Schedule Delay Analysis

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Types of Construction Delay

Basic Distinctions:

- Excusable and Non-Excusable
- Compensable and Non-Compensable
- Concurrent and Non-Concurrent
- Critical versus Non-Critical

Types of Construction Delay

Excusable Delays:

- General labor strikes
- Fires, floods and other natural disasters
- Owner directed changes
- Errors and omissions in the plans and specifications
- Differing site conditions or concealed conditions
- Lack of action by government bodies
- Intervention by outside agencies

Types of Construction Delay

Excusable Delays (defined):

"Excusable delays are caused by conditions that are reasonably unforseeable and not within the contractor's control"

Note: Always check the particular construction contract documents for valid delay factors and limitations.

Types of Construction Delay

Non-Excusable Delays:

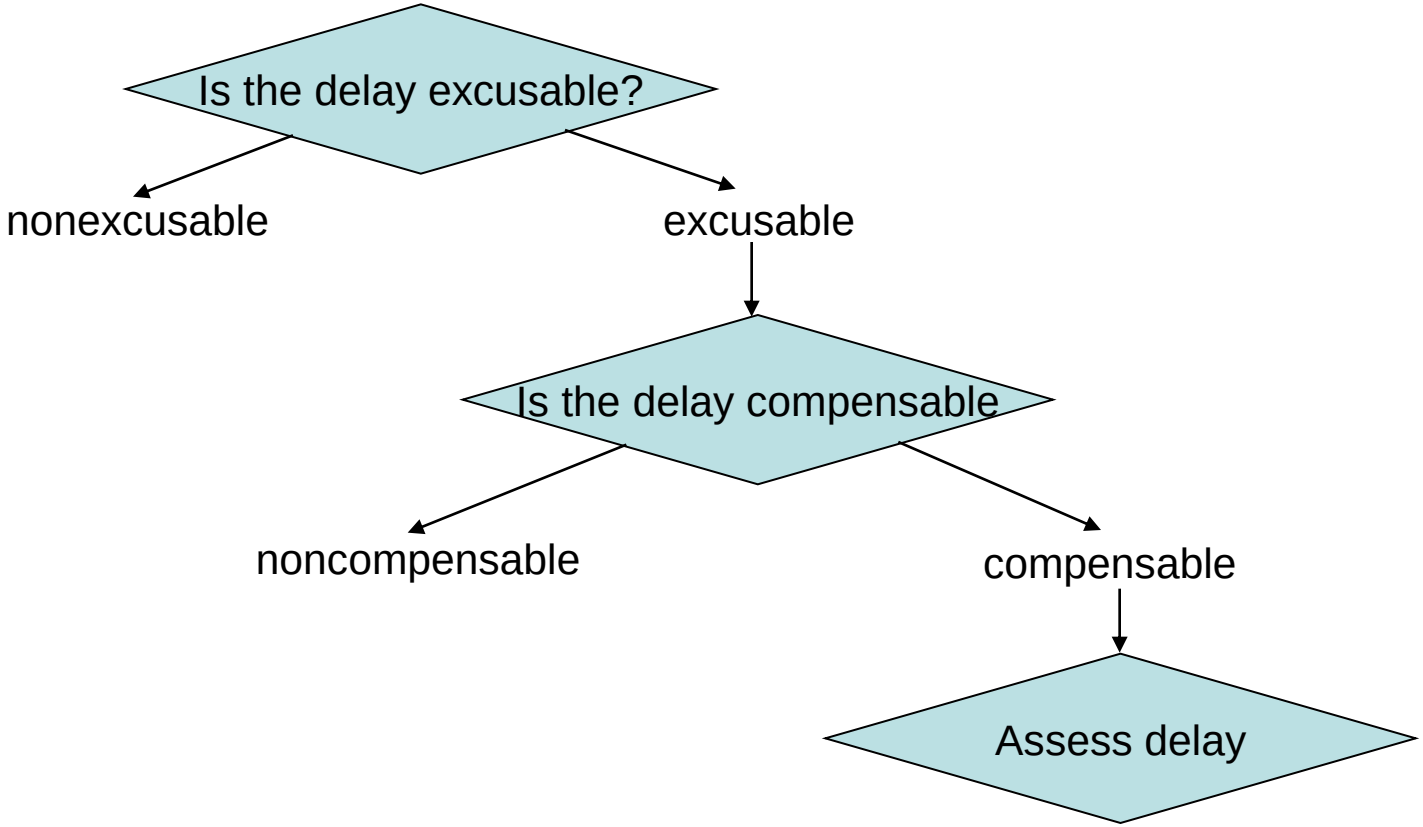
- Late performance of subcontractors
- Late performance by suppliers
- Faulty workmanship by the contractor or subcontractors
- A project specific labor strike caused by either the contractor's unwillingness to negotiate or by unfair job practices

Types of Construction Delay

Non-Excusable Delays:

Again: *Verify the particular contract language for definitions and limitations!*

Categories of Delays



Critical Documentation

As Planned Schedule:

- Detailed Critical Path Method schedule;

  or

- Bar chart schedule;

  or

- Narrative schedule

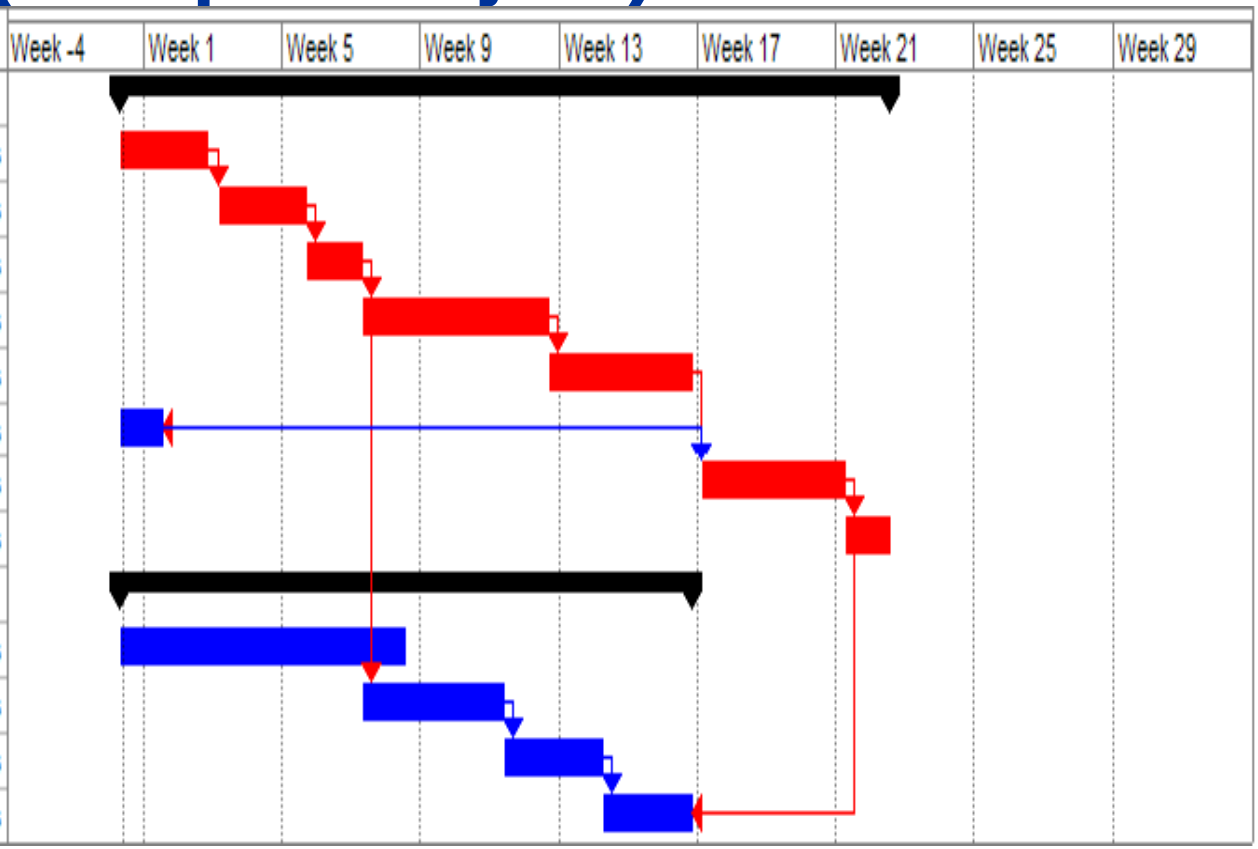
Critical Documentation

As Built Schedule:

