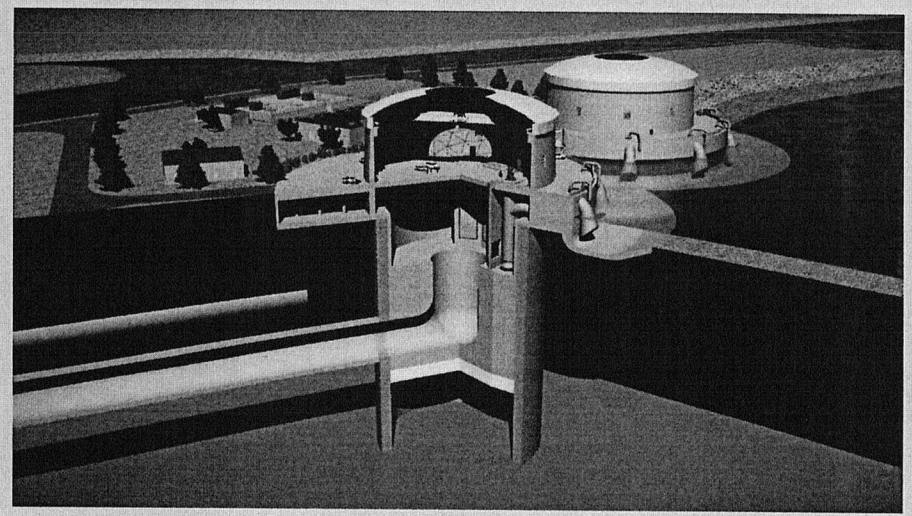


RIVER INTAKES



"Giant sump pump"

CLIFTON COURT PUMP PLANTS



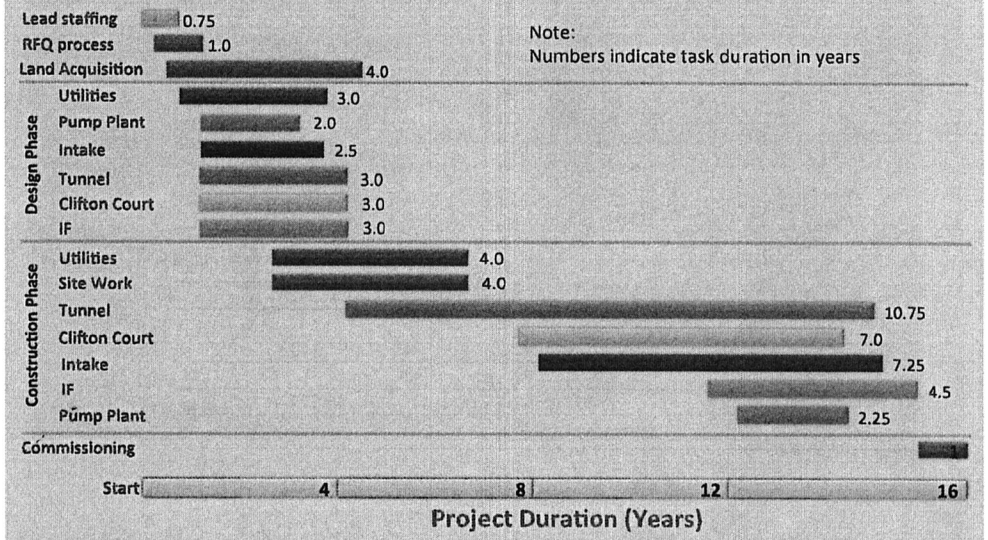
Ca acknowledges it will take a long time

PROGRAM ESTIMATES

	Amount ($ billions)
Total	**$ 14.94**
PM/CM/Engineering	$ 1.91
Tunnels/Shafts Construction	$ 6.82
Remaining construction	$ 2.68
Land Acquisition	$ 0.15
Contingency *(approx. 36% for tunnels/shafts and remaining construction)*	$ 3.38

Program Estimate in 2014 Dollars

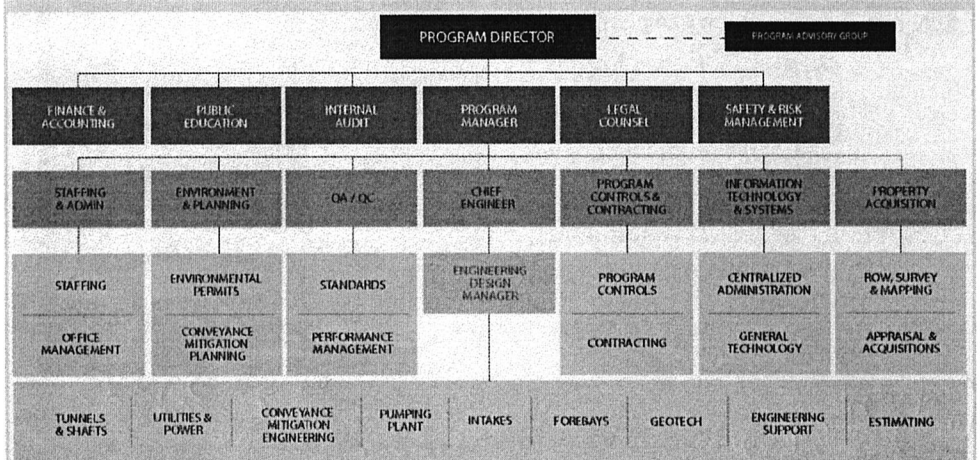
DCE PROGRAM SCHEDULE



11 years of tunneling 5 10 hr days
You want to make sure you're taking care of the machine as you go.

