

Improved CIP Planning and Budgeting Using Economic Study and Risk Based Planning

the
OCSD Experience

NACWA

David May PE, PMP

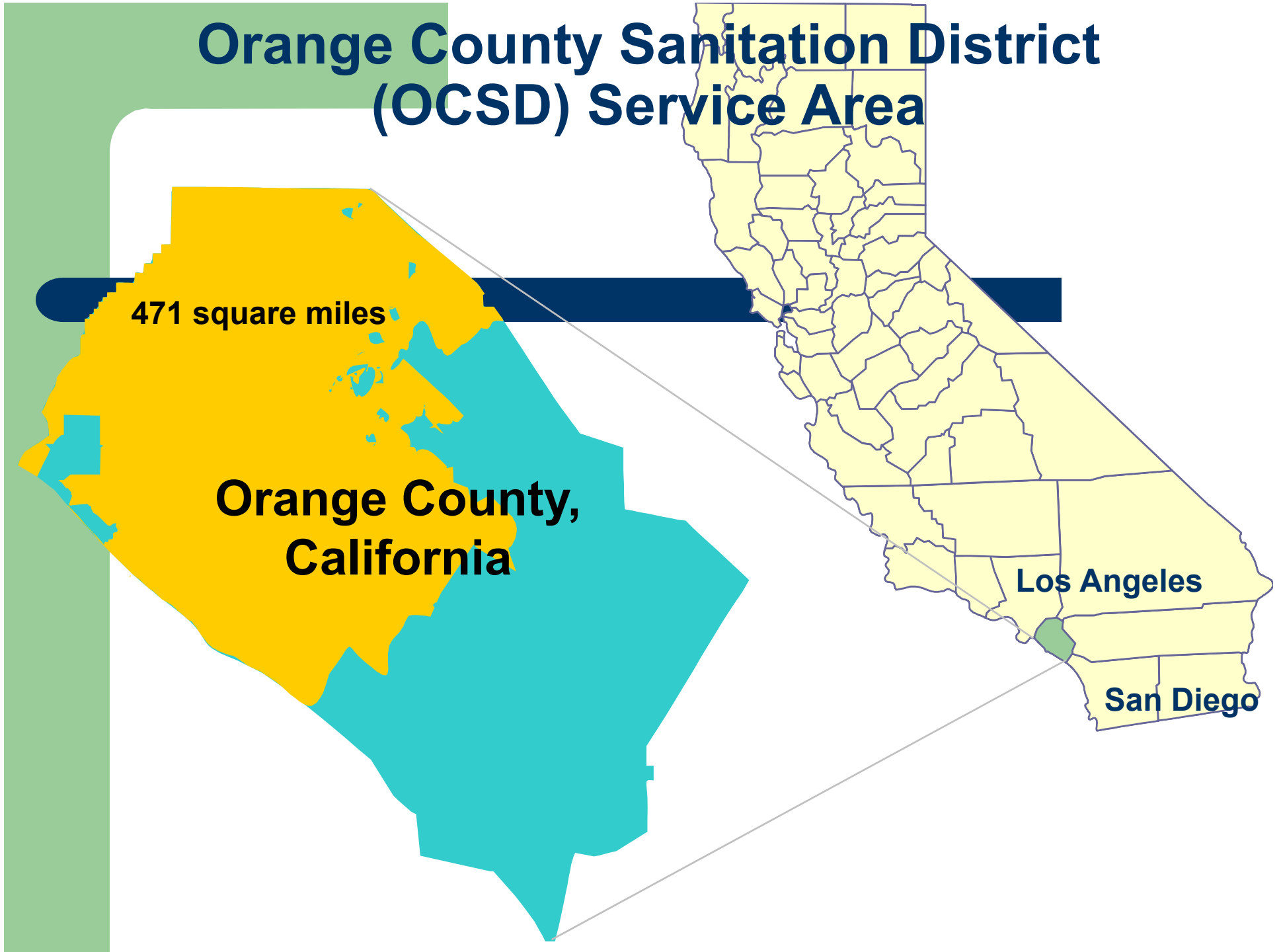
Orange County Sanitation District (OCSD) Service Area