- Final as-built CPM schedule with periodic updates;
  and
- Project daily reports;
- Meeting minutes;
- Inspection reports by the designer, owner, bldg inspector
- Correspondence
- Memos to file

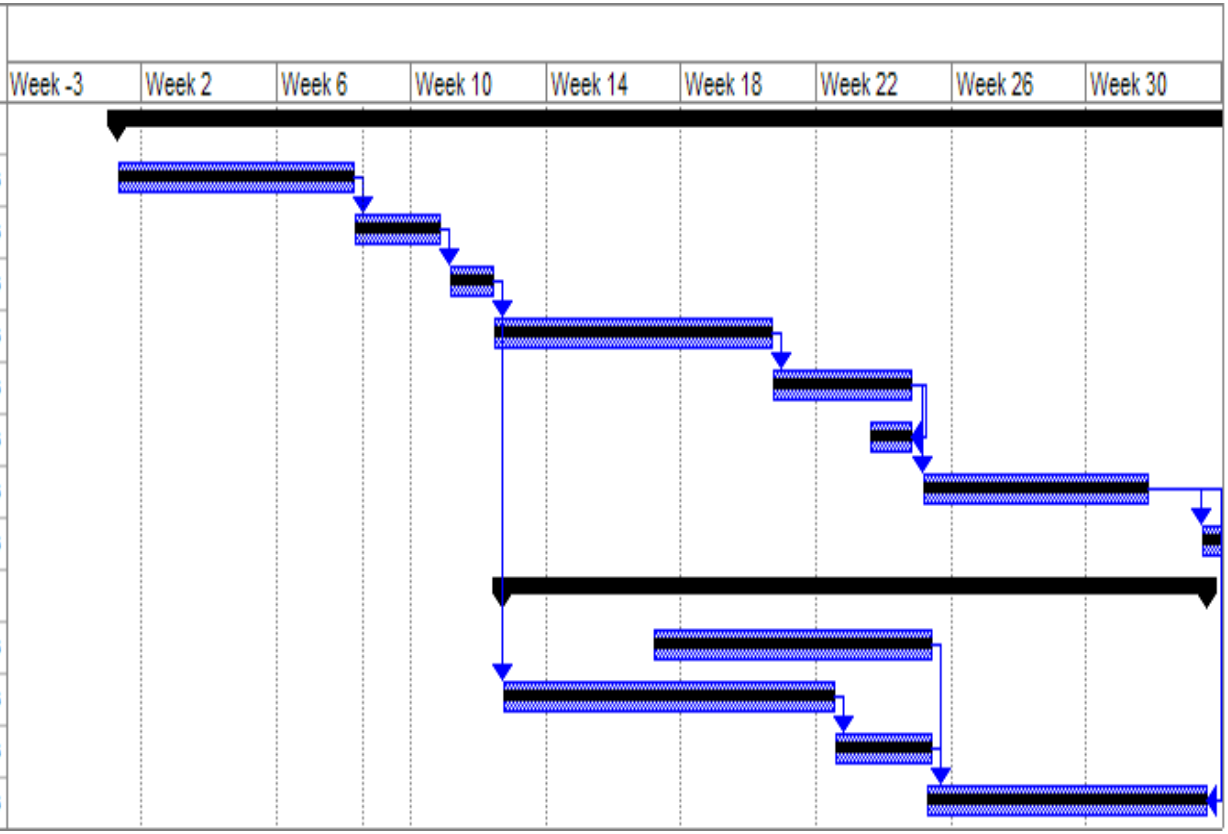
As Planned Schedule
(Sample Project)

ID	Task Name	Duration	Total Slack
1	**House**	**112 days**	**0 days**
2	Excavation	14 days	0 days
3	Foundation	14 days	0 days
4	Joining Wall	7 days	0 days
5	House Walls	28 days	0 days
6	House Roof	21 days	0 days
7	Select Finishes	7 days	77 days
8	Interior Finishes	21 days	0 days
9	Clean-up	7 days	0 days
10	**Garage**	**84 days**	**28 days**
11	Fab/Del Garage Doors	42 days	70 days
12	Garage Walls	21 days	28 days
13	Garage Roof	14 days	28 days
14	Garage Doors	14 days	28 days



As Built Schedule
(Sample Project)

ID	Task Name	Baseline Duration	Duration
1	**House**	**112 days**	**168 days**
2	Excavation	14 days	35 days
3	Foundation	14 days	14 days
4	Joining Wall	7 days	7 days
5	House Walls	28 days	42 days
6	House Roof	21 days	21 days
7	Select Finishes	7 days	7 days
8	Interior Finishes	21 days	35 days
9	Clean-up	7 days	7 days
10	**Garage**	**105 days**	**104 days**
11	Fab/Del Garage Doors	42 days	42 days
12	Garage Walls	21 days	49 days
13	Garage Roof	14 days	14 days
14	Garage Doors	14 days	42 days