JPA will oversee
DCE - supervised by DWR

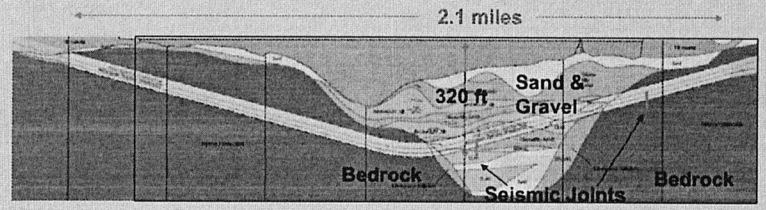
DESIGN AND CONSTRUCT ENTERPRISE
ORGANIZATIONAL STRUCTURE



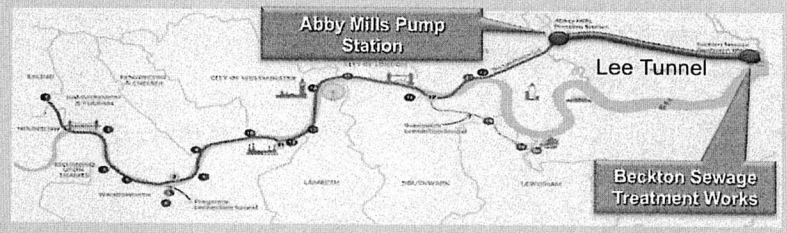
REVIEW OF OTHER MEGA-TUNNEL PROJECTS

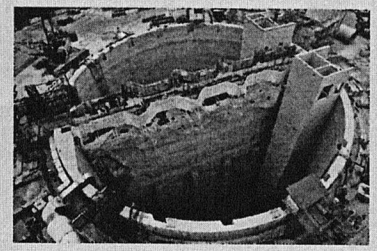
- The Eurasia Tunnel - Turkey
- ✓ Lee Tunnel - London
- ✓ Port of Miami Tunnel – Florida
- ✓ East Side Access - New York
- ✓ Blue Plains Tunnel Project - District of Columbia
- ✓ Bay Tunnel - San Francisco
- ✓ Willamette River Combined Sewer Outfall Program - Portland
- ✓ Gotthard Base Tunnel - Swiss Alps
- ✓ SR-99 Alaskan Way Replacement – Seattle
- ✓ *= projects visited by program team*

THE EURASIA TUNNEL – TURKEY



LEE TUNNEL - LONDON

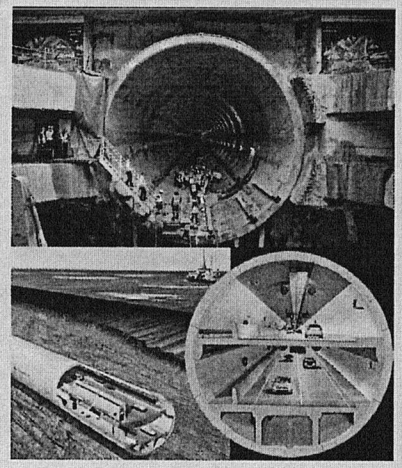




THE EURASIA TUNNEL – TURKEY

Project Information

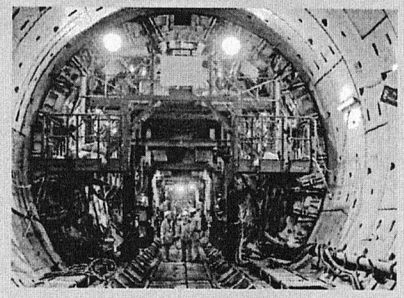
- Transportation Tunnel
  40 ft Internal Diameter (ID) x 2.1 miles
- 320 ft deep
- Completed Dec 2016
  - 3 months ahead of schedule
- Challenges
  - Complex geology, seismically active zone, and high groundwater pressure



LEE TUNNEL – LONDON

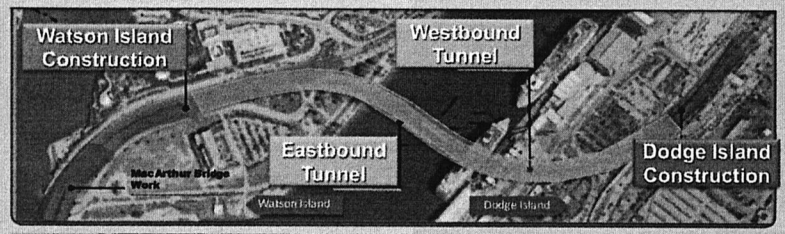
Project Information

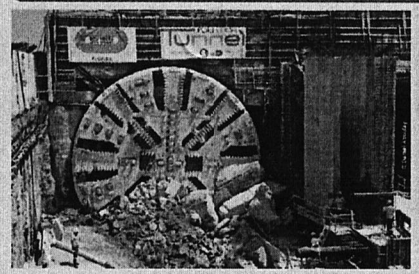
- 23.6 ft ID x 4.3 mile Combined Sewer Outfall (CSO) Tunnel
- 160 ft deep
- Completed December 2015
  - On schedule
  - Within budget
- Challenges
  - Groundwater contamination, complexity of Tunnel Boring Machine launch, and spoil removal



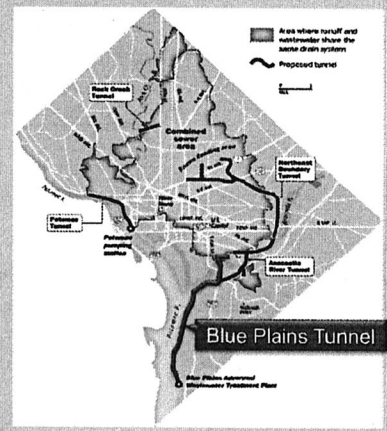
To keep cruise ship traffic out of downtown

PORT OF MIAMI TUNNEL - FLORIDA





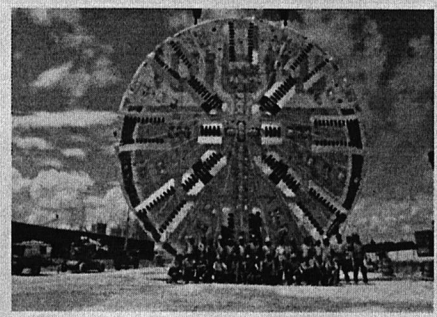
BLUE PLAINS TUNNEL PROJECT
DISTRICT OF COLUMBIA



PORT OF MIAMI TUNNEL - FLORIDA

Project Information

- (2) 39 ft ID x 4,200 ft Long Transportation Tunnels
- 120 ft deep
- Completion May 2014
  - On schedule
  - Within budget
- Challenges
  - Porous coral and limestone required grouting, restricted access above tunnel due to shipping channel