471 square miles

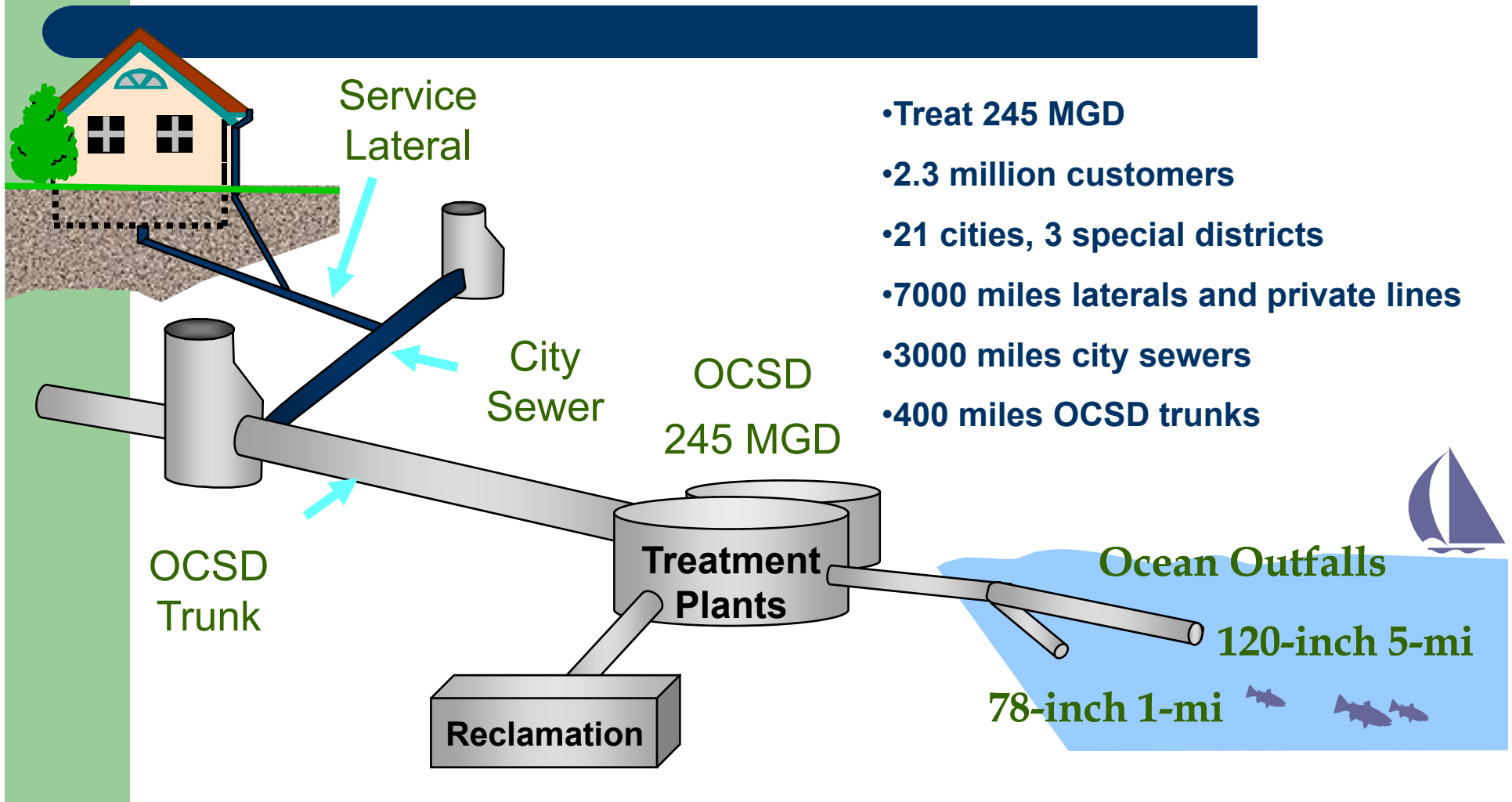
Orange County,
California

Los Angeles

San Diego



OCSD Regional Wastewater System





● **Capital Improvement Program**
\$3.0 Billion



**How Confident are You that the
Program can be Delivered for \$3.0
Billion?**



Budgeting Before Economic Analysis and Monte Carlo

- Reported “one” number for program cost and annual cash flow to Board
- Actual costs exceeded budgets due to deficient planning (scope definition) and unanticipated events (technology, regulations, construction cost escalation etc)
- No tools existed to quantify costs associated with the unanticipated events (risks).
- \$3 Billion CIP – 142 projects – Limited Confidence - A significant problem

Objectives for Improved Budgeting

- Clear communication to stakeholders
- Reduce debt financing cost
- Stabilize rates to acceptable levels for ratepayers
- Quantify the budget variance due to project risk events
- Include macro economic results as escalation factor

Program vs. Project Risk

- Program risk events are global affecting all projects
– accounted for by a using programmatic factors (i.e. Macro Economic Study / Escalation Factor)
- Project specific risks are accounted for at the project level with input by the PM (via the Monte Carlo Analysis)

Macro Economic Study - Components

- 3 Categories – Treatment Facilities, Pump Stations, & Collection Piping
- Determined proportion of key commodities & labor for each category
- Developed macro forecasts for each commodity and labor for remaining program years.

Macro Economic Study - Results

- Escalation was composed of differing mixes
 - Treatment – 20 / 40 / 20 / 20 %
concrete / equipment / steel / labor
 - Pipeline – 80 / 20 % pipe / labor
 - Pump Stations 20 / 70 / 10 %
concrete / equipment / labor
- Chose to apply aggregate of all categories at 5.0% average escalation to mid point of construction

Adopt Risk Management Approach

- Project Risk Management Plan
 - Avoidance – change the plan to avoid risk
 - Transference – Shift by contract, insurance, etc.
 - Mitigation – Reduce probability/impact to acceptable level
 - Acceptance – Deal via contingency planning
- OCSD budgeting approach includes costs to employ the appropriate risk response but most fall into the last 2 categories

Including Risk in Budget Development

- Use commercially available software – Decision Pro (Monte Carlo)
- Get project specific input from PM's & key / knowledgeable stakeholders
- Focus on top 22 highest impact projects –represent 70% of program budget
- Effort took approximately 6 months from start to finish—training, risk analysis, economic study, stakeholder buy in and budget input

What Is Monte Carlo Simulation?