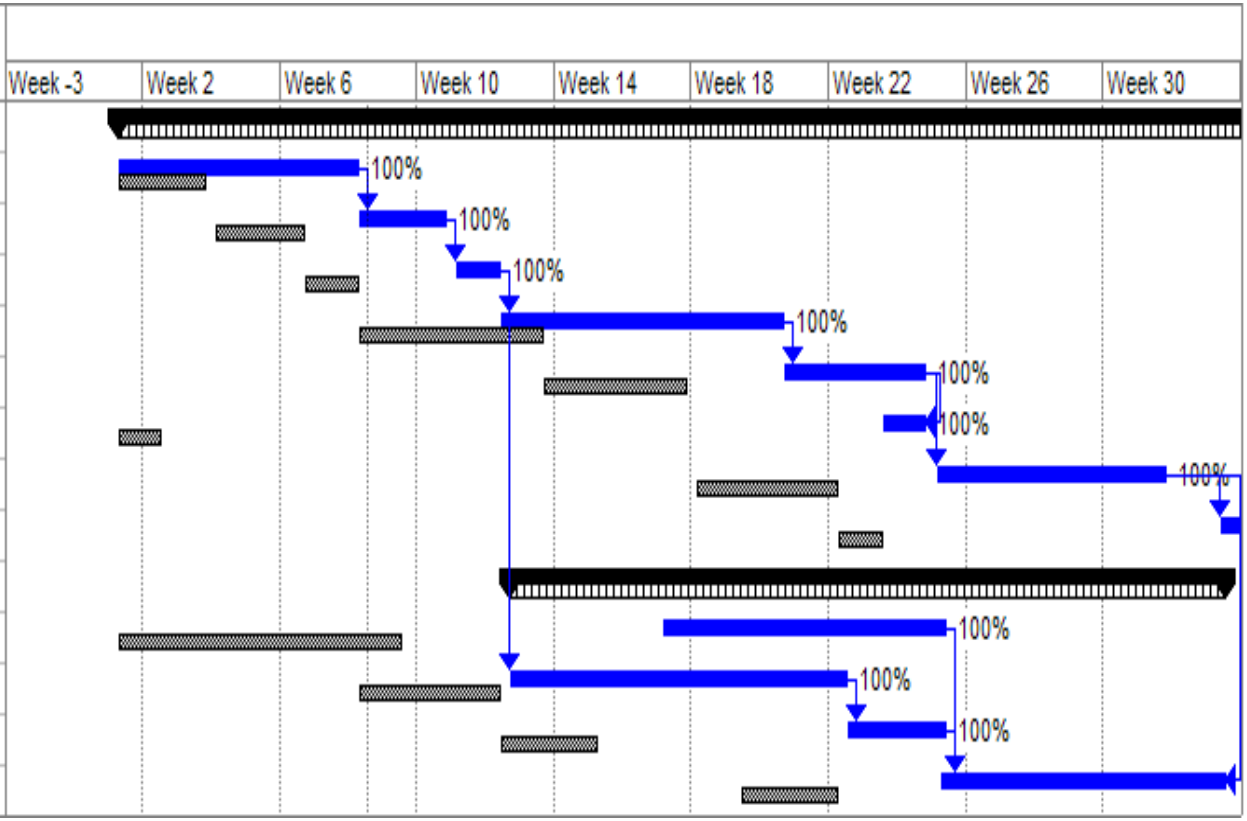


Schedule Analysis Methods

1. As Planned versus As Built Comparison
2. The Impacted As Planned Method
3. Collapsed (But for) As Built Method
4. Contemporaneous Period (Windows) Analysis

As Planned versus As Built Comparison

ID	Task Name	Baseline Duration	Duration
1	**House**	**112 days**	**168 days**
2	Excavation	14 days	35 days
3	Foundation	14 days	14 days
4	Joining Wall	7 days	7 days
5	House Walls	28 days	42 days
6	House Roof	21 days	21 days
7	Select Finishes	7 days	7 days
8	Interior Finishes	21 days	35 days
9	Clean-up	7 days	7 days
10	**Garage**	**105 days**	**104 days**
11	Fab/Del Garage Doors	42 days	42 days
12	Garage Walls	21 days	49 days
13	Garage Roof	14 days	14 days
14	Garage Doors	14 days	42 days



As Planned versus As Built Comparison

Benefits:

- Simple to Prepare:

  168 actual days – 112 planned days = 56 delay days

Shortcomings:

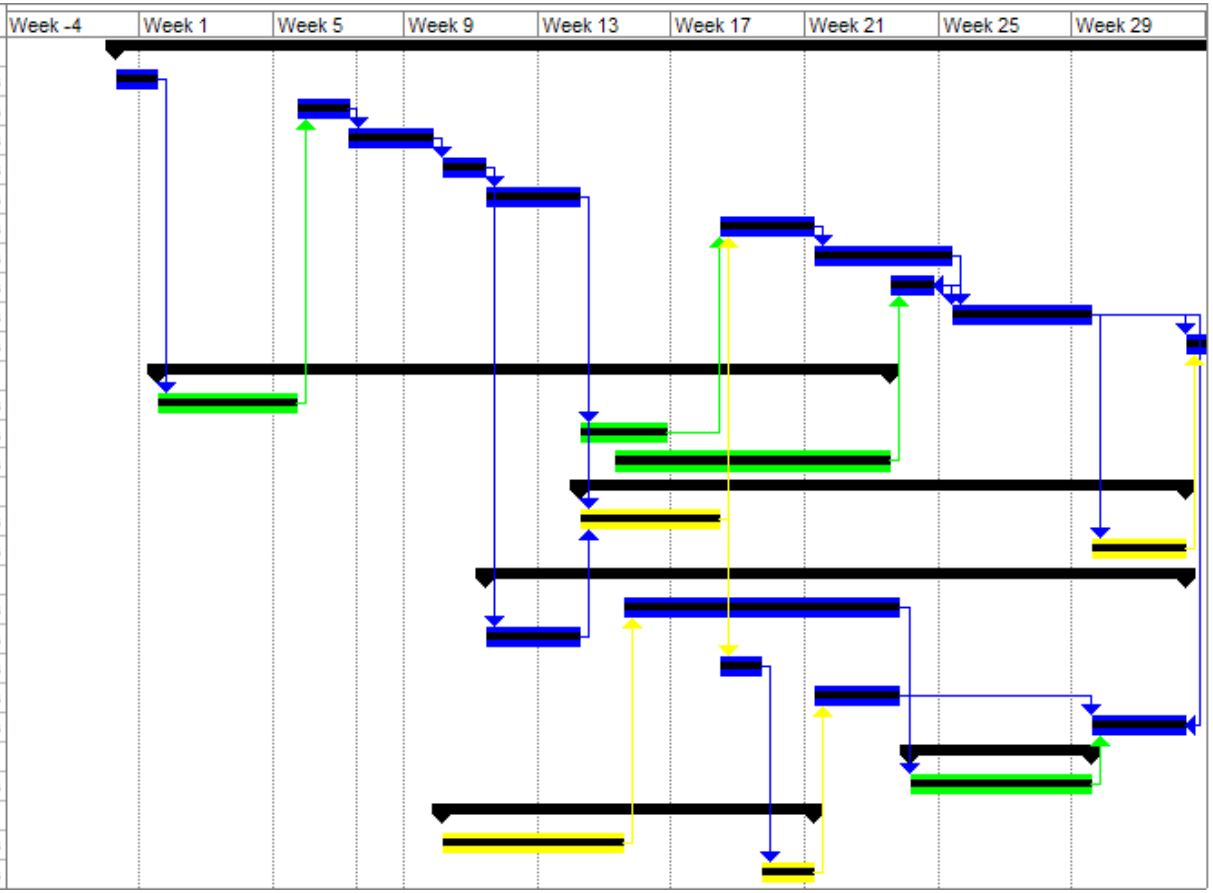
- No information on particular delay events;
- Similar to “Total Cost” approach

Impacted As Planned Method

- Begin with As Planned Schedule
- Add Owner or Contractor Delays
- Compute Owner caused delay and Contractor caused delay