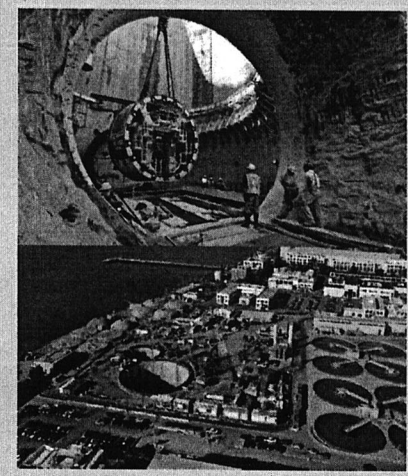


CG: Has really big shafts

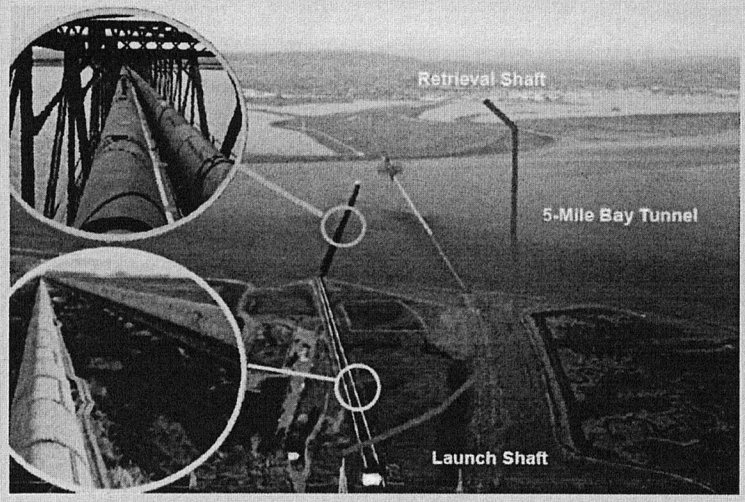
BLUE PLAINS TUNNEL PROJECT

Project Information

- 23 ft ID x 24,200 ft CSO Tunnel
- 160 ft deep
- Completed Dec 2015
  - 3 months ahead of schedule
  - Under budget
- Challenges
  - Large deep shafts, existing infrastructure above tunnel



BAY TUNNEL – SAN FRANCISCO



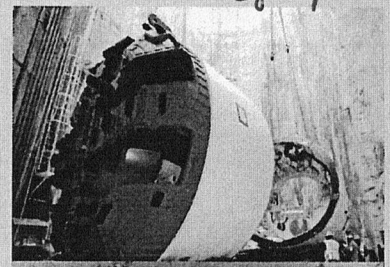
WILLAMETTE RIVER COMBINED SEWER OUTFALL PROGRAM – PORTLAND

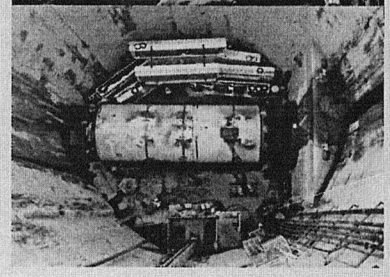
CG: smaller Tunnels can slow you down because of space shortage

BAY TUNNEL – SAN FRANCISCO

Project Information

- 15 ft ID x 5 mile water tunnel
- 110 ft deep
- Completed Oct, 2014
  - On schedule
  - Within budget
- Challenges
  - Long tunnel drive, no intermediate shafts, limited surface access, and high ground water pressure

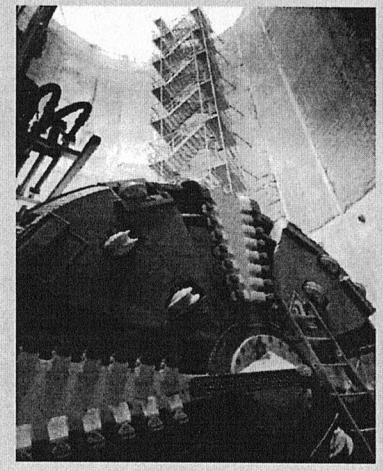




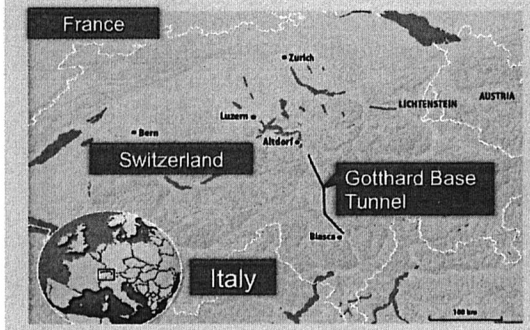
WILLAMETTE RIVER TUNNELS – PORTLAND

Project Information

- (1) 14 ft ID x 3.5 mile 120 ft deep and (1) 22 ft ID x 6 mile
- 150 ft deep CSO tunnels
- Cost Reimbursable Fixed Fee
- Construction Complete Feb 2012
  8 months ahead of schedule
- Construction value US $719 M, 9% under budget
- Challenges
  - Schedule, existing infrastructure, groundwater, Tunnel Boring Machine breakout, soil modification, and subcontract changes

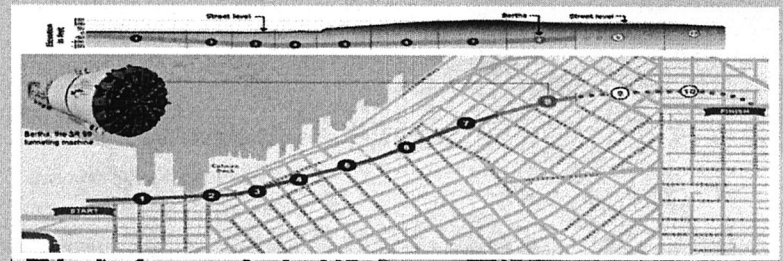


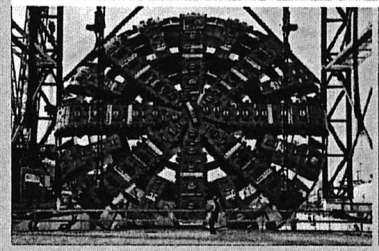
GOTTHARD BASE TUNNELS – SWISS ALPS

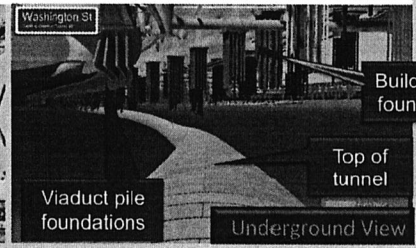


CG "This one's not so remarkable."

