Panama Canal - Third Set of Locks Expansion Project

Project Controls in a multi-cultural environment

Agenda

- SIS Relationship to the Project
- SIS Scope of Work Summary
- Building the Canal – Then and Now
- Baseline Development & Challenges
- Project Scale vs. Complexity
- Complex Projects – Project Controls Issues
- Lessons Learned & Recomendations

SIS Relationship to the Project

- Provided scheduling services for Impregilo-Healy on the Portland Combined Sewer Overflow tunneling project in 2005/2006
- Provided scheduling services for Impregilo-Healy on the Las Vegas Lake Mead Intake Structure Project 2007/2008
- Retained by GUPC to develop the Baseline Schedule for the Locks Expansion Project in 2009
- Provide ongoing support for the Locks Expansion Project 2009 to present

SIS Panama Canal Project Involvement

- Phase 1: Baseline Schedule Development
- Phase 2: Ongoing Project Scheduling and Document Control Support
- Phase 3: Project Controls Assessment and Recommendations

SIS Panama Canal Project Involvement

- Phase 1: Baseline Schedule Development
  - Develop the Baseline Master Schedule from the bid schedule
  - Evaluate / Prove Production Rates
  - Establish Earned Value Systems Outline
  - Perform Schedule Risk Analysis
  - Facilitate Baseline Schedule Workshop (10 days long)
  - Baseline Submittal Package (565 pages when completed)

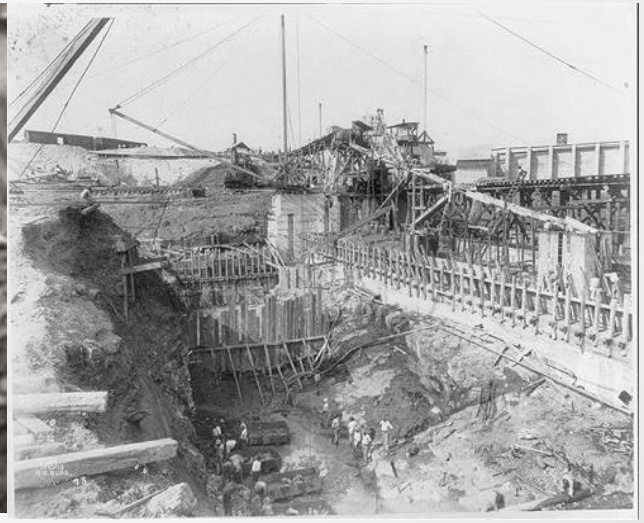
SIS Panama Canal Project Involvement

- Phase 2:
  - Provide on site scheduling support
  - Quarterly Risk Analysis
  - Train local staff in P6 scheduling techniques
  - Provide Document Control Manager

SIS Panama Canal Project Involvement

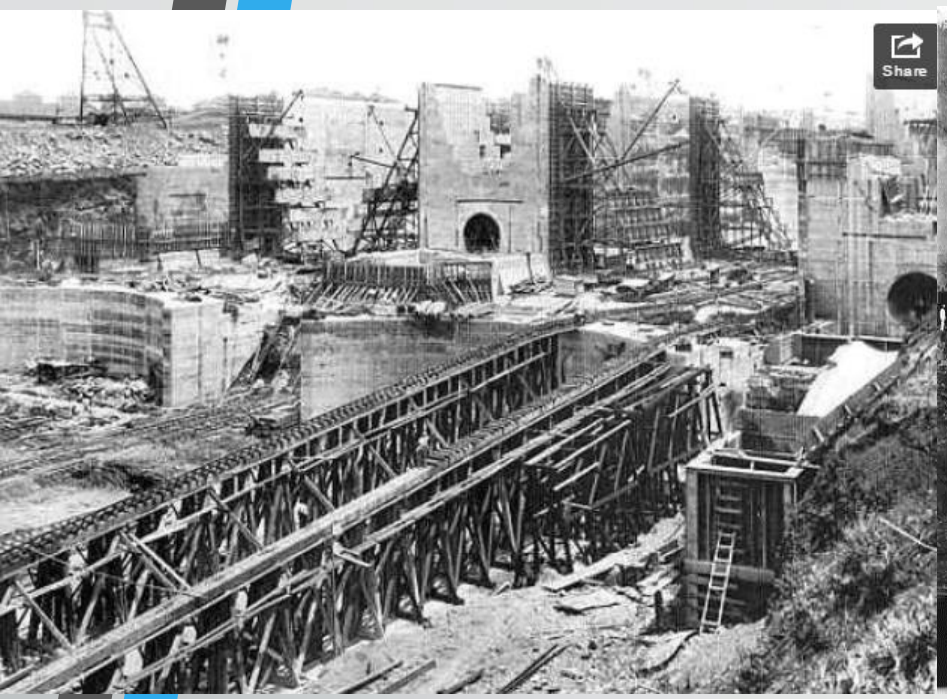
- Phase 3:
  - Evaluate Planning, Scheduling and Tracking processes
  - Assess ability of the processes to provide required information
  - Identify short comings and provide direction for improvement

Building the Original Canal



- First surveyed in 1534 by order of Charles V of the Holy Roman Empire
- Men behind the Suez Canal and Eiffel Tower failed at building the canal between 1880 and 1893
  - More than 20,000 workers died
- In 1903 US Congress authorized the purchase of French assets for $40 million and negotiated a treaty with Panama for $10 million for 500 square miles in which to build and operate the canal
  - Annual lease payment $250,000
- US spent $375 million to build the canal from 1904 to 1913 (about $9 billion adjusted for inflation)
  - More than 5,600 workers died

Building the Original Canal



- First ship passed through the Canal in September 1913
- Official opening August 1914
- US transferred control of the Canal to Panama on December 31, 1999