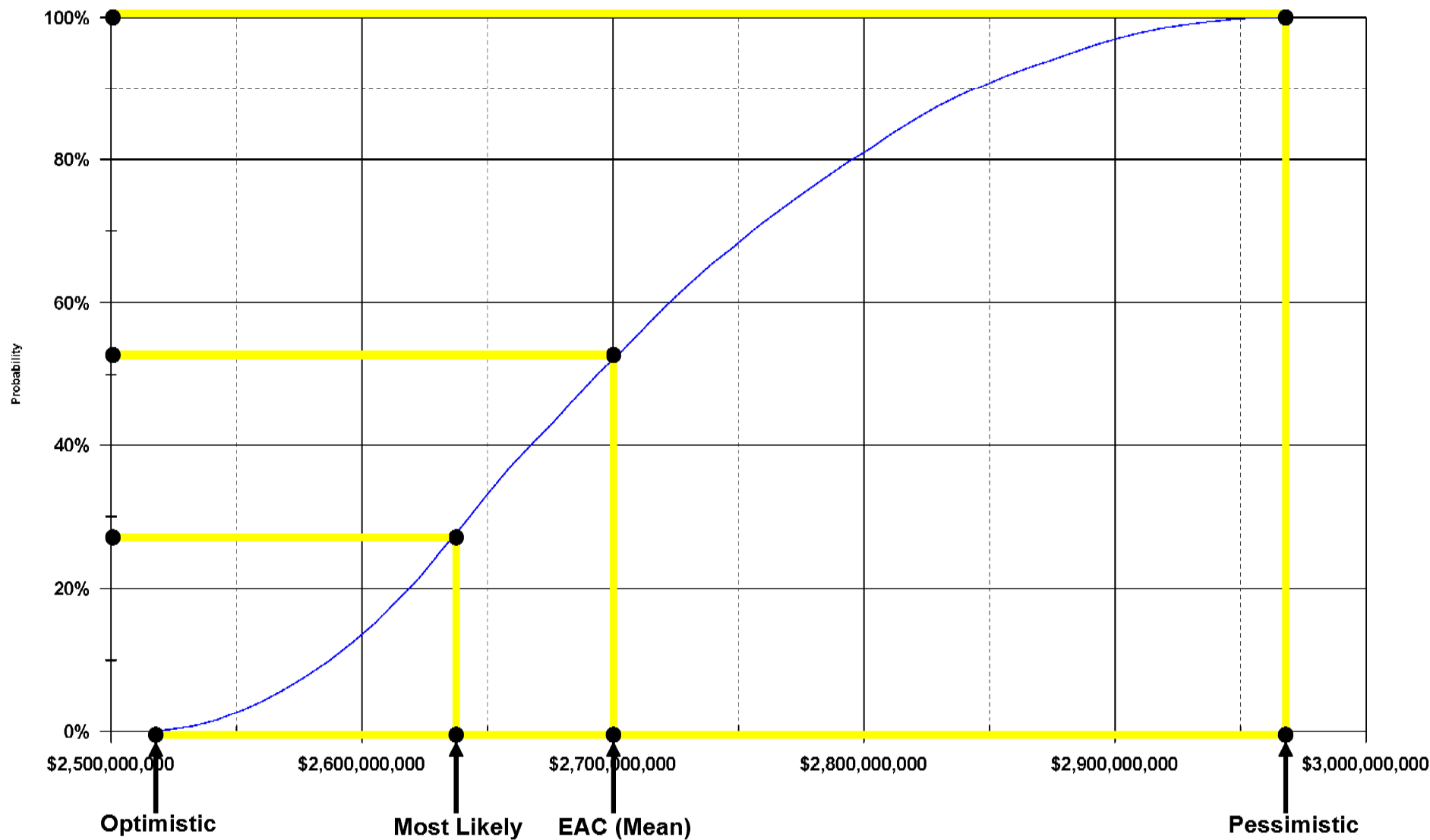
- Simulates probability of events utilizing statistical methods
- Able to capture with statistical certainty the probability of risk events and their cost
- Can be applied to CIP program to help estimate project cost and cash flow projections

Value of the Monte Carlo Analysis

- Allowed OCSD to budget for statistically likely costs of risk impact
- Increased confidence in our ability to deliver projects within budget
- Validated adequacy of contingency held
- Demonstrated that OCSD could reduce contingency from 15% to 10% or about \$100M (this recommendation accepted in 2006 by OCSD Board)
- **Note: MC analysis does not establish contingency – management does. However it can be used to validate contingency levels**

What Are the OCSD Results?

- ~3 percent (\$66 million) of the program budget established for risk
- Only statistically likely risk (\$66 million) was budgeted; budgeting for all identified risk would require \$333 million



Programmatic S-Curve



Project Specific Results

- Project I-10 – Pump Station Engr's Estimate of \$28.9 million – Bids from \$27.7 to \$30.9 million
- Project P2-90 – Trickling Filters Engr's Estimate \$200 million – Bids of \$175 and \$184 million

Objectives Achieved

- Clear communication to stakeholders – Engineering / Finance / Board agree with approach and have better understanding
- Reduced debt financing cost – Debt financing strategies can be developed based on risk tolerance
- Improved input has stabilized rates – tools now used routinely during budget development
- Quantify the budget variance held for risk – Board can set own tolerance level for risk
- Developed and included macro economic factors during budgeting and as part of engineers estimates

Questions?

Electronic copies of the following may be obtained upon request:

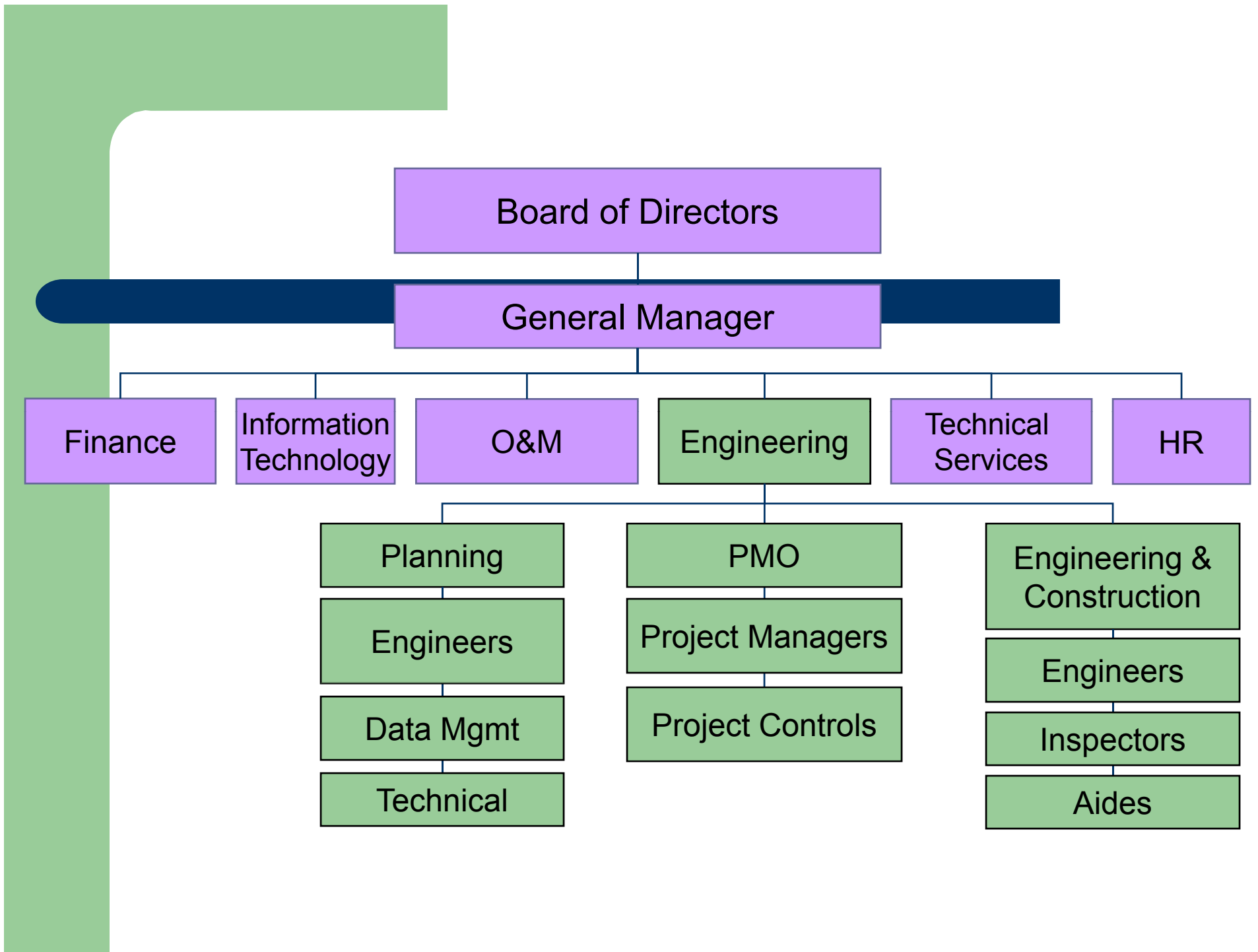
- Presentation
- Economic Study
- Sample Risk Management Plan
- Sample Risk Analysis Input & Output Information

Please send requests by email to the address shown below. Please provide your contact information in the request as well as any questions you might have.

david.may@ch2m.com

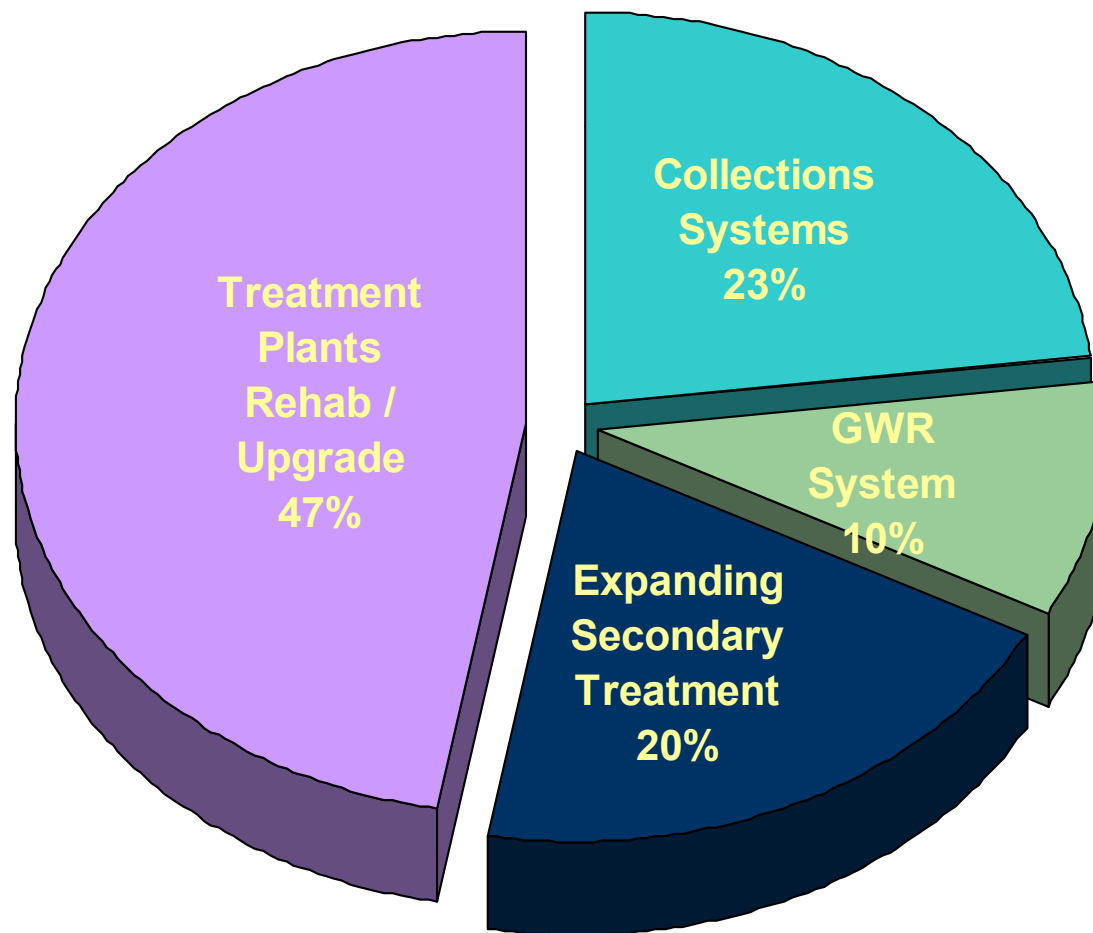
Added Planning / Budgeting Tools

- Program / Global Factors: Macro Economic Analysis – construction cost escalation
- Project Specific Factors: Monte Carlo Analysis - develop impact probability and associated cost