SR-99 ALASKAN WAY REPLACEMENT-SEATTLE







GOTTHARD BASE TUNNELS-SWISS ALPS

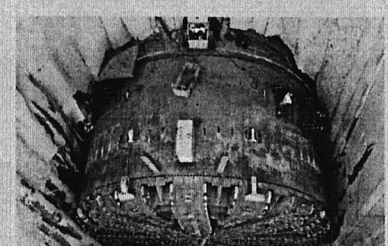
Project Information

- (2) 30 ft ID x 35 mile rail tunnel
- Up to 6,560 ft deep
- Completed June 2016 within schedule (17 years)
- Final construction cost $12.5B within budget
- Challenge: Safety, geology
- For the 2 main tunnels and the safety, ventilation and cross cuts, a total of 95 miles tunnel has been bored

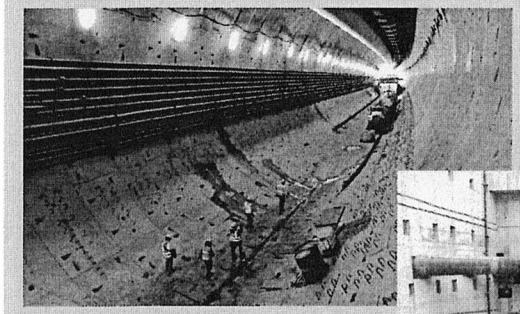
SR-99 ALASKAN WAY TUNNEL-SEATTLE

Project Information

- 53 ft ID x 2 mile transportation tunnel
- Construction schedule
  - Approximately 2 year delay
- Challenges
  - Equipment malfunction, existing pile foundations and other infrastructure, difficult ground

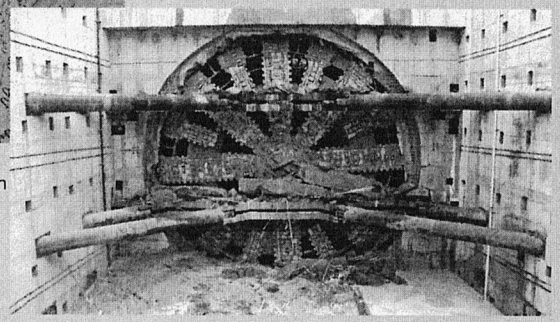


SEATTLE TUNNEL SUCCESS

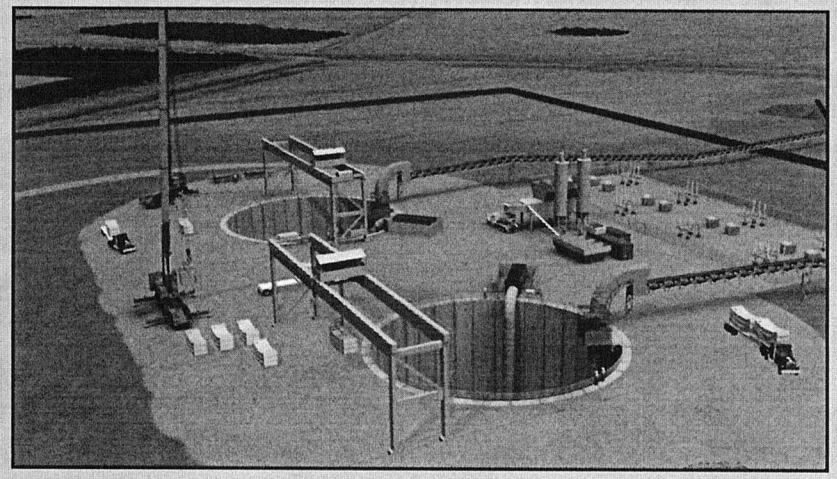


Inside Tunnel, prior to roadway construction

Tunnel breakthrough April 4, 2017



QUESTIONS



LESSONS LEARNED

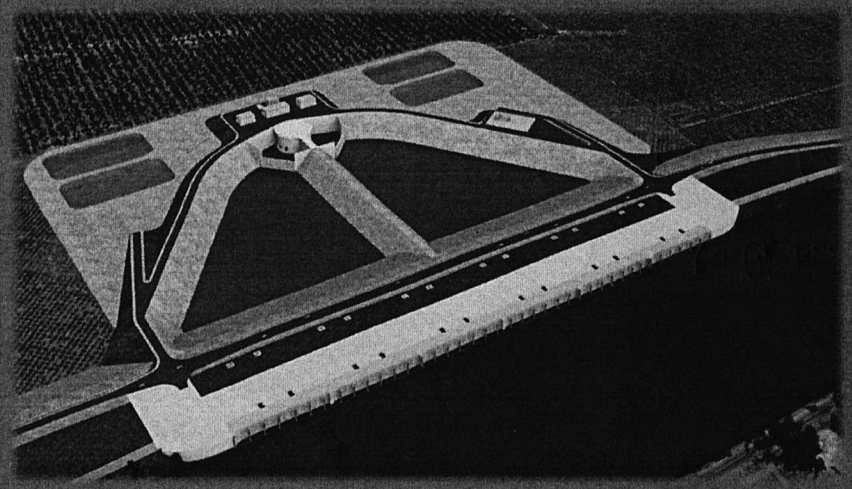
- Proactive risk management strategy at all stages
- Assign risk to appropriate party
- Select project delivery method to maximize project benefits
- Get construction input early
- Invest in good geotechnical program and GBR
- Must have strong owner involvement
- Co-locate project team
- Resolve Right-of-Way and property acquisition early
- Resolve utility issues early
- Identify long lead items early
- Proactively manage logistical issues
- Develop effective program communication strategy

Geotech baseline reports

] acknowledges the HSR ROW challenges.
-> CWF will seek 3D easement - have to find subsurface owners of mineral rights.

The California WaterFix

April 2015 Construction Cost Estimate



1. 5RMK Qualifications

5RMK Is a project management and planning organization providing the following services to the infrastructure and resource development industries:

- Estimating, scheduling, project planning
- Permitting, siting assessments, environmental compliance
- Program & construction management
- Claims support, defense & dispute resolution

5 Retired guys from Morrison Knudsen (5RMK)

Today's Presentation

1. 5RMK Qualifications/experience
2. Scope of program
3. Cost summary
4. Basis of estimate
5. Intakes
6. Clifton Court pump plants
7. Tunnel reaches

1. 5RMK Qualifications

2. Scope of 2015 Estimate

- New class 3 estimate as defined by the Association for The Advancement of Cost Engineering International
- New scope definition based on new quantity take-offs, crew definitions, equipment selections and productivities
- Scope of the Project:
  - 3 - 3000 CFS Intakes
  - 2 - 4500 CFS Clifton Court Pump Plants
  - 1 - Intermediate Forebay
  - 1 - Clifton Court modifications, include embankments, siphons, canals and control structures
  - Tunnels with shafts and safe havens
    - 1- 28 ft inside diameter x 2 mile long (reach 1)
    - 1 - 28 ft inside diameter x 4.8 mile long (reach 3)
    - 1 - 40 ft inside diameter x 6.8 mile long (reach 2)
    - 2 - 40 ft inside diameter x 30.1 mile long (reaches 4-7)

(G: These are pretty conservative.