Building the Original Canal – Fun Facts

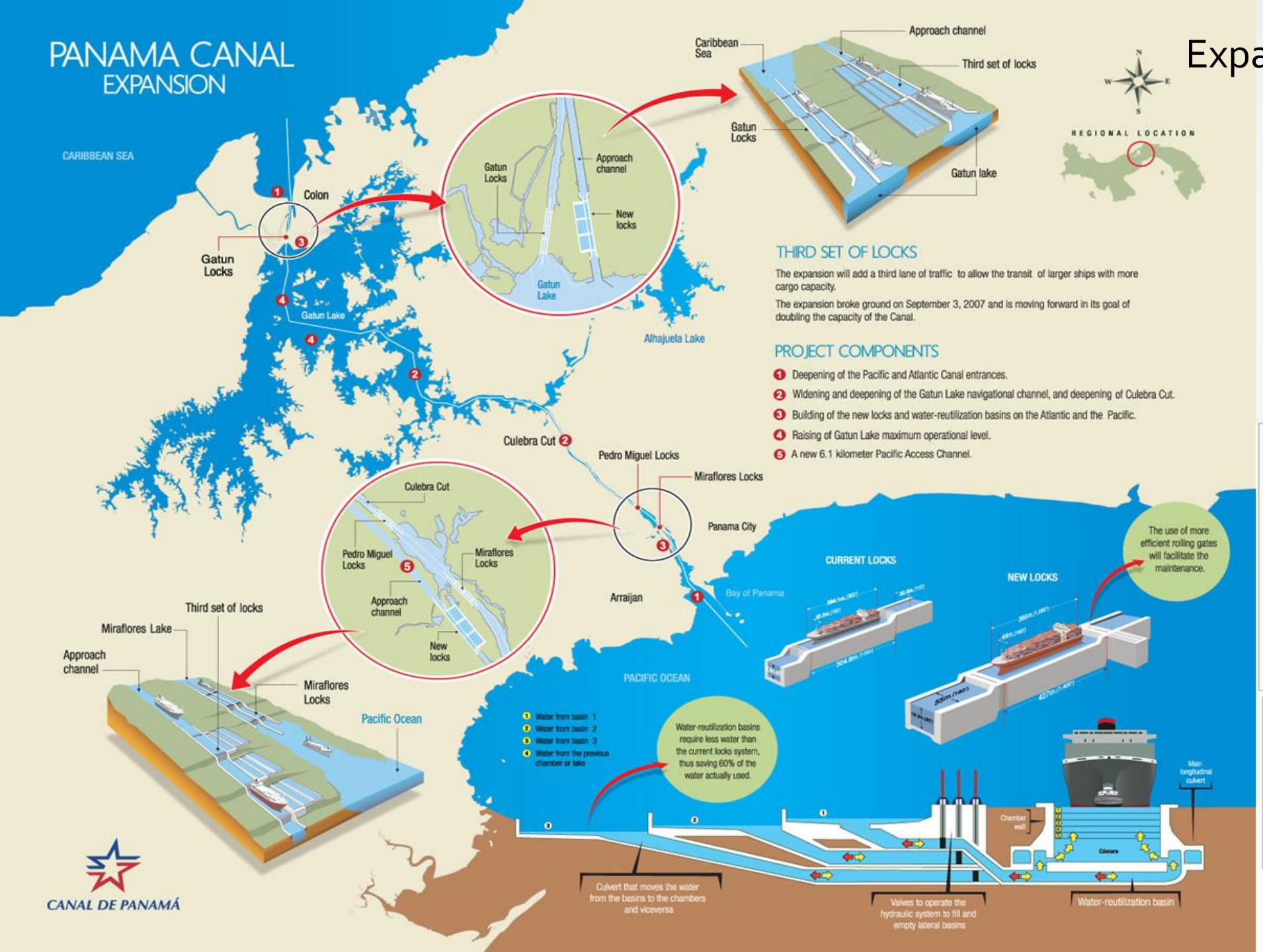
- More than four and half million cubic yards of concrete went in to the construction of the locks and dams.
- If material originally excavated to build the Canal were put on to a train of flat cars it would encircle the world four times.
- Excavation of the Canal was equal to digging a trench 10’ deep by 55’ wide from California to New York.

Building the Original Canal – Fun Facts

- More than 60,000,000 pounds of dynamite was used to excavate and construct the Panama Canal.
- In 1963 the Panama Canal started operating 24 hours per day, thanks to the introduction of high mass fluorescent lighting.
- Due to the reclining "S" shape of the Isthmus of Panama the sun rises from the Pacific and sets in the Atlantic Ocean and the Atlantic Entrance is 22 ½ miles West of the Pacific Entrance.

Expansion Project Summary

[Video overview]



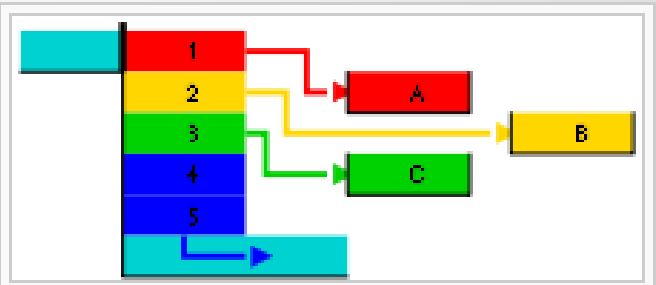


Diagram of water-saving basins (descending)

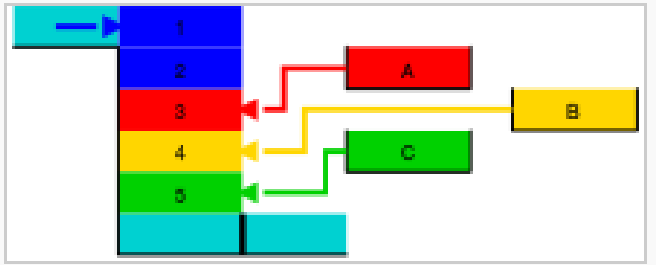


Diagram of water-saving basins (ascending)

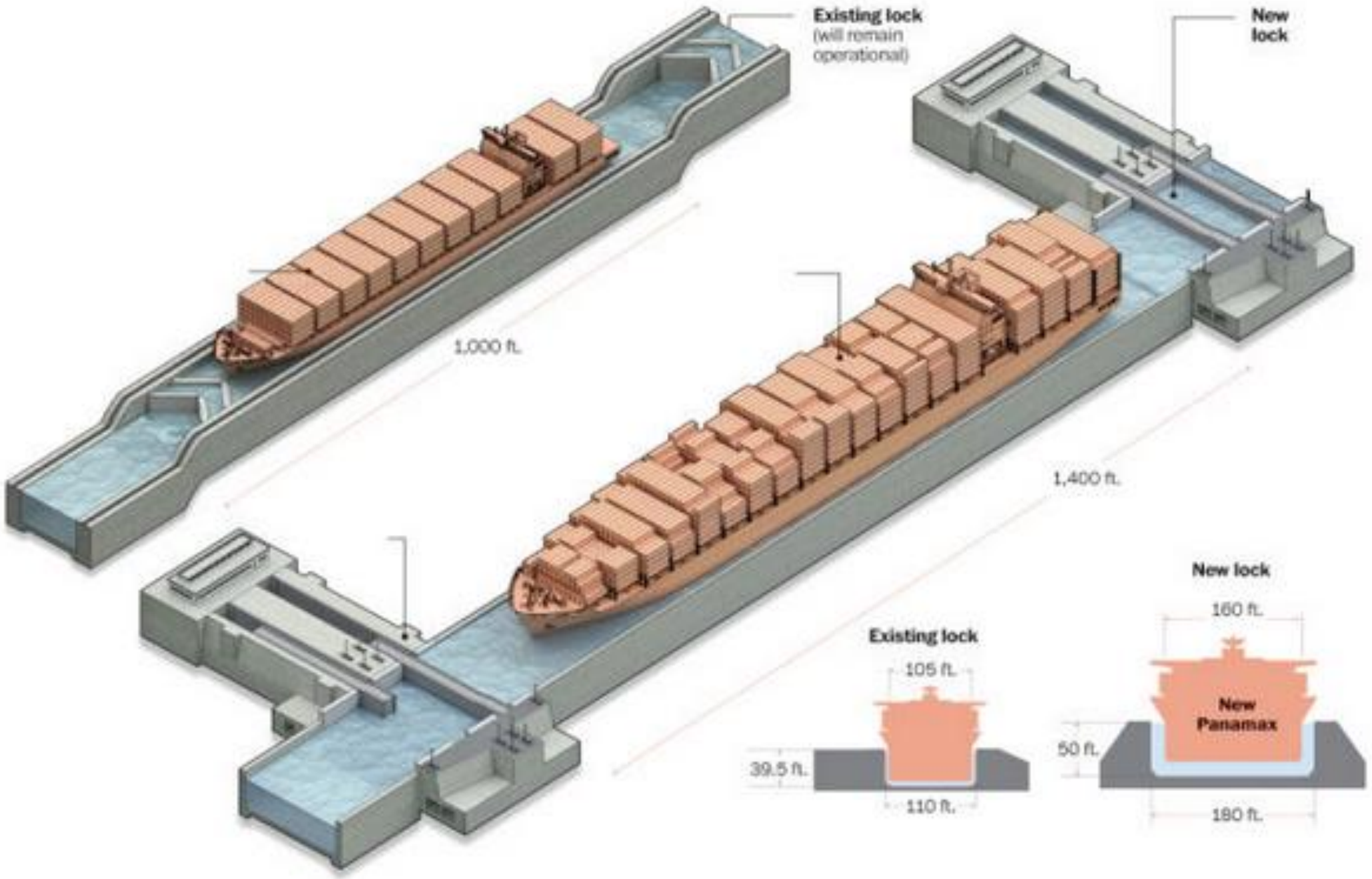
Canal Operations

Current System

- Lock Size: 1000′ x 110′ x 42′
- Max ship size: 965′ x 106′ x 39 ½′
- Max Cargo: 4,400 TEU's
- Fresh water used per transit: 52 million gallons
- Transports 4% of world trade

Post Panamax

- Lock Size: 1400′ x 180′ x 60′
- Max ship size: 1200′ x 160′ x 50′
- Max Cargo: 12,600 TEU's
- Fresh water used per transit: 21 million gallons


Existing lock
(will remain
operational)
New
lock
1,000 ft.
1,400 ft.
New lock
160 ft.
Existing lock
105 ft.
New
Panamax
50 ft.
39.5 ft.
110 ft.
180 ft.