CIP Budget Breakdown

Total = \$3 Billion

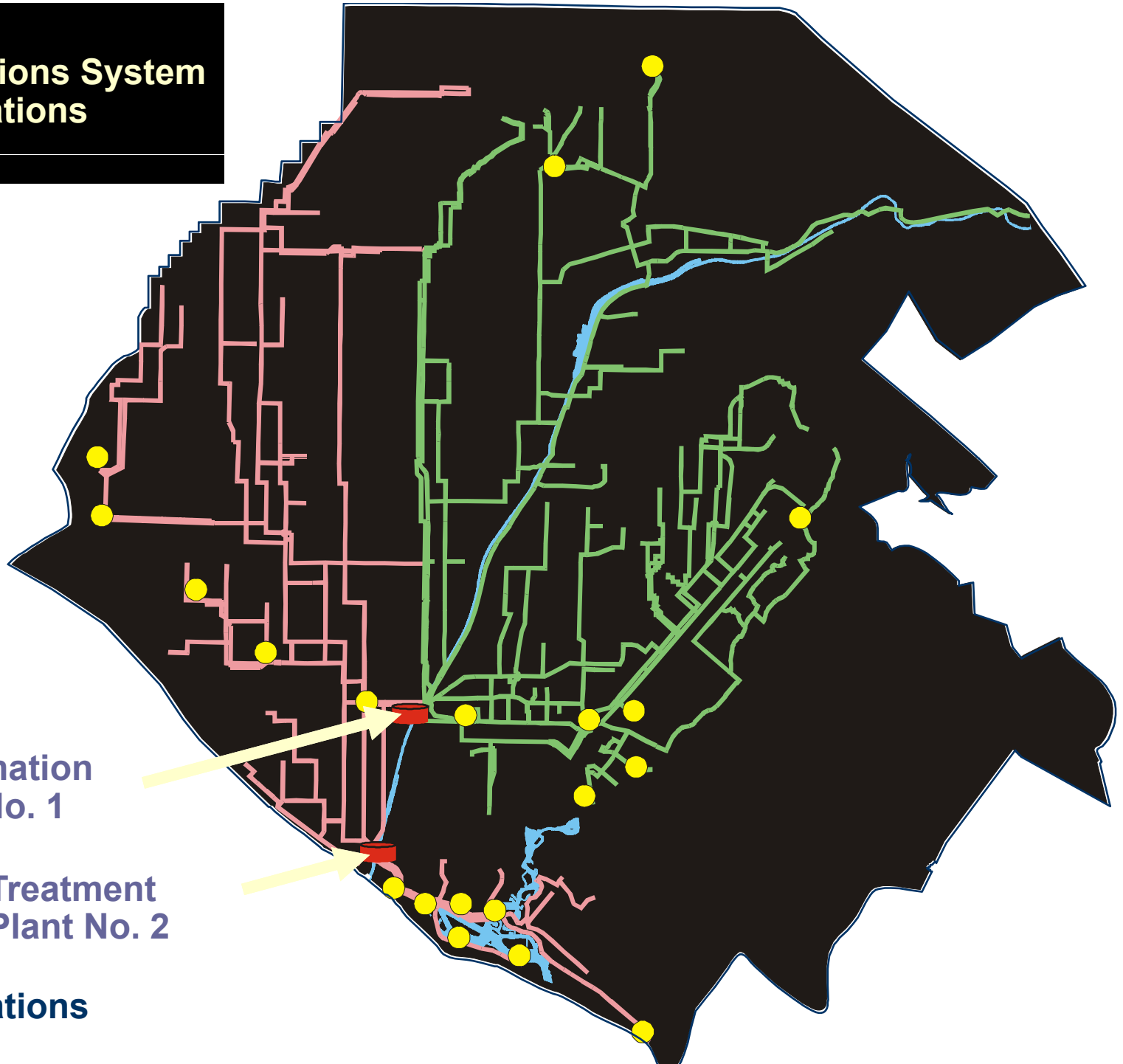


OCSD Collections System and Pump Stations

Reclamation
Plant No. 1

Treatment
Plant No. 2

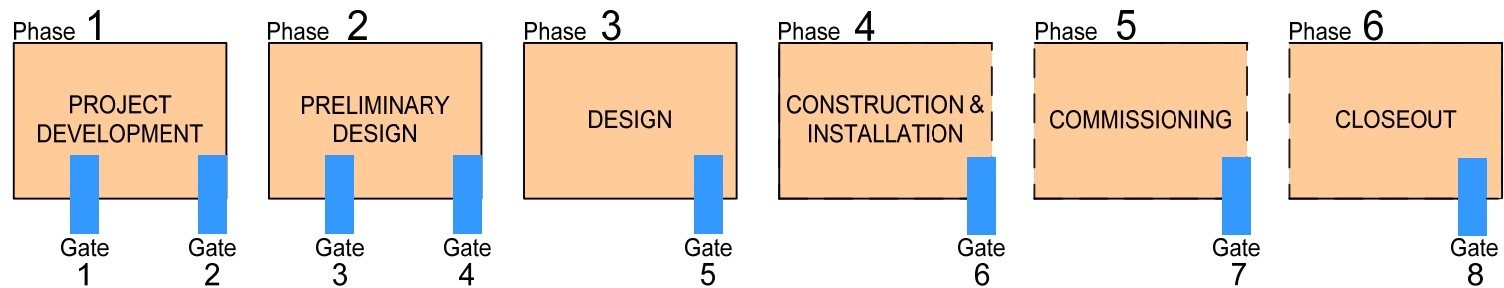
•20 Pump Stations



Project Life Cycle

Orange County Sanitation District

Capital Project Management Life Cycle



OCSD Work Breakdown Structure (WBS)