4. Basis of Estimate

- Based on April 1, 2015 Conceptual Engineering Report (CER)
- Detailed quantity takeoffs prepared from CER
- Wage & workmen's comp rates based on "prevailing rates" listed by California Department of Industrial Relations
- Equipment ownership and operating costs based on US Army Corps Engineers
- Vendor and subcontract costs based on independent supplier solicitations
- All costs data is in 2014 dollars
- Work shifts – surface facilities: 4 days per week, 10 hours per day
- Work shifts – tunnels: 5 days per week, (2)10 hours shifts per day
- Geotechnical data is limited – further investigations are planned
- Advance rate for 40' diameter tunnels – 31.1 to 34.1 ft/day
- Advance rate for 28' diameter tunnels - 34.5 ft/day (reach 1); 40.4 ft/day (reach 2)

new cost estimate late next year 2018

2. Scope of 2015 Estimate

Total constructed value includes:

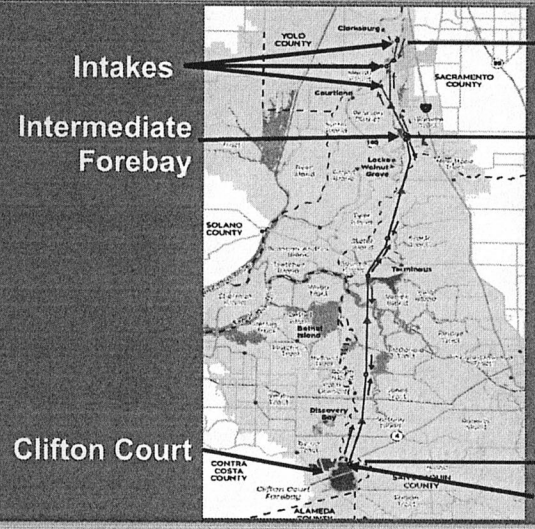
- All craft labor costs
- Construction equipment operating and ownership cost
- All permanent material and supply cost
- Field offices, laydown and staging area development
- Personnel, material, equipment and other transport cost
- Construction supervision, administration and management

Cost does not include:

- Land Acquisition, Program Management, Construction Management, Engineering, or Contingency

PMCM

7. Tunnel Reaches

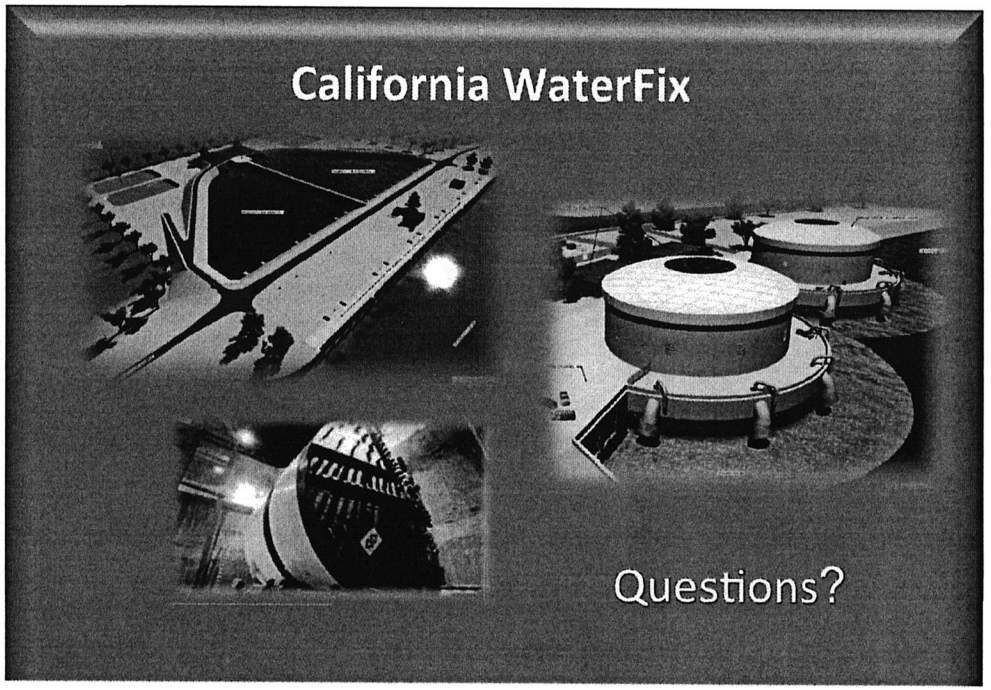


3. Construction Cost

CWF April 2015 Estimate Summary

Contract		Estimate
Intakes 2,3, 5	$	1,082,880,306
Intermediate Forebay	$	159,579,782
Clifton Court Forebay	$	593,720,041
Clifton Court Pump Plant	$	446,577,237
Reach 7 Tunnels	$	1,538,449,966
Reach 6 Tunnels	$	1,559,673,985
Reach 5 Tunnels	$	899,619,545
Reach 4 Tunnels	$	1,603,383,401
Reach 1, 2, & 3 Tunnels	$	1,218,681,541
Communication Network, Scada	$	25,065,734
Access, Power Delivery & Utility Relocations	$	371,300,000
Construction Total	**$**	**9,498,931,538**

CG: More robust ~~more~~ geotech program needs another $150M



Estimate Summary

Item	5RMK Estimate [1],[2] (Billions)
Construction	$9.50
Contingency	$3.38
Construction Subtotal	**$12.88**
PM/CM/Eng	$1.91
Land acquisition	$0.15
Grand Total	**$14.94**

(1) Program estimates in 2014 dollars
(2) ~36% Contingency on construction

CG: DCE will begin design ASAP once JPA is formed
Construction to begin ASAP after SWRCB issues WR permit for points of diversion