SIS Panama Canal Project Involvement

- Phase 1: Baseline Schedule Development
  - Develop the Baseline Master Schedule from the bid schedule
  - Evaluate / Prove Production Rates
  - Establish Earned Value Systems Outline
  - Perform Schedule Risk Analysis
  - Facilitate Baseline Schedule Workshop (10 days long)
  - Baseline Submittal Package (565 pages when completed)

Expansion Project Major Parties

- ACP: Panama Canal Authority
- CH2MHill: Program Manager
- GUPC: Sacyr Vallerhermoso S.A., Impregilo S.p.A., Jan de Nul n.v., Constructora Urbana S.A., Montgomery Watson Harza, IV-Groep, Tetra Tech, Heerema Fabrication Group

Expansion Project Challenges

- Multi-national Participants
  - Language barriers
  - Cultural differences
  - Execution differences
  - Internal systems differences
  - Expectations
  - Financial Considerations

Project Controls Systems in use by GUPC

- Scheduling
  - Master
  - Detailed
- Earned Value
  - Design
  - Construction Quantities / Commodities
- Procurement
- Document Control
- Financial

Schedule Development Considerations

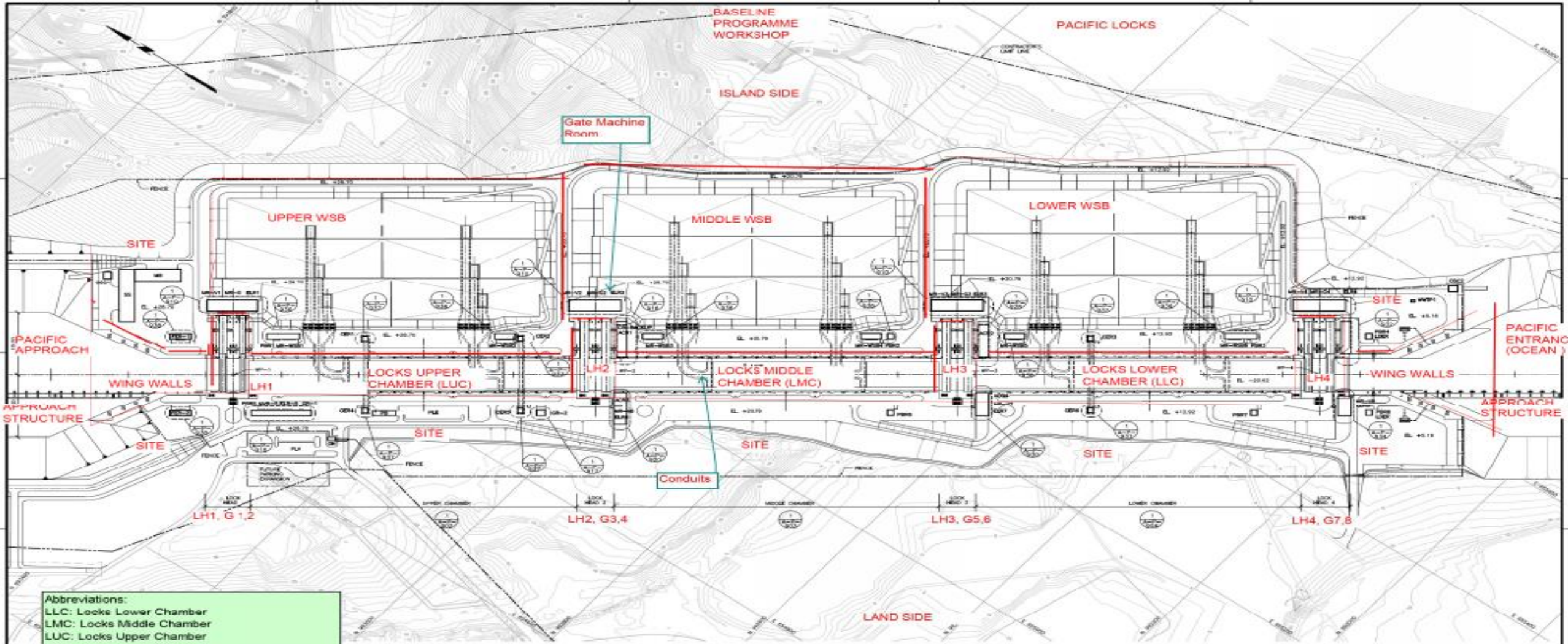
- Structure
  - Coding
  - WBS
  - Naming Conventions
  - Area Designations

Schedule Development Considerations

- Consistency
- Settings / Rules
- Methods for adding details
- Methods for tracking impacts

Schedule Development Considerations

- Calendars
- Resources
- Reporting
- Communicating the Plan



Abbreviations:
LLC: Locks Lower Chamber
LMC: Locks Middle Chamber
LUC: Locks Upper Chamber
WSB-LC: Water Saving Basin Lower Chamber
WSB-MC: Water Saving Basin Middle Chamber
WSB-UC: Water Saving Basin Upper Chamber
LH1: Lock Head 1
LH2: Lock Head 2
LH3: Lock Head 3
LH4: Lock Head 4

GENERAL PLAN
SCALE 1 = 2000

GUPC - Third Set of Locks Project - Schedule Area Reference

Pac Entr	LLC	LMC	LUC	WW Pac Aprch	Gatun Lake	WW Atl Aprch	LUC	LMC	LLC	WW Atl Entr
	LH4	LH3, LH2	LH1				LH1	LH2 - LH3	LH4	
Gates:	8,7	6,5 - 4,3	2,1				1,2	3,4 - 5,6	7,8	
Gate Install Seq:		3,6 3,4,7,6, 1, 2					3, 6, 3, 4, 1, 2, 7, 8			

ABBREVIATIONS:

Buildings by Contractor:

ACP	AIR COMPRESSOR ROOM
CB	MAIN CONTROL BUILDING
CER	CHRONAMMER ELEVATOR ROOM
ELH	ELECTRICAL ROOM
HL	EMERGENCY MONITORED WORKER TOWER
TEH	EMERGENCY EQUIPMENT ROOM
MR-S	MACHINERY ROOM-GATES
MR-WSB	MACHINERY ROOM-WATER SAVING BASIN
SSI	GUARD HOUSE
CH	GUARD HOUSE
MS	MAINTENANCE BUILDING
PE	PERSONNEL BUILDING
PER	PERSONNEL BREAK ROOM
PLE	PARKING LOT-EMPLOYEES
PLV	PARKING LOT-VISITORS
SS	LOCKS SPARE STORAGE BUILDING
WTP	WASTEWATER TREATMENT PLANT

Buildings by Employer:

DSC	OIL SPILL CONTROL ROOM
GE	GENERATOR ROOM

ACP | UPC

CONSULTORES INTERNACIONALES DEL CANAL DE PANAMÁ

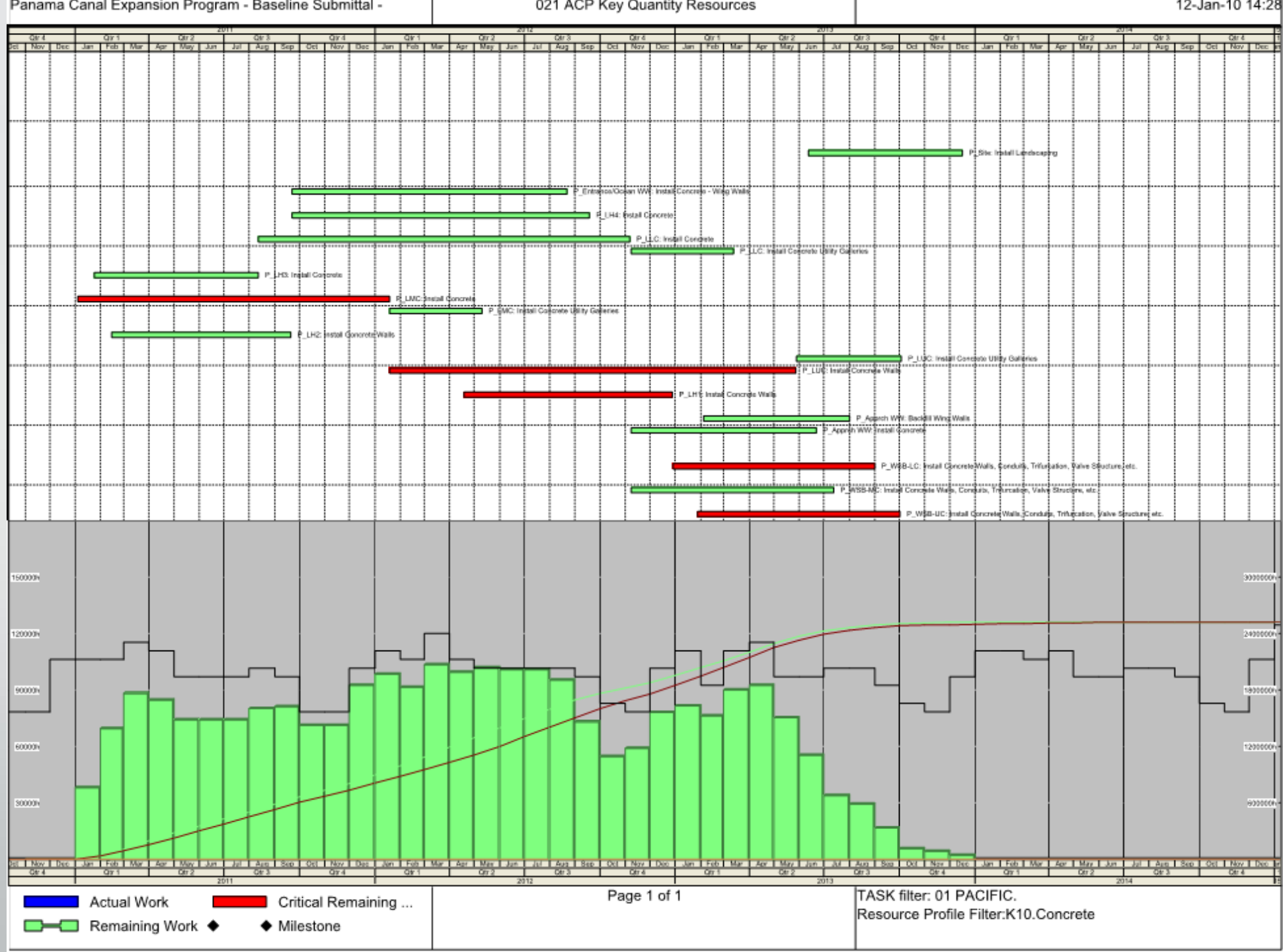
THE PANAMA CANAL
THIRD SET OF LOCKS PROJECT
PACIFIC LOCK COMPLEX
MASTER PLAN
TENDER DESIGN

A-P-901

Baseline Schedule Assumptions

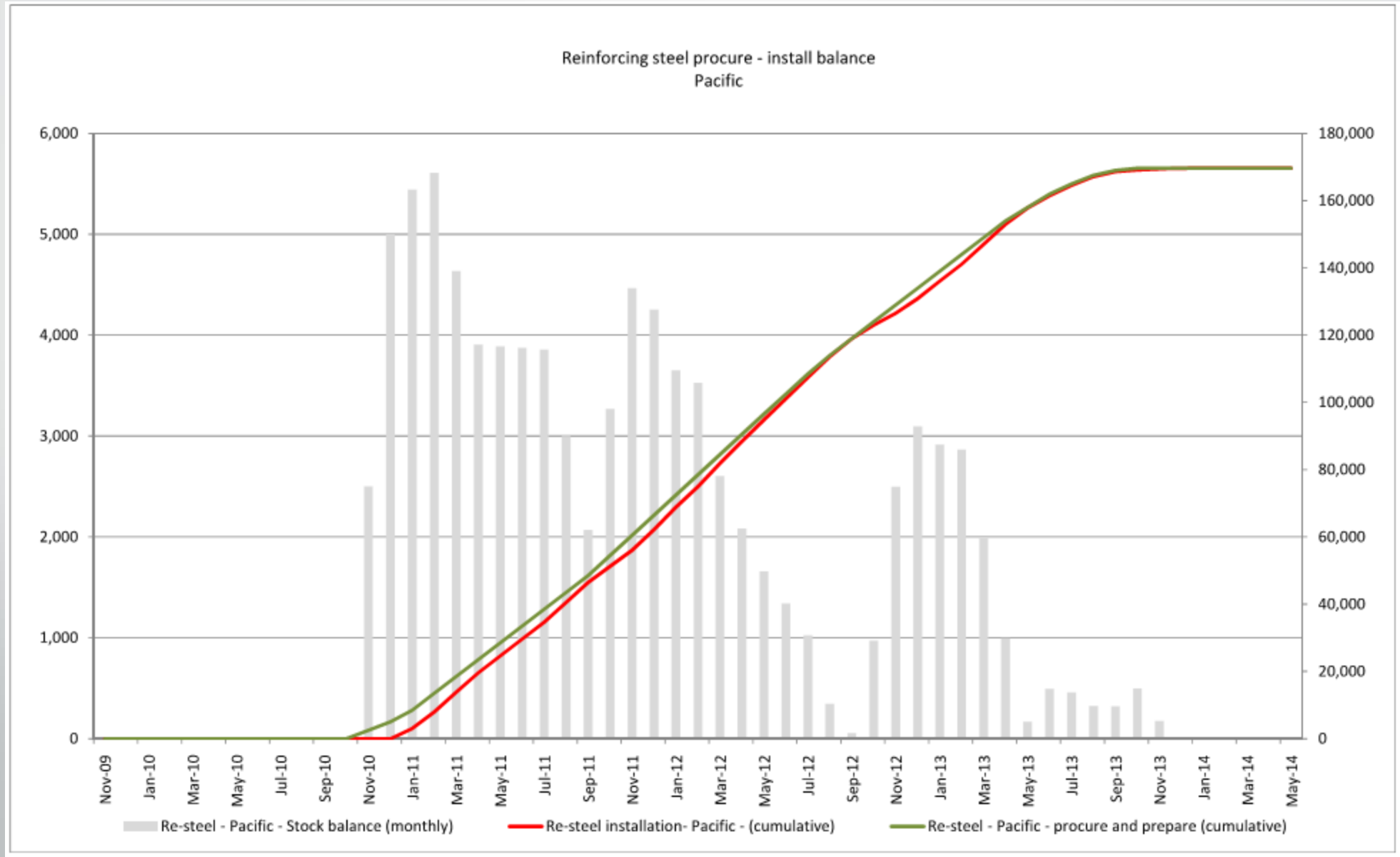
- Schedule development considerations:
  - Production Rates / Limits
    - Dredging ~600,000 cm/mth
    - Excavation ~900,000 cm/mth
    - Backfill ~600,000 cm/mth
    - Concrete ~110,000 cm/mth
    - Re-Steel ~6,000 mt/mth