Level 1

OCSD Engineering CIP

Level 2

Secondary Treatment

Plant 1

Plant 2

Collections

Joint Works

Special Projects

Water Mgmt.

Planning

Level 3

Project FIS No.

Level 4

Phase 1
Project Development
3000

Phase 2
Preliminary Design
3100

Phase 3
Design
3200

Phase 4
Construction & Installation
3300

Phase 5
Commissioning
3400

Phase 6
Close-out
3500

Phase 7
Contingency
3600

Level 5

3010 Project Management
3020 Project Technical Support
3031 Feasibility Study #1
3032 Feasibility Study #2

3110 Project Management
3120 Project Technical Support
3141 Engineering Study #1
3142 Engineering Study #2
3143 New Equipment Studies/Testing
3146 Preliminary Design Report
3158 Environmental Documentation
3170 Consultant Selection

3210 Project Management
3220 Project Technical Support
3250 Consultant Services
3251 DS1
3252 DS2
3253 DS3
3254 Bid Support Services
3258 Environmental Documentation
3259 Design Reviews
3273 Construction Bid & Award
3280 Permit Acquisition
3281 Land Acquisition
3290 Legal Costs (Phases 1, 2, & 3)

3310 Project Management
3320 Project Technical Support/Resident Engineering
3321 PCI Support
3350 Consultant Services During Construction
3360 Construction Contractor Work
3362 Inspection
3363 Testing
3390 Legal Costs (Phases 4, 5 & 6)

3410 Project Management
3420 Project Technical Support
3421 PCI Support
3422 O&M Training
3450 Consultant Services During Commissioning
3460 Construction Contractor Work

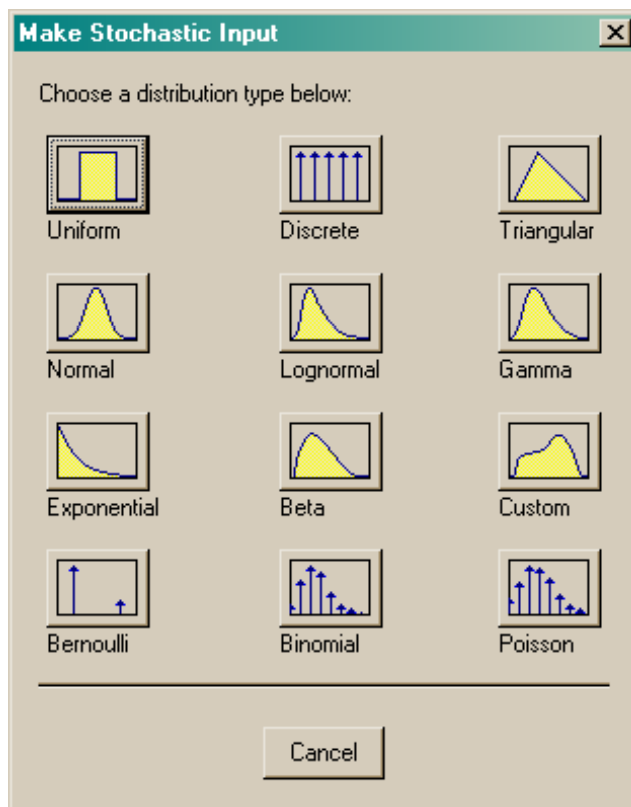
3510 Project Management
3520 Project Technical Support
3550 Consultant Services During Close-out
3560 Construction Contractor Work

3010 Cost Code
District Only
Consulting/ Contractor Services
Either Consultant or District

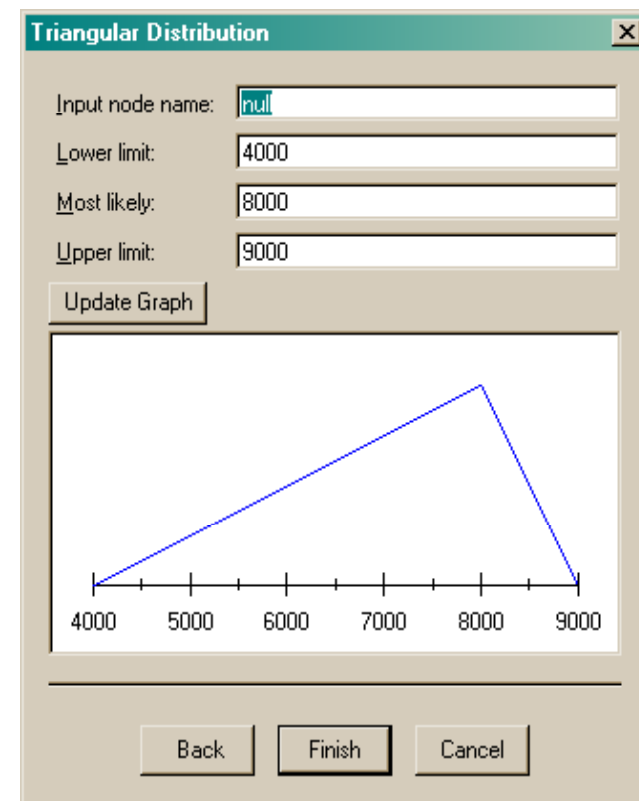
Performance of the Monte Carlo Analysis

- 12 different distribution curves available
- OCSD chose the triangular distribution curve
- The O,P, and ML value's define the shape of the triangular distribution curve
- This generated a random cost for each iteration of the 43 work packages on each project.
- The costs were then summed to phase and project levels, resulting in unique costs for each of the 10,000 iterations.