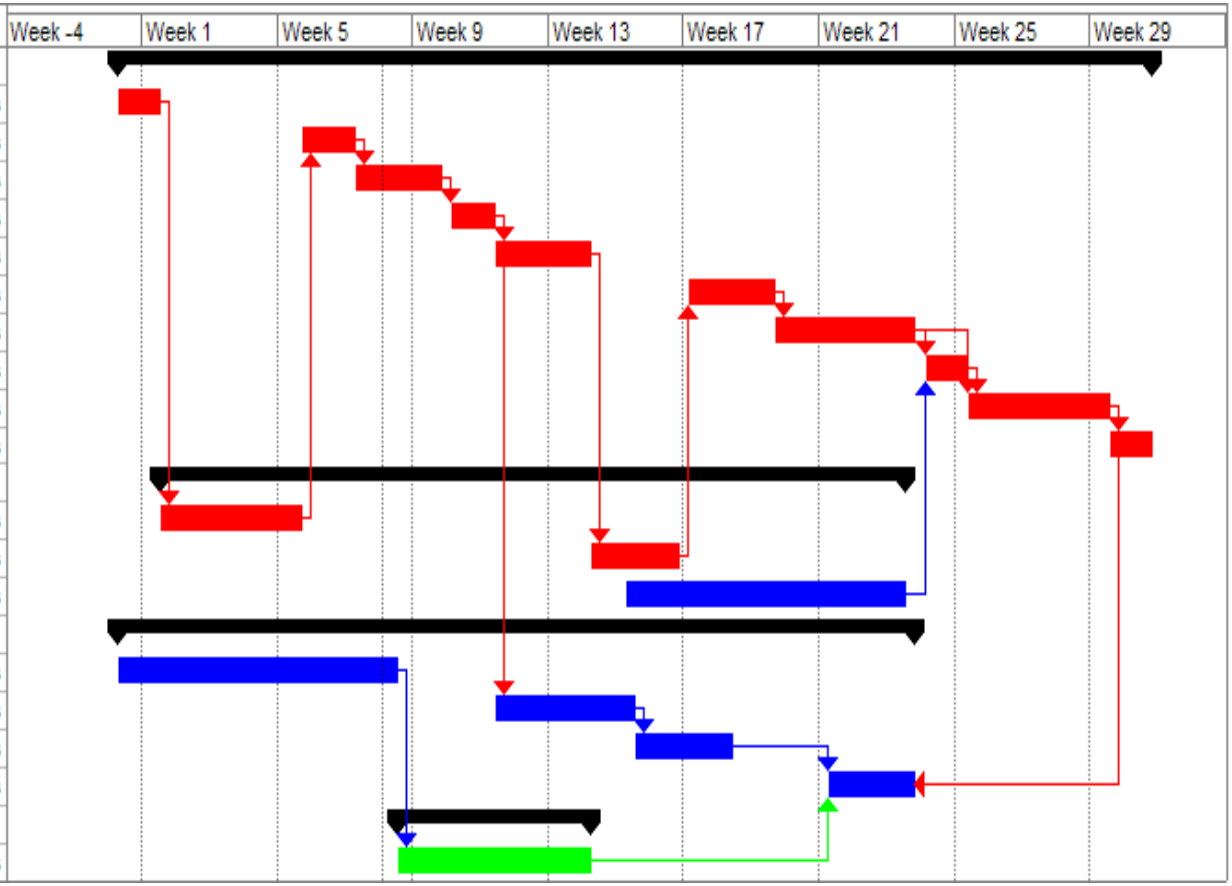
As Built with Delays

ID	Task Name	Duration	Total Slack
1	**House**	**168 days**	**0 days**
2	Excavation	7 days	0 days
3	Excavation	7 days	0 days
4	Foundation	14 days	0 days
5	Joining Wall	7 days	0 days
6	House Walls	14 days	0 days
7	House Walls	14 days	0 days
8	House Roof	21 days	0 days
9	Select Finishes	7 days	0 days
10	Interior Finishes	21 days	0 days
11	Clean-up	7 days	0 days
12	**Owner Delay**	**110 days**	**0 days**
13	Excavation Delay	21 days	0 days
14	Design Changes	14 days	0 days
15	Late selection of finishes	42 days	0 days
16	**Contractor Delay**	**91 days**	**0 days**
17	Replace subcontractor	21 days	0 days
18	Interior Finishes Delay	14 days	0 days
19	**Garage**	**105 days**	**0 days**
20	Fab/Del Garage Doors	42 days	0 days
21	Garage Walls	14 days	0 days
22	Garage Walls	7 days	0 days
23	Garage Roof	14 days	0 days
24	Garage Doors	14 days	0 days
25	**Owner Delay**	**28 days**	**0 days**
26	Garage Door Change	28 days	0 days
27	**Contractor Delay**	**56 days**	**0 days**
28	Late Garage Door Order	28 days	0 days
29	Garage Walls Delay	7 days	0 days



As Planned with Owner Delays

ID	Task Name	Duration	Total Slack
1	**House**	**154 days**	**0 days**
2	Excavation	7 days	0 days
3	Excavation	7 days	0 days
4	Foundation	14 days	0 days
5	Joining Wall	7 days	0 days
6	House Walls	14 days	0 days
7	House Walls	14 days	0 days
8	House Roof	21 days	0 days
9	Select Finishes	7 days	0 days
10	Interior Finishes	21 days	0 days
11	Clean-up	7 days	0 days
12	**Owner Delay**	**110 days**	**0 days**
13	Excavation Delay	21 days	0 days
14	Design Changes	14 days	0 days
15	Late selection of finishes	42 days	2 days
16	**Garage**	**119 days**	**35 days**
17	Fab/Del Garage Doors	42 days	70 days
18	Garage Walls	21 days	49 days
19	Garage Roof	14 days	49 days
20	Garage Doors	14 days	35 days
21	**Owner Delay**	**28 days**	**70 days**
22	Garage Door Change	28 days	70 days



As Planned with Owner Delays

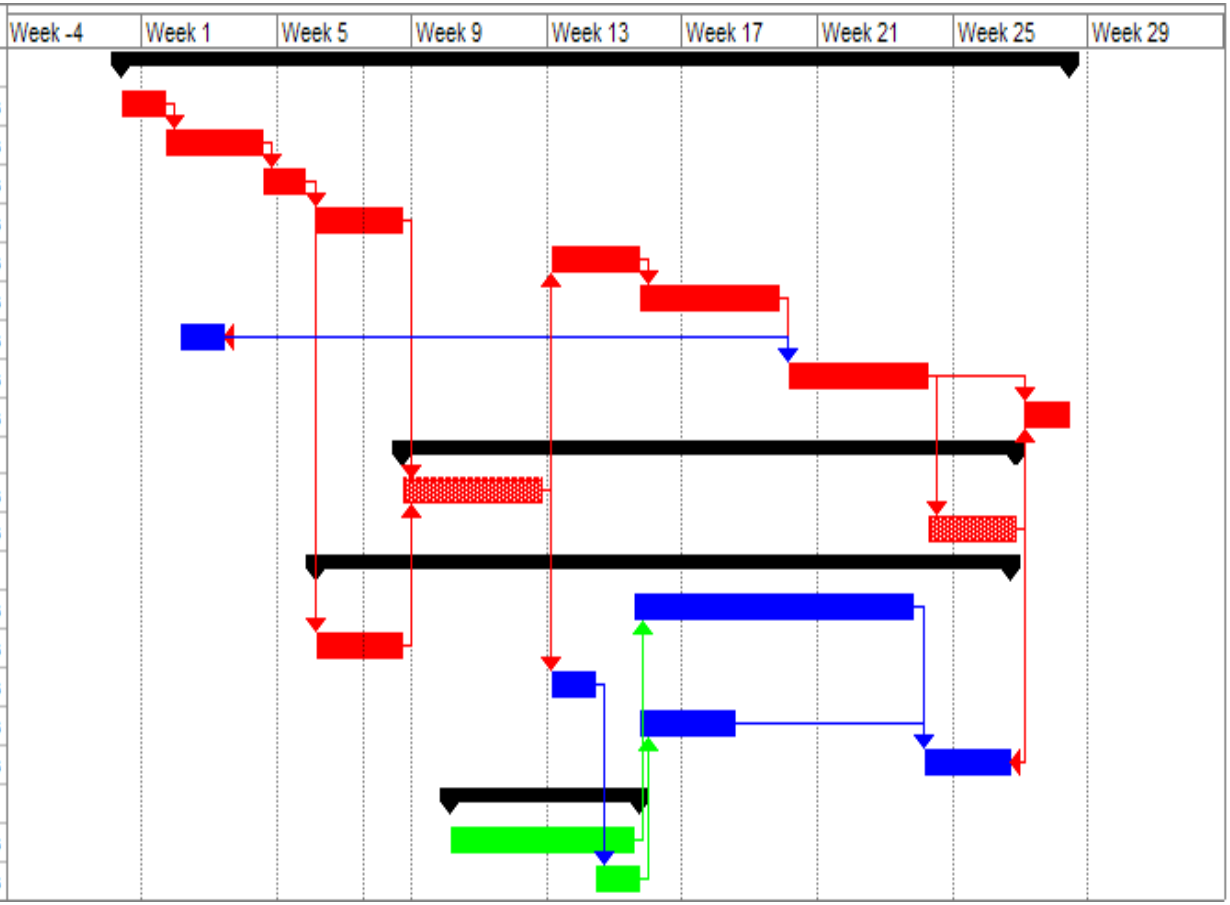
- Total duration of As Built = 168 days
- Total duration of As Planned with Owner Delays = 154 days
- Total duration of original As Planned = 112 days
- The Owner is responsible for the difference between impacted and the original as planned:

  154 – 112 = 42 days
- Contractor is responsible for the remaining difference:

  168 – 154 = 14 days

As Planned with Contractor Delays

ID	Task Name	Duration	Total Slack
1	**House**	**140 days**	**0 days**
2	Excavation	7 days	0 days
3	Foundation	14 days	0 days
4	Joining Wall	7 days	0 days
5	House Walls	14 days	0 days
6	House Walls	14 days	0 days
7	House Roof	21 days	0 days
8	Select Finishes	7 days	83 days
9	Interior Finishes	21 days	0 days
10	Clean-up	7 days	0 days
11	**Contractor Delays**	**91 days**	**0 days**
12	Replace Subcontractor	21 days	0 days
13	Interior Finishes Delay	14 days	0 days
14	**Garage**	**104 days**	**0 days**
15	Fab/Del Garage Doors	42 days	8 days
16	Garage Walls	14 days	0 days
17	Garage Walls	7 days	35 days
18	Garage Roof	14 days	35 days
19	Garage Doors	14 days	8 days
20	**Contractor Delay**	**29 days**	**8 days**
21	Late Garage Door Order	28 days	8 days
22	Garage Walls Delay	7 days	35 days



As Planned with Contractor Delays

- Total duration of As Built = 168 days
- Total duration of As Planned with Contractor Delays = 140 days
- Total duration of original As Planned = 112 days
- The Contractor is responsible for the difference between impacted and the original as planned:

  140 – 112 = 28 days
- The Owner is responsible for the remaining difference:

  168 – 140 = 28 days

As Planned Method Discussion

Benefits:

- Relatively simple to implement
- Allows for mitigation of delays

Shortcomings:

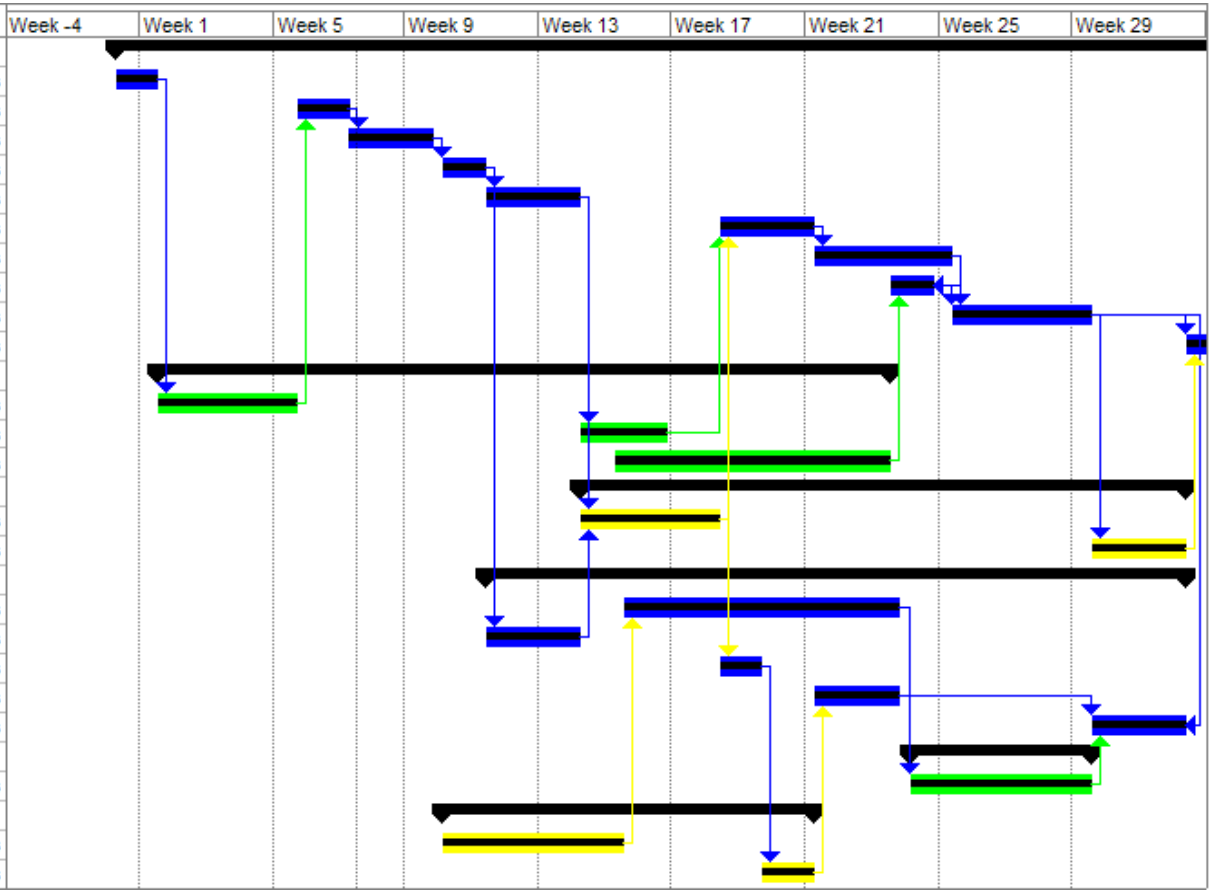
- Highly subjective
- Assumes as-planned (baseline) logic holds.

Collapsed (But For) As Built Method

- Begin with As Built Schedule, including;
- Owner and Contractor Delays.
- Remove Owner (Contractor) caused delays.
- Resulting schedule shows when Contractor (Owner) would have finished “but for” Owner (Contractor) delays.