Baseline Schedule Sample

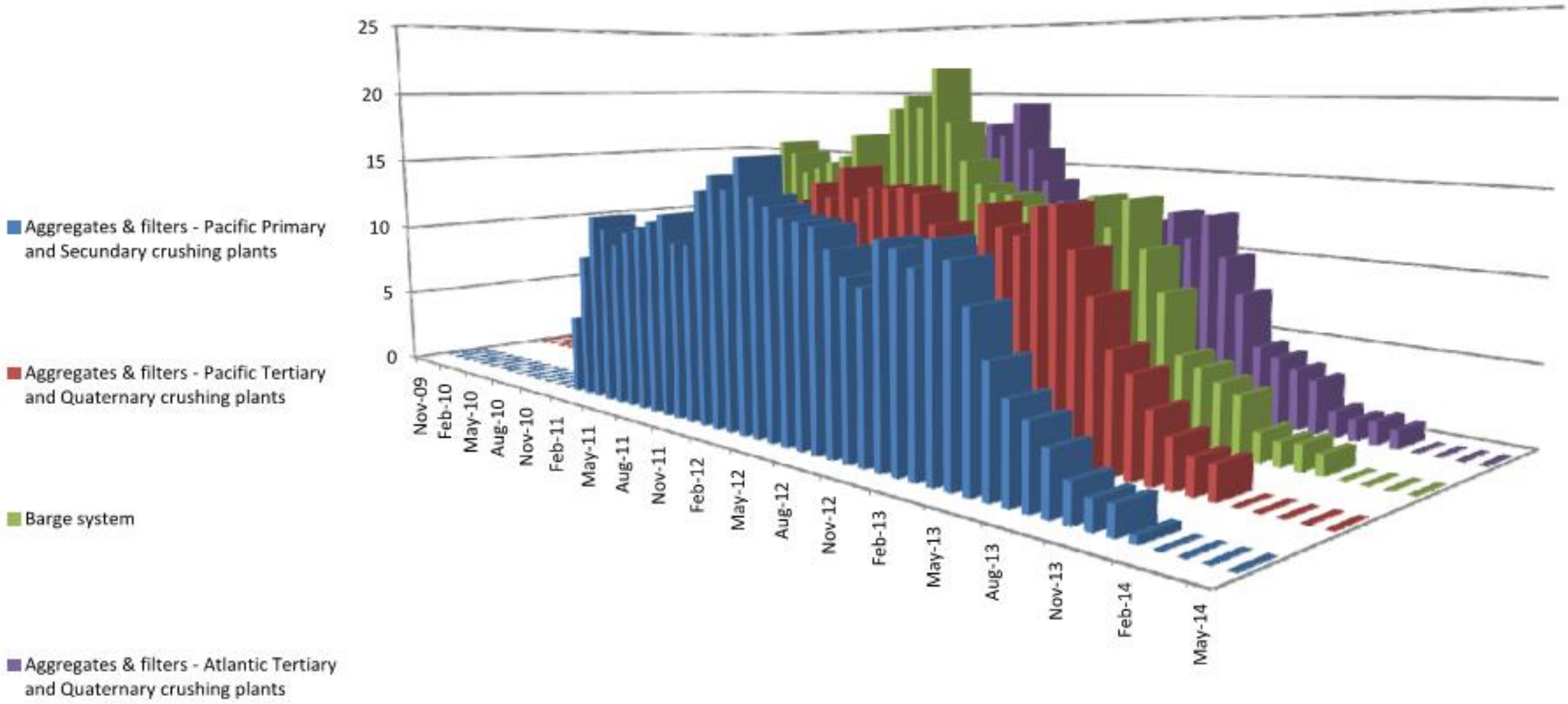


Baseline Schedule Samples

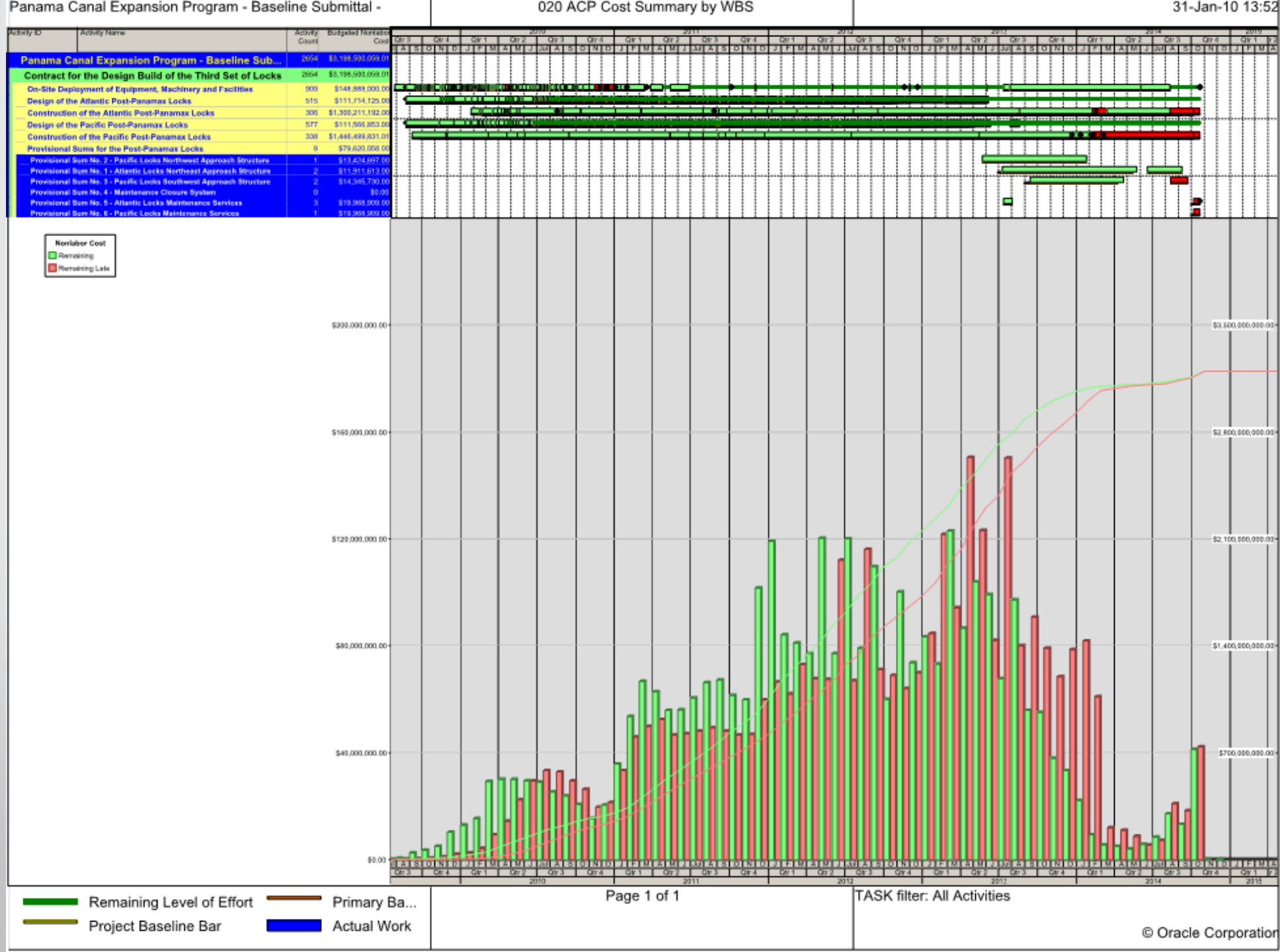
Baseline Schedule Sample



Crushing plants and Barges system
Monthly number of working days necessary to fulfill requirements