Model – Best Business Case Fit Curves



Curve Choices



Triangular Distribution

Monte Carlo Analysis Steps

- PM's identified potential risks at work package levels
- PM's established the optimistic, pessimistic and most likely costs for each work package
- Used Monte Carlo simulation to calculate mean
- Rolled up project costs to calculate program cost

Develop Input Data for the Model

- PM is the best input source for model input data
- The PM's provided O, P, and ML Estimate at Completion costs for each of 43 work packages in each project
- Developed standard guidelines for the PMs to determine risks
- The guidelines specifically excluded global program level risk input by the PM (i.e. construction cost escalation)

Example of data Input

Act. ID	Activity Name	Optimistic	Pessimistic	Most Likely	Monte Carlo	LOGIC
3146	Preliminary Design Report	\$1,377,500	\$2,172,500	\$1,450,000	\$1,667,525	ML = Original PSA Scoped work + PSA Amendment No. 1 scope addition for Preliminary Design. P = ML plus the following additional scope items. Additional Geotechnical Work due to tunneling: 200k Tunneling design work versus open cut: 300k Miscellaneous support during Pre Dsn: 150k + 5% of ML for unknown changes / risk. O = Estimated 5% below budget - considered unlikely.
3250	Consultant Services - Design	\$346,750	\$593,250	\$365,000	\$435,026	ML = Scope & Fees through PSA Amendment No. 1 P = ML plus the following scope changes that will occur: Create new 2nd contract documents package: 50 of 250k Design Bar Screen Facility: 100 of 750k Excavation/Shoring/Dewatering Design: 60 of \$60k plus 5% of ML for unknown change / risk. O = 5% below ML costs, but considered unlikely.
3350	Consultant Services - Construction	\$779,950	\$1,511,000	\$821,000	\$1,039,723	ML = Scope & Fees through PSA Amendment No. 1 P = ML plus the following additional scope items: Specialty Inspection Services for Tunneling: \$350k Add'l support for FCO's due to field conditions of traffic, soils, etc.: \$300k O = 5% below ML costs, but considered unlikely.
3360	Contractor Work - Construction	\$28,575,000	\$39,687,500	\$31,750,000	\$33,353,269	ML = Latest pre-PDR construction estimate from Malcolm Pirnie w/o 84" Interplant Pipeline element . O = Potential for cost reduction - eliminate screen facility (\$3M) plus miscellaneous savings. Reduce estimate by -10%. P = Potential for cost increase as estimate is based on estimating guidelines. Increase estimate by +25%

Cash Flow Forecasting

- Focus on “schedule” risks...not “cost” risks
 - Schedule changes: Advances or Delays
 - Durations changes: Expansion or Compression

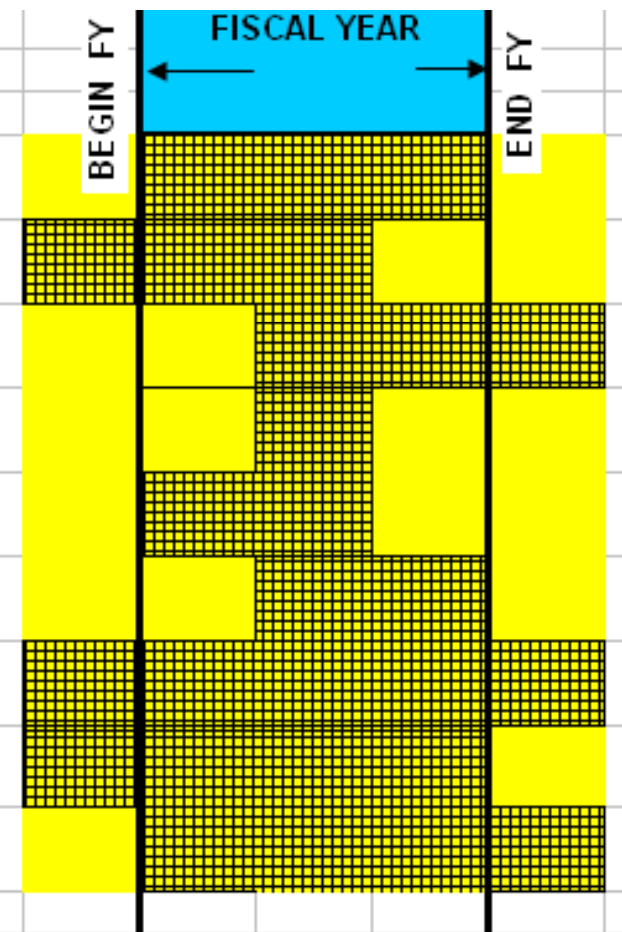
Cash Flow Forecasting

- Copy P3 Output worksheet for optimistic and pessimistic projections .
- Separately, for optimistic and pessimistic:
 - Consider Schedule changes by moving \$\$ toward present or future (copy/paste values).
 - Consider Duration changes by redistributing \$\$. (Total project costs should not change.)
 - Sum projections for each month of FY.
 - Link totals to P3 Output worksheet