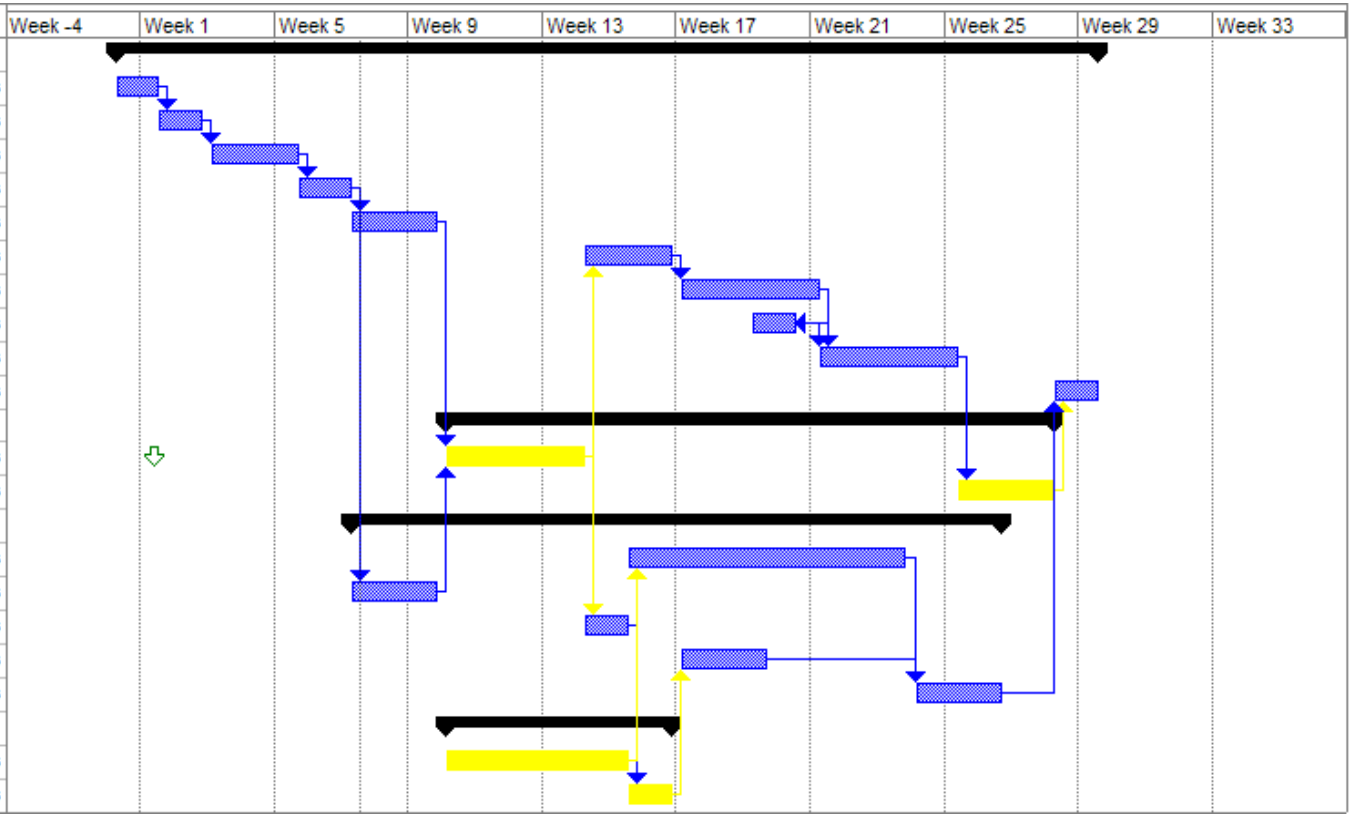
As Built with Delays

ID	Task Name	Duration	Total Slack
1	**House**	**168 days**	**0 days**
2	Excavation	7 days	0 days
3	Excavation	7 days	0 days
4	Foundation	14 days	0 days
5	Joining Wall	7 days	0 days
6	House Walls	14 days	0 days
7	House Walls	14 days	0 days
8	House Roof	21 days	0 days
9	Select Finishes	7 days	0 days
10	Interior Finishes	21 days	0 days
11	Clean-up	7 days	0 days
12	**Owner Delay**	**110 days**	**0 days**
13	Excavation Delay	21 days	0 days
14	Design Changes	14 days	0 days
15	Late selection of finishes	42 days	0 days
16	**Contractor Delay**	**91 days**	**0 days**
17	Replace subcontractor	21 days	0 days
18	Interior Finishes Delay	14 days	0 days
19	**Garage**	**105 days**	**0 days**
20	Fab/Del Garage Doors	42 days	0 days
21	Garage Walls	14 days	0 days
22	Garage Walls	7 days	0 days
23	Garage Roof	14 days	0 days
24	Garage Doors	14 days	0 days
25	**Owner Delay**	**28 days**	**0 days**
26	Garage Door Change	28 days	0 days
27	**Contractor Delay**	**56 days**	**0 days**
28	Late Garage Door Order	28 days	0 days
29	Garage Walls Delay	7 days	0 days



Collapsed As Built without (but for) Owner Delays

ID	Task Name	Duration
1	**House**	**147 days**
2	Excavation	7 days
3	Excavation	7 days
4	Foundation	14 days
5	Joining Wall	7 days
6	House Walls	14 days
7	House Walls	14 days
8	House Roof	21 days
9	Select Finishes	7 days
10	Interior Finishes	21 days
11	Clean-up	7 days
12	**Contractor Delay**	**91 days**
13	Replace subcontractor	21 days
14	Interior Finishes Delay	14 days
15	**Garage**	**98 days**
16	Fab/Del Garage Doors	42 days
17	Garage Walls	14 days
18	Garage Walls	7 days
19	Garage Roof	14 days
20	Garage Door	14 days
21	**Contractor Delay**	**35 days**
22	Late Garage Door Order	28 days
23	Garage Walls Delay	7 days



Collapsed As Built without (but for) Owner Delays

- Total duration of As Built = 168 days
- Total duration of Collapsed As Built without Owner's Delays = 147 days
- Total duration of original As Planned = 112 days
- The Owner is responsible for the difference between collapsed as built and the as built schedules:

  168 – 147 = 21 days
- The Contractor is responsible for the remaining difference between collapsed as built and as planned:

  147 – 112 = 35 days

Collapsed As Built Discussion

Benefits:

- Very good accuracy

Shortcomings:

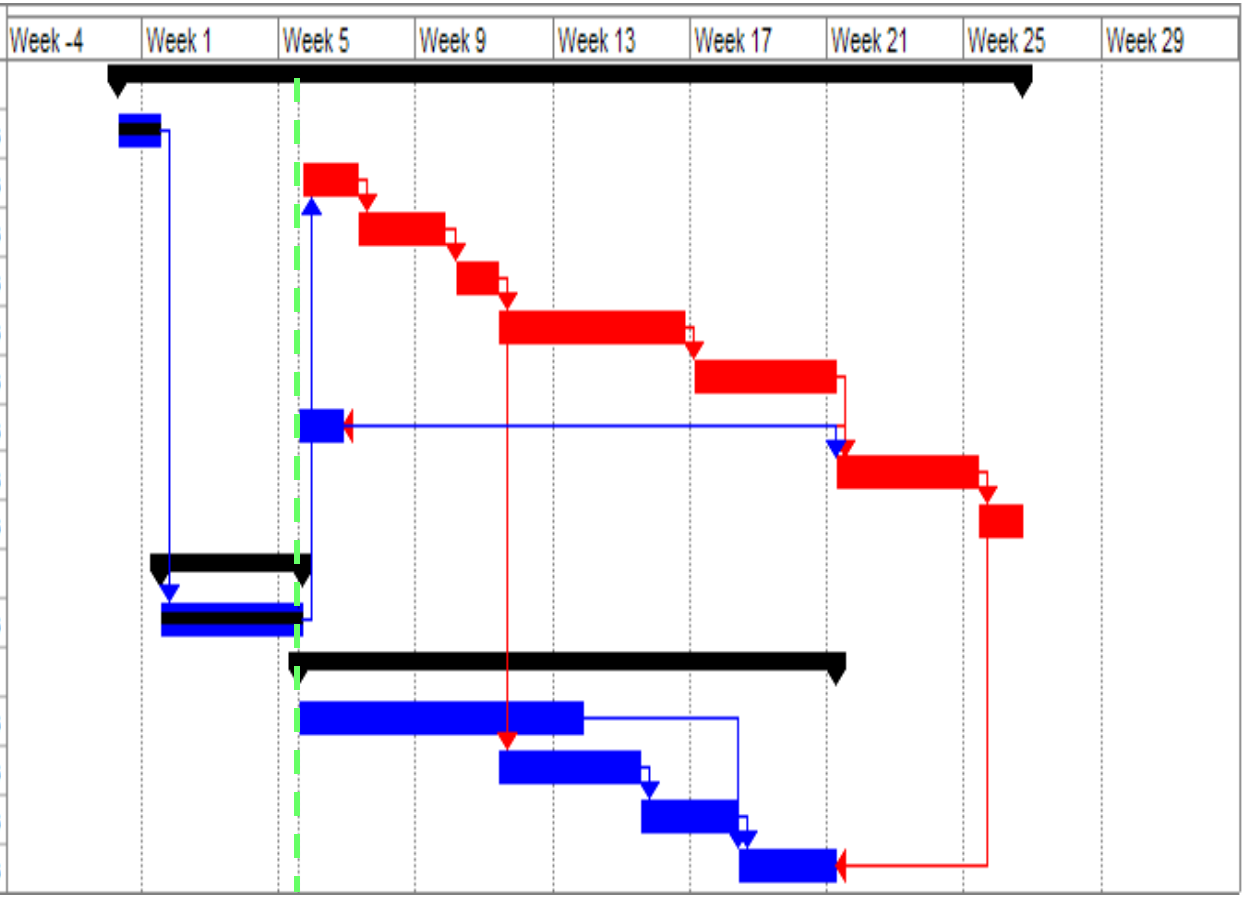
- No allowance for mitigation of delays

Contemporaneous Period Analysis (Windows)

- Begin with As Planned Schedule;
- Select periods (windows) to analyze;
- Enter actual progress and delay activities using contemporaneous project documents;
- Calculate the schedule;
- Repeat the process for the next window