ALDEA SERVICES

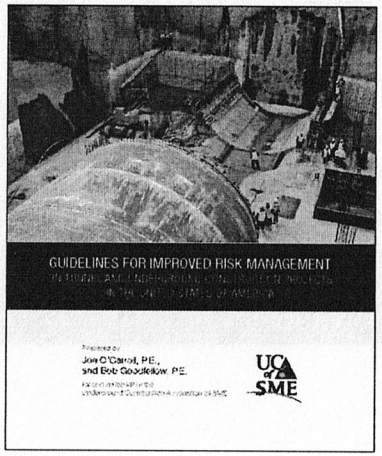
CALIFORNIA WATER FIX

RISK MANAGEMENT – DESIGN AND CONSTRUCTION

ALDEA SERVICES LLC
RELIABLE RESOURCES DELIVERED

US Guidelines Exist for Risk Management on Tunnel Projects

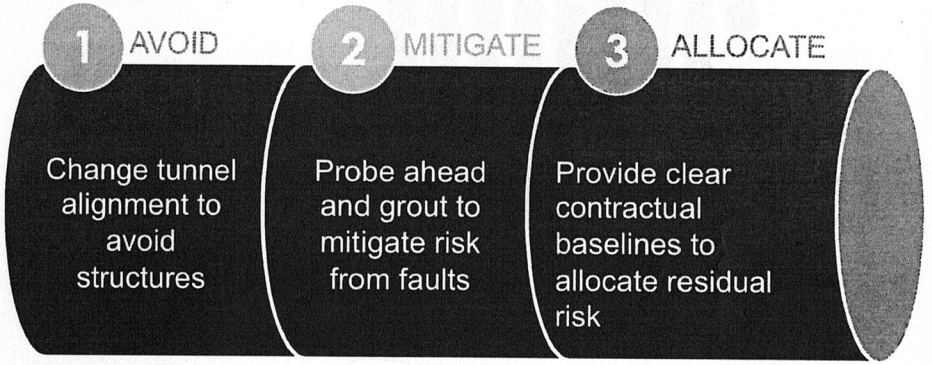
- US Risk Management practice established by this document
- Published and available online by Underground Construction Association of Society for Mining, Metallurgy, and Exploration
- Emphasizes:
  - The importance of experience in project team
  - The use of Risk Registers as a risk management tool
  - Consistent risk management approach from early planning throughout life of project



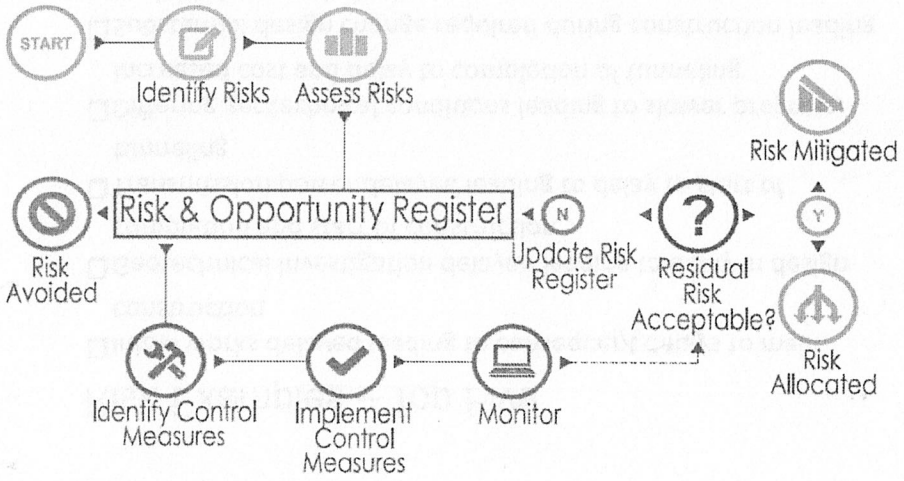
http://www.smenet.org/SME/media/UCA/Resources/SME3409-GIRM-Report-Booklet-WEB.pdf

Ch Cost of delay = $415 M/year

Three-Step Risk Management Process



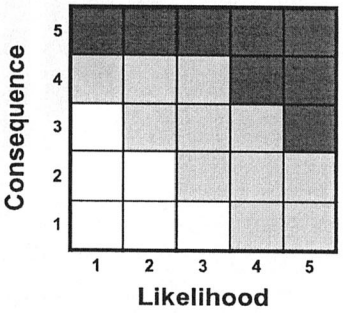
Process of Risk Management



Design and Construction Risks

Probability Rating	AKA
5	Probable
4	Likely
3	Possible
2	Unlikely
1	Improbable

Consequence



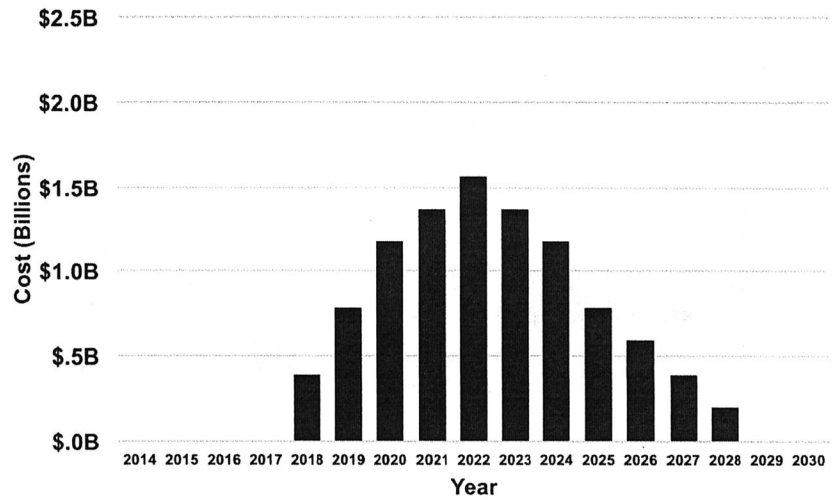
Design and Construction Risks

Risk Examples – Top Five

- ❑ Initial works delayed leading to consequent delays to main construction
- ❑ Geotechnical investigation delayed leading to delay in design completion and start of construction
- ❑ Transmission power delayed leading to delay to start of tunneling
- ❑ Differing geotechnical conditions leading to slower progress, increased cost and delay to completion of tunneling
- ❑ Substantial design change required during construction leading to delay in commissioning