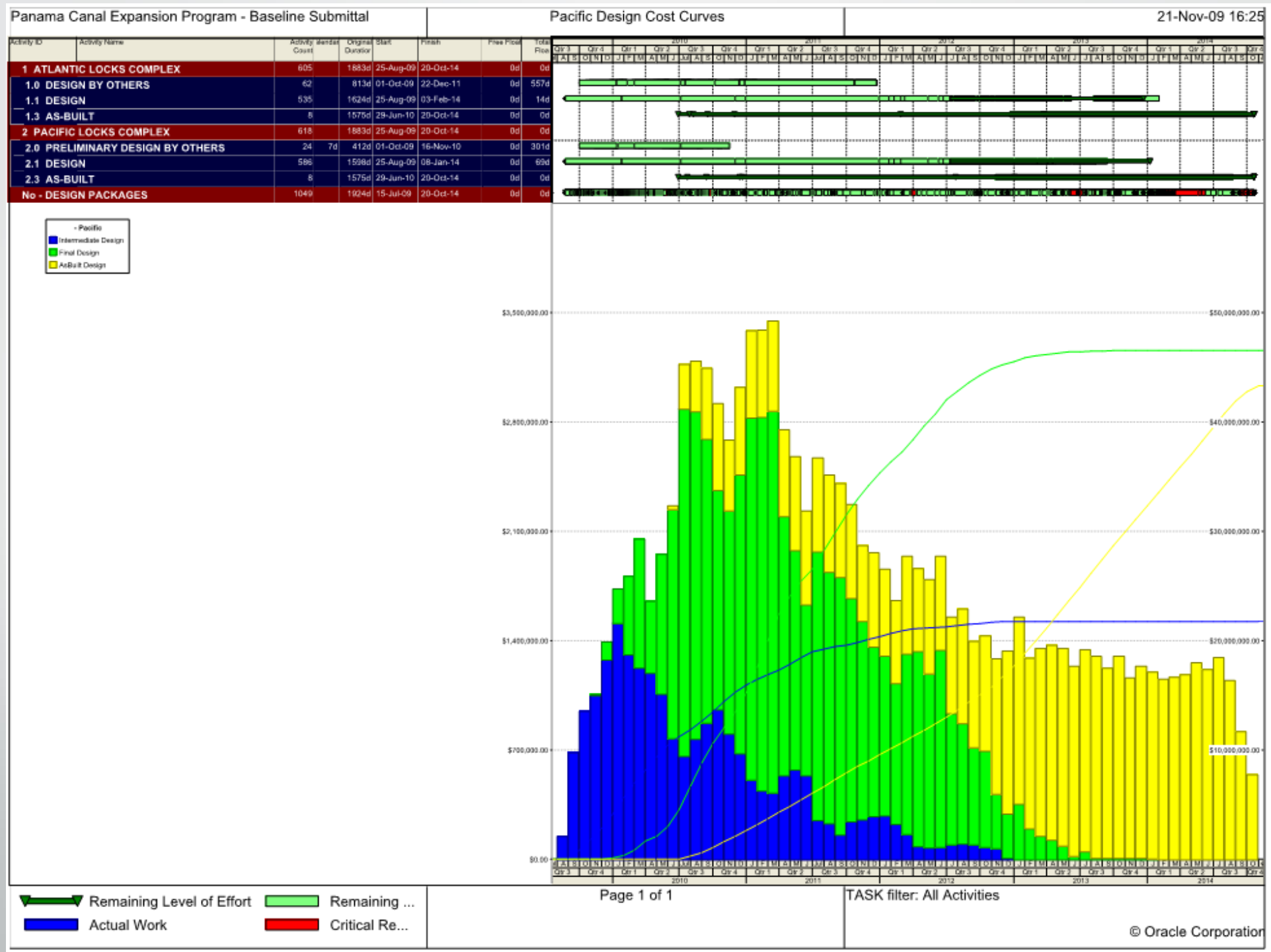
Baseline Schedule Sample



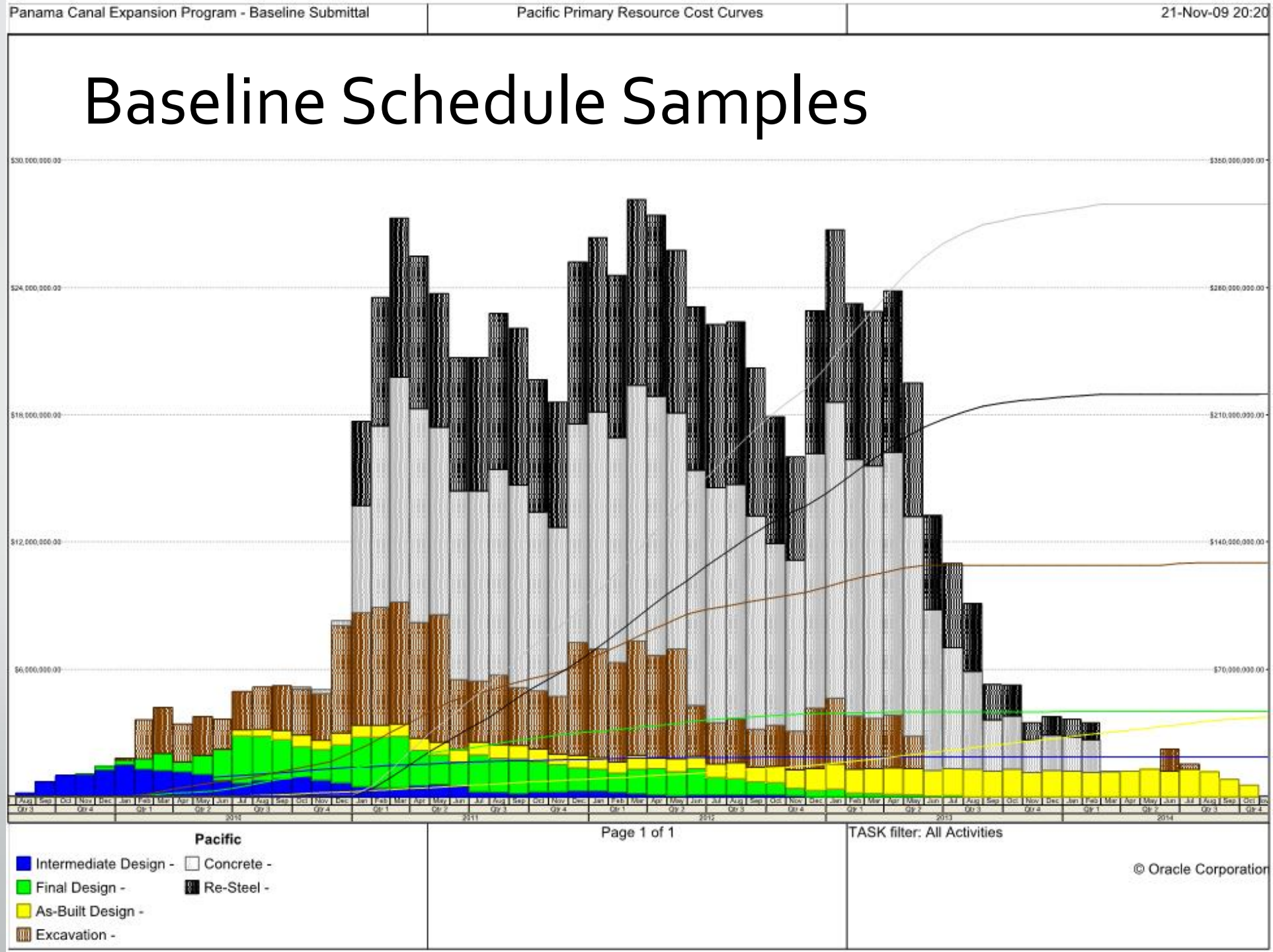
Baseline Schedule Sample – Temp Facilities