CPA Method – Window 1

ID	Task Name	Duration	Total Slack
1	**House**	**133 days**	**0 days**
2	Excavation	7 days	0 days
3	Excavation	7 days	0 days
4	Foundation	14 days	0 days
5	Joining Wall	7 days	0 days
6	House Walls	28 days	0 days
7	House Roof	21 days	0 days
8	Select Finishes	7 days	71 days
9	Interior Finishes	21 days	0 days
10	Clean-up	7 days	0 days
11	**Owner Delay**	**21 days**	**0 days**
12	Excavation Delay	21 days	0 days
13	**Garage**	**78 days**	**28 days**
14	Fab/Del Garage Doors	42 days	50 days
15	Garage Walls	21 days	28 days
16	Garage Roof	14 days	28 days
17	Garage Doors	14 days	28 days



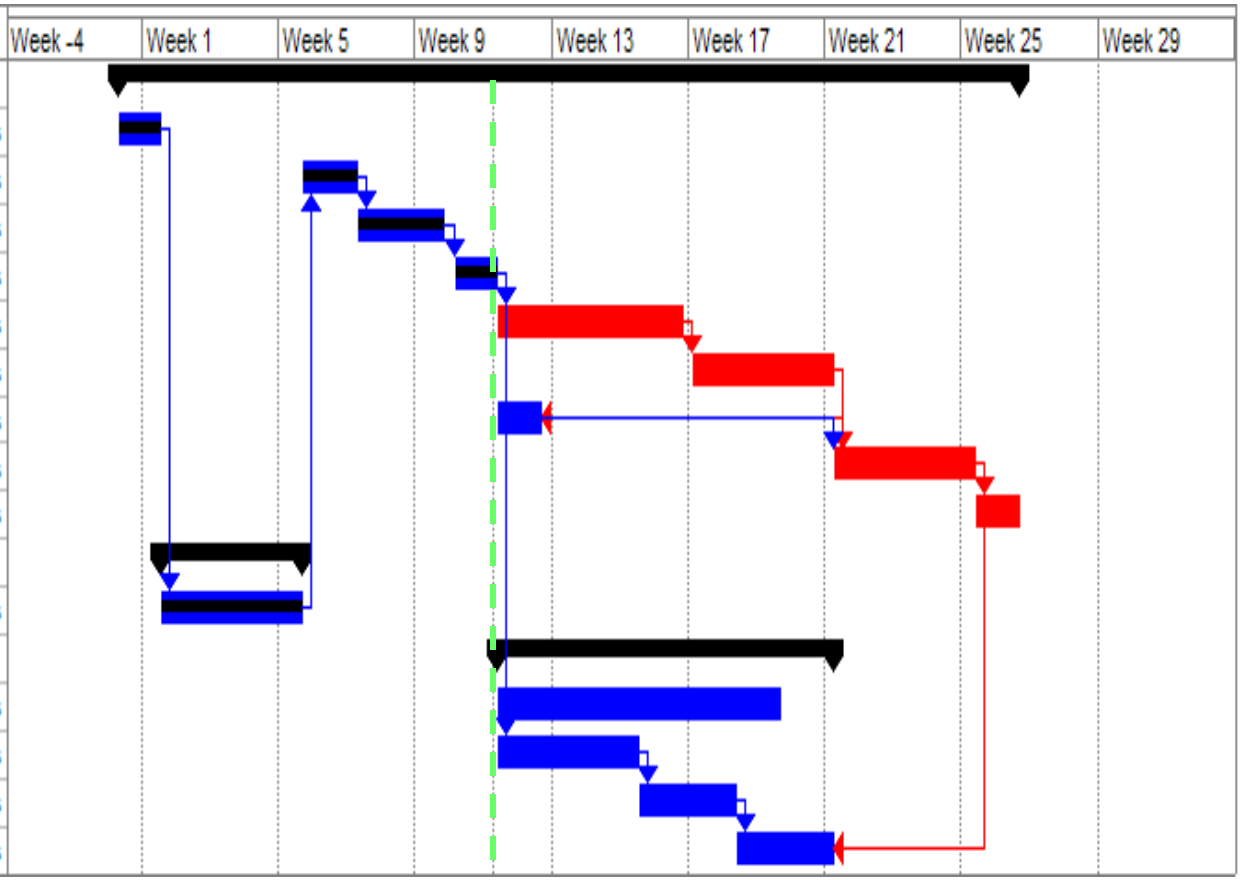
CPA Method – Window 1

Update Number	Schedule Date (Week No.)	Project Completion (days)	Delay During Period	Delays			Comments
				Non Excusable	Excusable Noncompensable	Excusable Compensable	
0	0	112	0	0	0	0	
1	4	133	21	0	0	21	Unforseen site condition

- The first update is compared to the original schedule.
- Delays in that period are analyzed using “but for” method.
- The first update becomes the new baseline for subsequent window.
- Evaluation of non-excusable, compensable and non-compensable delays performed at each update

CPA Method – Window 2

ID	Task Name	Duration	Total Slack
1	**House**	**133 days**	**0 days**
2	Excavation	7 days	0 days
3	Excavation	7 days	0 days
4	Foundation	14 days	0 days
5	Joining Wall	7 days	0 days
6	House Walls	28 days	0 days
7	House Roof	21 days	0 days
8	Select Finishes	7 days	42 days
9	Interior Finishes	21 days	0 days
10	Clean-up	7 days	0 days
11	**Owner Delay**	**21 days**	**0 days**
12	Excavation Delay	21 days	0 days
13	**Garage**	**49 days**	**28 days**
14	Fab/Del Garage Doors	42 days	35 days
15	Garage Walls	21 days	28 days
16	Garage Roof	14 days	28 days
17	Garage Doors	14 days	28 days



CPA Method – Window 2

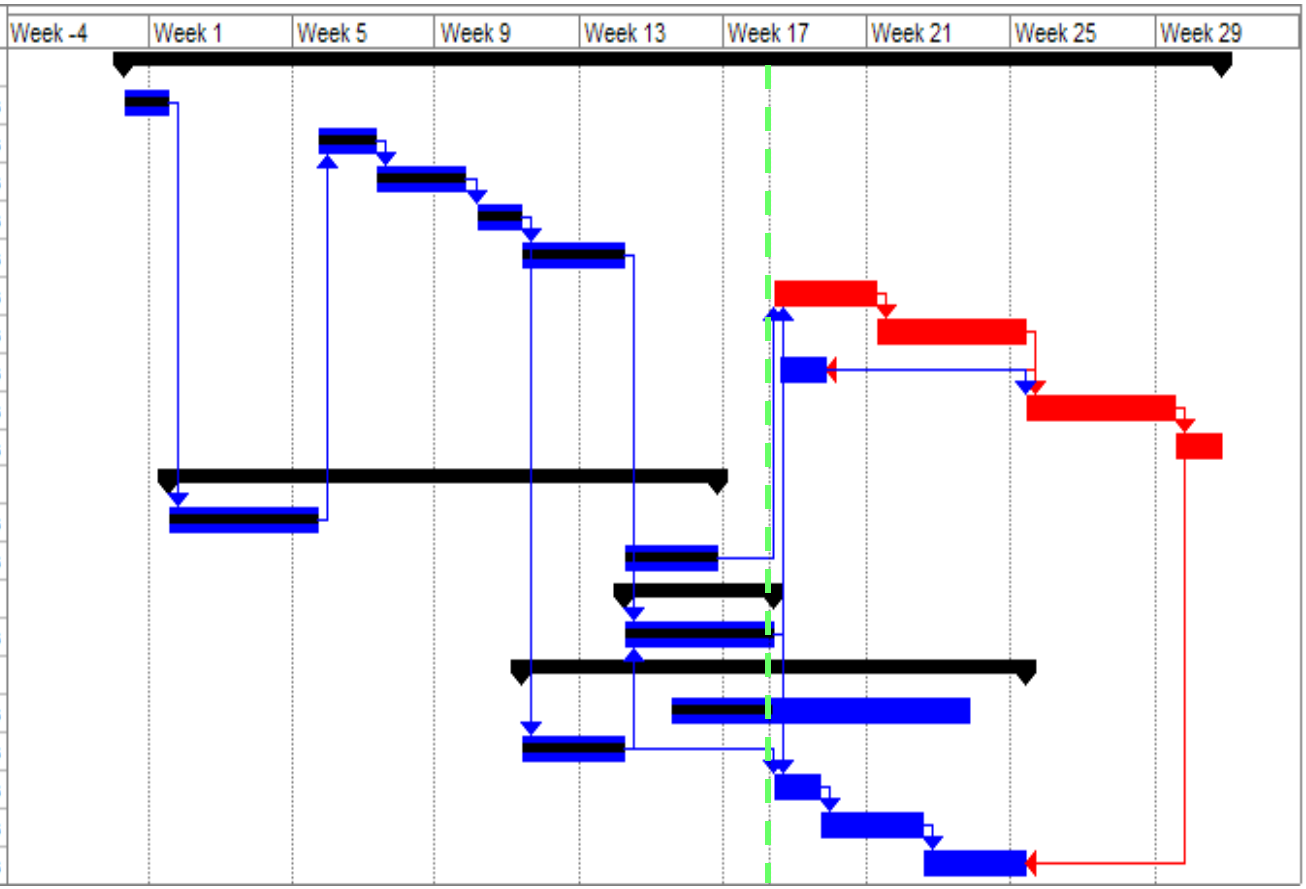
Update Number	Schedule Date (Week No.)	Project Completion (days)	Delay During Period	Delays			Comments
				Non Excusable	Excusable Noncompensable	Excusable Compensable	
0	0	112	0	0	0	0	
1	4	133	21	0	0	21	Unforseen site condition
2	8	133	0	0	0	0	No delay