Cash Flow Forecasting

1
2
3
4
5
6
7
8
9

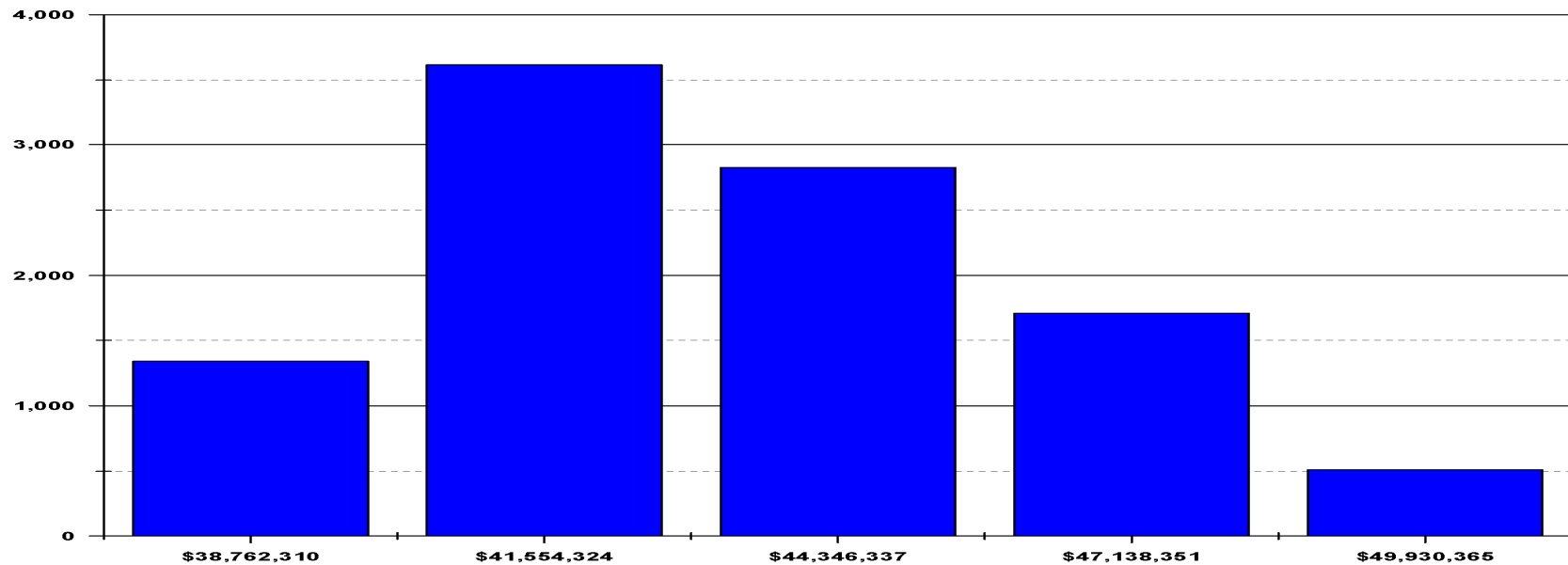
SCHEDULE CHANGE		DURATION CHANGE	CASH FLOW	FY TOTAL EXPENDITURE
START	FINISH			
No Change	No Change	<i>None</i>	<i>None</i>	<i>None</i>
EARLY	EARLY	<i>None</i>	<i>EXPEDITED</i>	<i>INCREASE -or- DECREASE</i>
LATE	LATE	<i>None</i>	<i>DELAYED</i>	<i>INCREASE -or- DECREASE</i>
LATE	EARLY	<i>COMPRESSED</i>	<i>INCREASED</i>	<i>INCREASE</i>
No Change	EARLY	<i>COMPRESSED</i>	<i>EXPEDITED & INCREASED</i>	<i>INCREASE</i>
LATE	No Change	<i>COMPRESSED</i>	<i>DELAYED & INCREASED</i>	<i>INCREASE</i>
EARLY	LATE	<i>EXPANDED</i>	<i>DECREASED</i>	<i>DECREASE</i>
EARLY	No Change	<i>EXPANDED</i>	<i>EXPEDITED & DECREASED</i>	<i>DECREASE</i>
No Change	LATE	<i>EXPANDED</i>	<i>DELAYED & DECREASED</i>	<i>DECREASE</i>



Simulation Summary

Measure	const 3300	Proj Mgmt 3310	Tech Support 3320	PCI 3321	Consult Svcs 3350	Contractor 3360	Inspection 3362	Testing 3363	Legal Svcs 3390
Observations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mean	\$16	\$133,266	\$503,980	\$28,496	\$1,090,234	\$40,706,746	\$749,424	\$120,097	\$20,161
Standard Deviation	\$0	\$15,671	\$23,013	\$4,605	\$204,699	\$2,873,429	\$30,689	\$20,738	\$10,809
Posterior STD	\$0	\$157	\$230	\$46	\$2,047	\$28,734	\$307	\$207	\$108
Variance	\$0	\$245,590,848	\$529,580,272	\$21,203,668	\$4e+10	\$8e+12	\$941,835,942	\$430,076,531	\$116,836,278
I									
5th Percentile	\$16	\$109,826	\$466,310	\$21,365	\$822,010	\$36,478,919	\$698,865	\$88,244	\$5,135
Median	\$16	\$131,618	\$503,346	\$28,128	\$1,054,993	\$40,324,775	\$748,997	\$118,123	\$18,476
95th Percentile	\$16	\$161,372	\$543,323	\$36,594	\$1,473,623	\$45,919,131	\$800,822	\$156,738	\$40,275
Maximum	\$16	\$174,353	\$560,391	\$40,473	\$1,655,992	\$48,339,780	\$823,930	\$174,830	\$49,859

Statistical Table



Histogram