Total	$165,749,488.59
BOTH SIDES: ATLANTIC AND PACIFIC	$18,756,695.00
TEMP DEPLOYMENT AND TEMPORARY FACILITIES	$18,756,695.00
PACIFIC	$92,068,719.87
TEMP DEPLOYMENT AND TEMPORARY FACILITIES	$92,068,719.87
SITE SITE	$15,020,090.87
CONINDUS CONTRACTOR AND INDUSTRIAL FACILITIES	$4,044,055.00
PLANTS TEMPORARY INDUSTRIAL PLANTS	$27,608,608.00
CONTRAC CONTRACTOR FACILITIES	$23,643,376.00
OFFSITE OFF-SITE FACILITIES	$21,752,590.00
ATLANTIC	$54,924,073.72
TEMP DEPLOYMENT AND TEMPORARY FACILITIES	$54,924,073.72
SITE SITE	$8,060,451.72
CONINDUS CONTRACTOR AND INDUSTRIAL FACILITIES	$3,002,913.00
PLANTS TEMPORARY INDUSTRIAL PLANTS	$17,581,947.00
CONTRAC CONTRACTOR FACILITIES	$15,146,255.00
OFFSITE OFF-SITE FACILITIES	$11,132,507.00

Baseline Schedule Sample



Baseline Schedule Sample

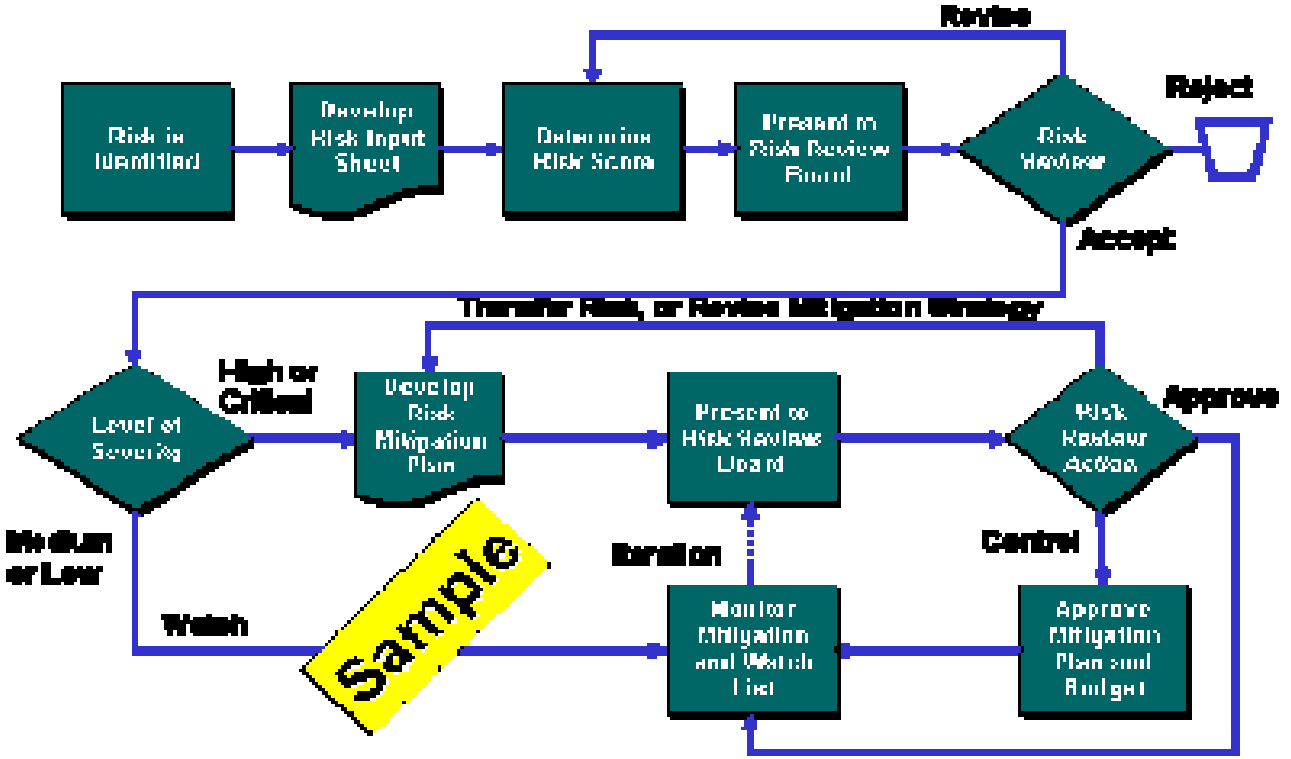


Baseline Schedule Sample

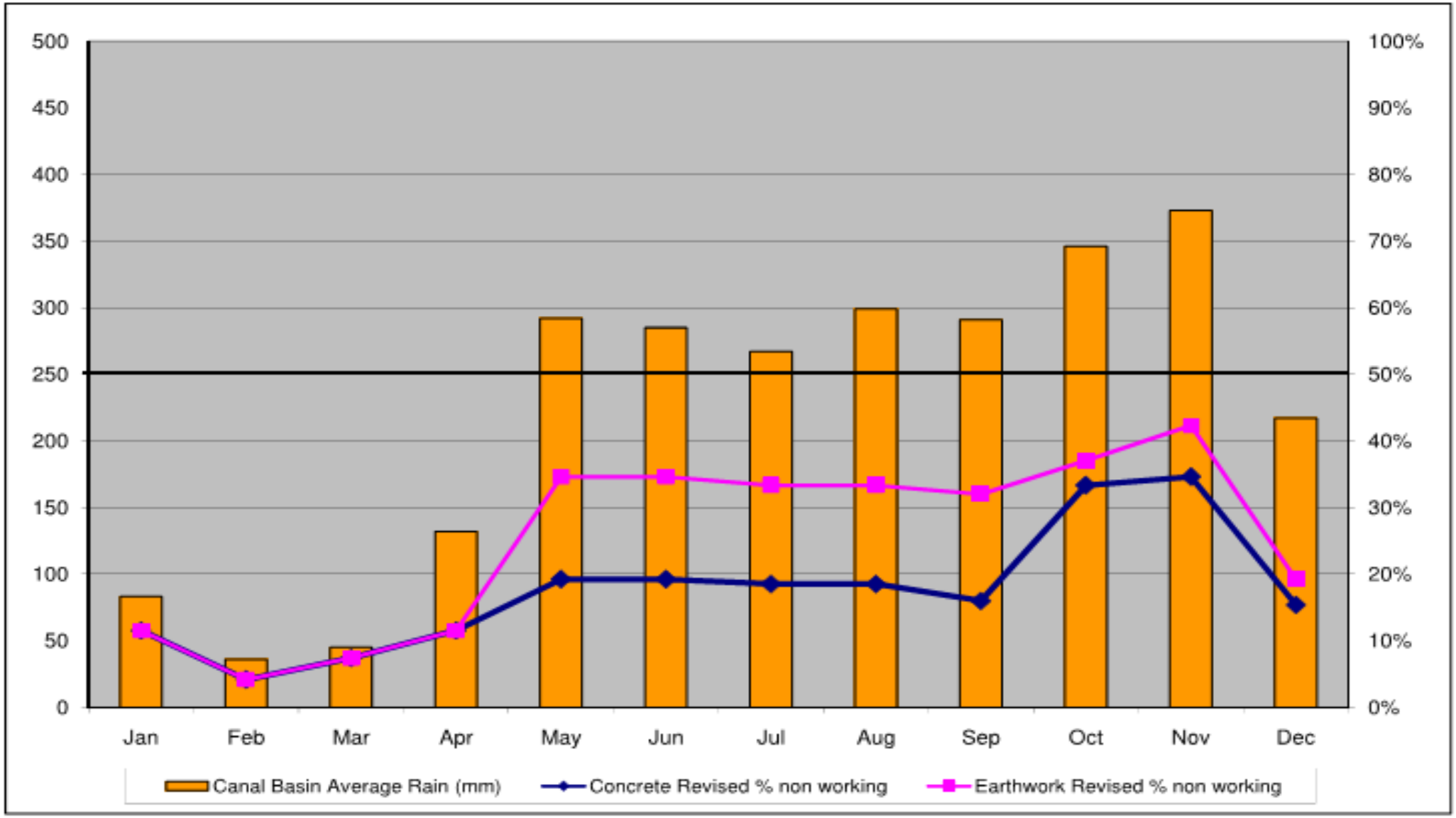
THIRD SET OF LOCKS PROJECT

RISK RATING MATRIX

PROBABILITY	SEVERITY	1 CATASTROPHIC	2 MAJOR	3 MODERATE	4 MINOR	5 NEGLIGIBLE
5	EXPECTED	Risk Simulation Run	Risk Simulation Run	Risk Simulation Run	Risk Simulation Run	Risk Workshoot Used
4	PROBABLE	Risk Simulation Run	Risk Simulation Run	Risk Worksheet Used	Risk Worksheet Used	Risk Owner Monitors
3	LIKELY	Risk Simulation Run	Risk Worksheet Used	Risk Owner Monitors	Risk Owner Monitors	Risk Owner Monitors
2	UNLIKELY	Risk Simulation Run	Risk Worksheet Used	Risk Owner Monitors		
1	REMOTE	Risk Worksheet Used	Risk Owner Monitors	Risk Owner Monitors		
0	NEGLIGIBLE	Risk Owner Monitors				



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gatun	88	44	44	134	313	285	314	338	285	389	490	291
Pedro Miguel	30	10	14	87	246	243	234	235	235	303	272	128
Balboa	38	18	24	77	239	226	206	192	248	277	235	125
Canal Basin Average Rain (mm)	83	36	45	132	292	285	267	299	291	346	373	217



Baseline Workshop

- 10 day workshop over three week time period
- Joint review of the planning and scheduling process by all parties
  - Structure
  - Rules
  - Production Rates
  - Sequencing
  - Earned Value Measurement
  - Cost Loading
  - Risk Analysis Review

Project Scale vs. Complexity

- 10,000 Cubic Yards over a 10 month time frame is not as complex as 10,000 Cubic Yards over a 10 week time frame
- $10,000,000 project is not just 10x larger than a $1,000,000 project it is also more complex (but not 10x more complex)
- As project scale increases project controls needs increase
- As project complexity increases project controls needs increase

Project Scale vs. Complexity

- Project Size tends to drive Project Controls expectations, usage & funding
  - Foreman and a pick-up truck: ~$50,000
  - GF and a Conex: ~$100,000
  - Superintendent and a single wide: ~$1,000,000
  - Construction Manager and a double wide: ~$5,000,000
  - Project Manager and a trailer complex: ~$50,000,000
  - Project Director and a compound: ~$200,000,000 & up

Project Scale vs. Complexity

- As projects get larger and more complex the basics often get overlooked in favor of fancier charts and graphs
- In it's simplest form project controls is about knowing the following:
  - What needs to be done
  - How much needs to be done
  - When does it need to be done
  - What resources are required to do it
  - What has been done
- Short changing any of these areas will decrease project performance

Complex Projects Controls Issues: Planning

- Multiple schedules, in multiple formats, utilizing multiple sources of external information, at varying levels of detail used by multiple departments
- Lack of integrated schedules or ties from detailed schedules to master schedule (manual date and logic transfers)