CG: Cost of delay ≥ $415 M

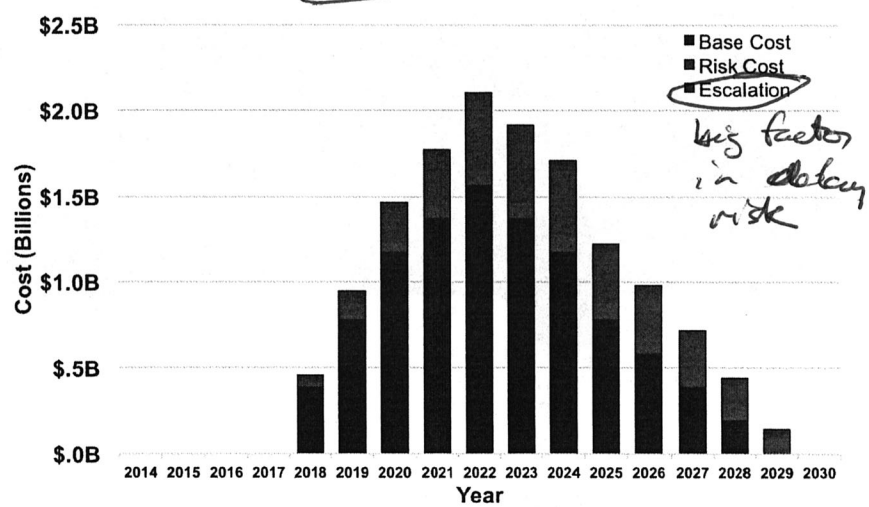
Annual Expenditures – 2014 Dollars



Program Estimate

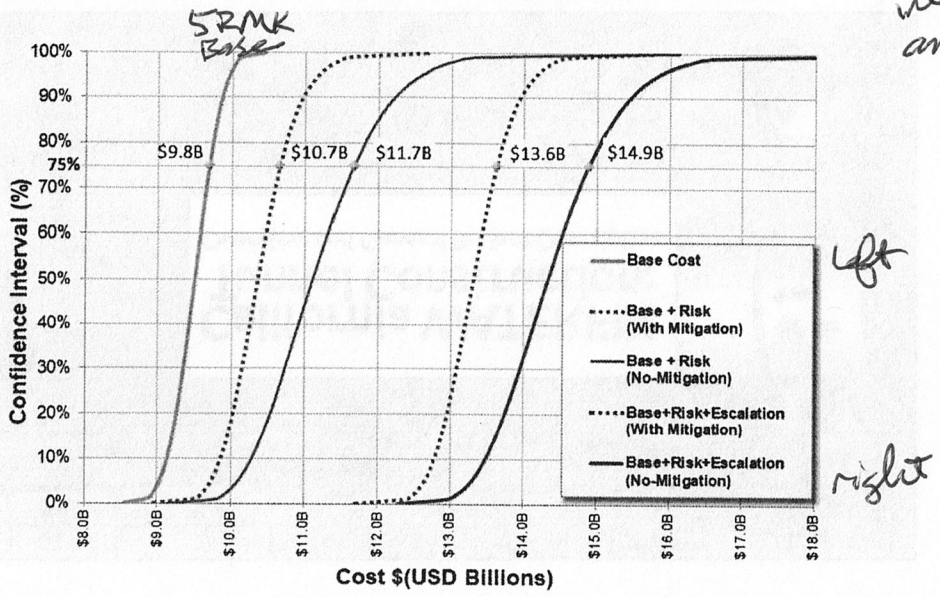
Item	5RMK Estimate (Billions)
Estimated Base Construction Cost	$9.50
Contingency	$3.38
Program Management/Construction Management/Engineering	$1.91
Land Acquisition	$0.15
Grand Total	**$14.94**

Annual Expenditures – with Risk and Inflation Cost



big factor in delay risk

California WaterFix Construction Cost Distribution Profile



confidence interval analysis

left

right

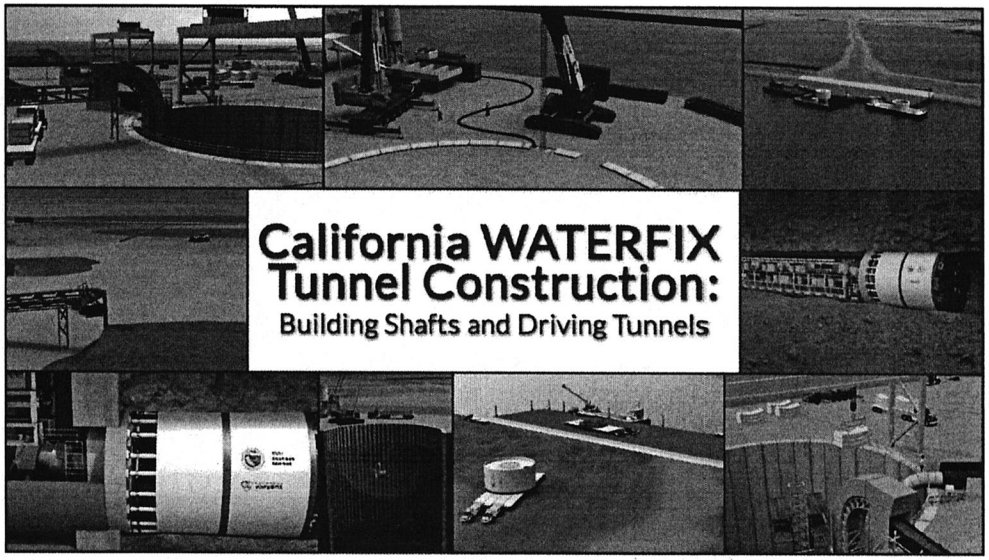
Questions ?