- Schedules lack labor or construction equipment resource information
- Short Interval Schedules do not support the master schedule

Complex Projects Controls Issues: Scheduling

- High volume of In Progress activities
- High volume of extended duration activities
- Use of FS lags to control planned activity dates
- Remaining Durations not accurate
- Monthly instead of weekly updates
- Lack of resources to schedule and status all of the work fronts

Complex Projects Controls Issues: Budgeting

- Multiple budgeting / estimate at completion systems and values
- System for moving from conceptual budgets to quantity at completion budgets varies widely by department / entity
- Timeliness of budget development

Complex Projects Controls Issues: Tracking

- Multiple Units of Measure for similar/same item in use by different departments
- Differing EAC values between departments for the same item
- Differing Percent Complete between departments
- Multiple Tracking/Reporting systems and formats in use for similar/same items

Complex Projects Controls Issues: Financial

- The hold back of money on cost loaded schedule items causes activities to extend well beyond their original forecast
- Schedule budgets not in alignment with cost systems
- Activities in progress with no billings

Complex Projects Controls Issues: Risk Assessment

- Risk Analysis performed with limited input
- Duration ranges are based on previous month performance of a select set of activities rather than cumulative performance on a broad base of activities
- Mitigation strategies not being developed and implemented for all high risk items

Lessons Learned about complex projects

- The bigger the project the more often the basics get skipped. (Budgets, updates, reporting, resource loading)
- Joint Ventures need more attention due to competing interests and company / country culture differences
- The more complex the work the more basic controls and cross checks need to be in place. (i.e., rather than just track concrete poured also track rebar received, rebar placed, cement received & placed, to get cross checks on progress)

Lessons Learned about complex projects

- Low bid may not be best value
- When financials are bad do not skimp on project controls and measurement
- Follow through on the project planning and kick-off
- Resource loaded schedules are key

Scheduling Practices and Project Success

Outcome Metric	Resource Loaded CPM	CPM	Milestone
Absolute Cost Index	0.95	0.98	1.03
Absolute Schedule Performance	0.91	0.97	1.04
Percent Cost Growth	-1%	2%	5%
Absolute Schedule Performance	0.91	0.97	1.04
Percent Schedule Slip	2%	19%	25%

Cost & Schedule Comparable to Similar Projects

Cost & Schedule Baseline Comparison

Recommendations for Effective Project Controls

- Keep it Simple
- Track performance as well as progress
- Multiple, smaller metrics rather than one big metric
- Evaluate all major resources
- Weekly Measurement & Response
- Monthly Analysis & Evaluation
- Quarterly Reforecast

"Simplicity is the result of a concentration of ideas and information , and not about leaving out ideas and information"

References

- Videos / Web Cams:
  - http://www.youtube.com/watch?v=olZ_6UVmoKo
  - http://micanaldepanama.com/expansion/webcams/pacific-locks/
  - https://www.youtube.com/watch?v=9svL4qIkOW8
  - https://www.youtube.com/watch?v=QfGP1ZXjKZI
  - https://www.youtube.com/watch?v=93qtCpfckPE
- Articles:
  - http://micanaldepanama.com/expansion/
  - http://www.pancanal.com/eng/general/canal-faqs/physical.html
  - http://www.history.com/news/7-fascinating-facts-about-the-panama-canal

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