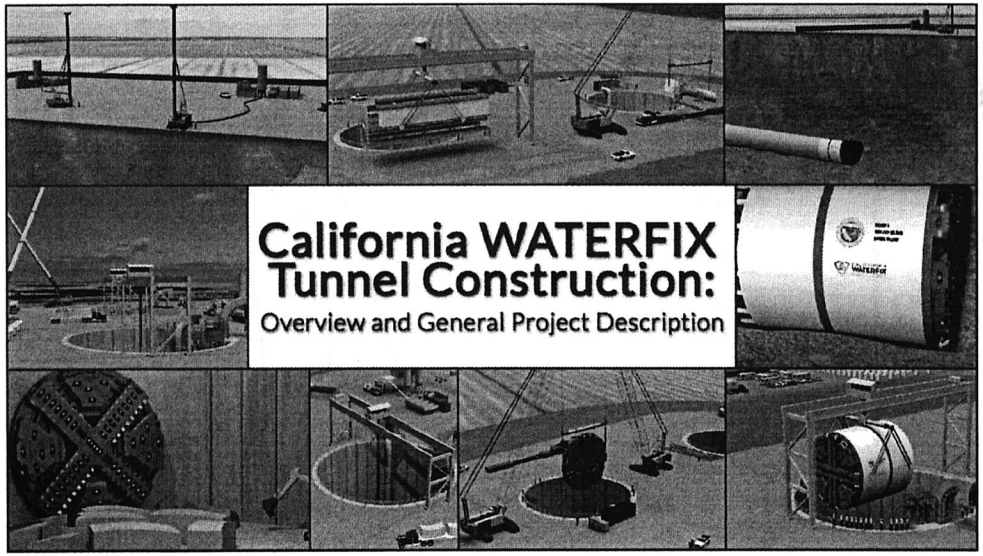
Estimate Summary

Item	Risk with Mitigation at 75% Confidence Interval (1)(3) (Billions)	5RMK Estimate (1),(2) (Billions)	Jacobs Eng Estimate (1),(2) (Billions)
Construction	$10.66	$9.50	$8.86
Contingency	—	$3.38	$3.15
Construction Subtotal	**$10.66**	**$12.88**	**$12.01**
PM/CM/Eng	$1.91	$1.91	$1.91
Land acquisition	$0.15	$0.15	$0.15
Grand Total	**$12.72**	**$14.94**	**$14.07**

(1) Program estimates in 2014 dollars
(2) ~36% Contingency on construction for 5RMK and Jacob Engineering estimates
(3) Based on risks known at time of assessment


California WATERFIX
Tunnel Construction:
Site Preparation Prior to Start of
Tunnel Construction


California WATERFIX
Tunnel Construction:
Building Shafts and Driving Tunnels


California WATERFIX
Tunnel Construction:
Overview and General Project Description

Next Steps

- Finalize necessary agreements 3
- Additional modeling of WWD supply with and without CWF 8/29 - will look at other capacity - CWF staff presentation - at Fresno office 9 AM

Questions?

Additional Resources

- California DNR's CWF website
  - https://www.californiawaterfix.com/
- Metropolitan Water District's 3 white papers on CWF
  - http://www.mwdh2o.com/DocSvcsPubs/WaterFix/
- State Water Resource Control Board's CWF website
  - http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/
- NOAA-NMFS' website
  - http://www.westcoast.fisheries.noaa.gov/central_valley/CAWaterFix.html
- USFWS' website
  - https://www.fws.gov/sfbaydelta/HabitatConservation/CalWaterFix/Index.htm

Gap Funding Agreement

- Parties Involved
  - DWR
  - SWPCA
  - CVP Participant(s)
- Purpose of Agreement
  - Requires SWPCA and CVP Participant(s) to fund CWF efforts until first bond issuance

Agreement on Implementation of the Biological Opinions

- Parties Involved
  - DWR
  - Bureau of Reclamation
- Purpose of Agreement
  - Defines the roles and responsibilities of each party for the obligations created by the CWF Biological Opinions

now called Implementation Agreement

Coordination Agreement

- Parties Involved
  - DWR
  - CVP Participants
  - Reclamation
- Purpose of Agreement
  - Describes how DWR and Reclamation will coordinate and integrate operations of the CWF into the operations of the Projects

Next Steps

CVP Participation Approach

- Parties Involved
  - Bureau of Reclamation
  - CVP contractors
- Purpose of Approach
  - Identify protections for Participants and Non-Participants
  - Describes new CWF Water allocation process

Banks will be made available to CVP CWF participants due to limits at Jones.

Master Agreement

- Parties Involved
  - DWR
  - CVP Participants
- Purpose of Agreement
  - Describe CVP Participants' interest in and payment for CWF
  - Provides CVP Participants with limited access to SWP facilities for CWF Water

Construction JPA

- Parties Involved
  - Various SWP & CVP Participants
- Purpose of Agreement
  - Creates the JPA responsible for the construction of the CWF

Construction JPA

DWR-JPA Agreement

- Parties Involved
  - DWR
  - Construction JPA
- Purpose of Agreement
  - Provides Authority to the Construction JPA for the construction of the CWF

avoids some of political ~~risks~~ risks

WWD Possible Participation

August 9, 2017

Shelley Ostrowski

1

Sept 19 WWD particip decision date

CWF Decision Timeline

- Prior to Decision
  - Finalize terms of key agreements
- Participation Decision
  - To be made in September or early October
  - State and Federal contractors will decide whether to participate in CWF
  - Participating CVP contractors will need to identify their 'Level of Participation'
- Post-Decision actions for Participants
  - CVP contract amendments
  - Execution of construction and financing agreements
  - Finalize remaining agreements

2

CVP Participation Decision

State at 55%

- Possible 'Level of Participation'
  - 20% Participation= $3.14B capital cost and 20% of capacity interest
  - 30% Participation= $4.71B capital cost and 30% of capacity interest
  - 45% Participation= $7.07B capital cost and 45% of capacity interest
- Factors affecting water supply
  - Implementation of Biological Opinions
  - Re-initiation of Consultation on Operations
  - Adaptive Management and Real-Time Operations
  - SWRCB Decision

ignores CC risk

↳ they're also not giving credence to WQCP decisions

Prior to Decision

- CVP Participation Approach
- Master Agreement
- Construction JPA Agreement
- DWR-JPA Agreement
- Gap Funding
- BO Implementation Agreement
- Coordination Agreement

WWD Workshop 8/22 Notes of Tim Stroshane

WWD members
SW, DP
GE, DE
News, Baudeau

Chuck Gardner - Hallmark Group

Gardner says seds will flow thru screens no problem.

2) Storms bring large sediment through.

CG says Project will cost $14.9 B in 2014 dollars, Met says $16.7 in 2017 dollars.

Design & Construction Enterprise organized as a large corporate bureaucracy, ~~yet~~ CG says everyone will be responsible for discipline by policies and procedures with real time auditing.

When you don't have more specifics about your ~~project~~ tunnels project, you talk about the tunnels ~~that~~ attempted elsewhere.

CG: acquiring subsurface mineral rights will be a significant challenge for WaterFix ROW.

Baudeau expressed frustration about the project decision being like The Twilight Zone with the state suing itself [validation suit].