- No delays during 2nd window

- *Note activities that were supposed to start by now.*

CPA Method – Window 3

ID	Task Name	Duration
1	**House**	**154 days**
2	Excavation	7 days
3	Excavation	7 days
4	Foundation	14 days
5	Joining Wall	7 days
6	House Walls	14 days
7	House Walls	14 days
8	House Roof	21 days
9	Select Finishes	7 days
10	Interior Finishes	21 days
11	Clean-up	7 days
12	**Owner Delay**	**77 days**
13	Excavation Delay	21 days
14	Design Changes	14 days
15	**Contractor Delay**	**21 days**
16	Replace subcontractor	21 days
17	**Garage**	**70 days**
18	Fab/Del Garage Doors	42 days
19	Garage Walls	14 days
20	Garage Walls	7 days
21	Garage Roof	14 days
22	Garage Doors	14 days



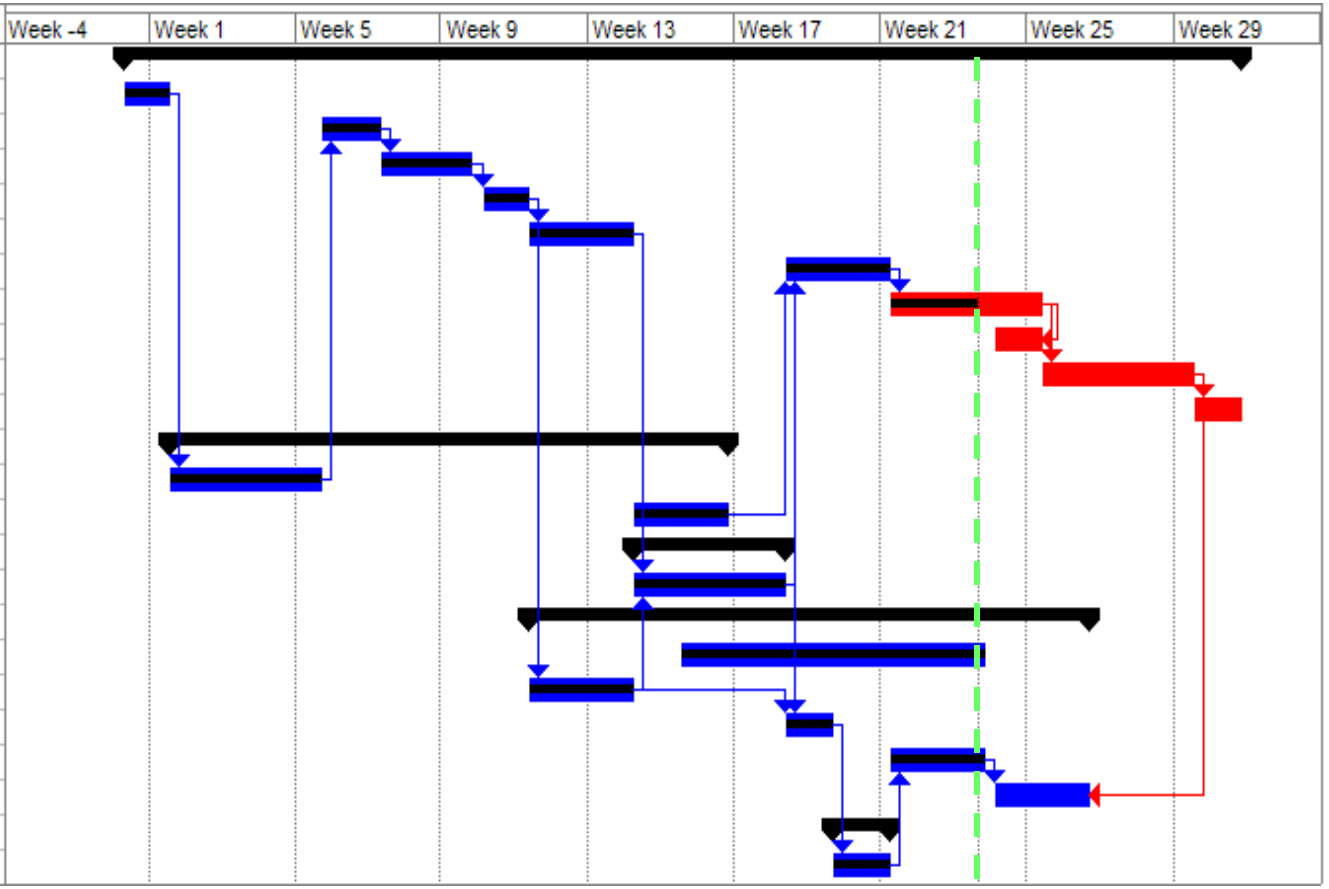
CPA Method – Window 3

Update Number	Schedule Date (Week No.)	Project Completion (days)	Delay During Period	Delays			Comments
				Non Excusable	Excusable Noncompensable	Excusable Compensable	
0	0	112	0	0	0	0	
1	4	133	21	0	0	21	Unforseen site condition
2	8	133	0	0	0	0	No delay
3	12	154	21	7	14	0	Subcontractor left job; Owner changed window design

- Two overlapping delays
- 2 weeks charged to concurrent delay (excusable and non-compensable)
- 1 week charged to contractor (non-excusable)

CPA Method – Window 4

ID	Task Name	Duration
1	**House**	**154 days**
2	Excavation	7 days
3	Excavation	7 days
4	Foundation	14 days
5	Joining Wall	7 days
6	House Walls	14 days
7	House Walls	14 days
8	House Roof	21 days
9	Select Finishes	7 days
10	Interior Finishes	21 days
11	Clean-up	7 days
12	**Owner Delay**	**77 days**
13	Excavation Delay	21 days
14	Design Changes	14 days
15	**Contractor Delay**	**21 days**
16	Replace subcontractor	21 days
17	**Garage**	**77 days**
18	Fab/Del Garage Doors	42 days
19	Garage Walls	14 days
20	Garage Walls	7 days
21	Garage Roof	14 days
22	Garage Doors	14 days
23	**Contractor Delay**	**7 days**
24	Garage Walls Delay	7 days



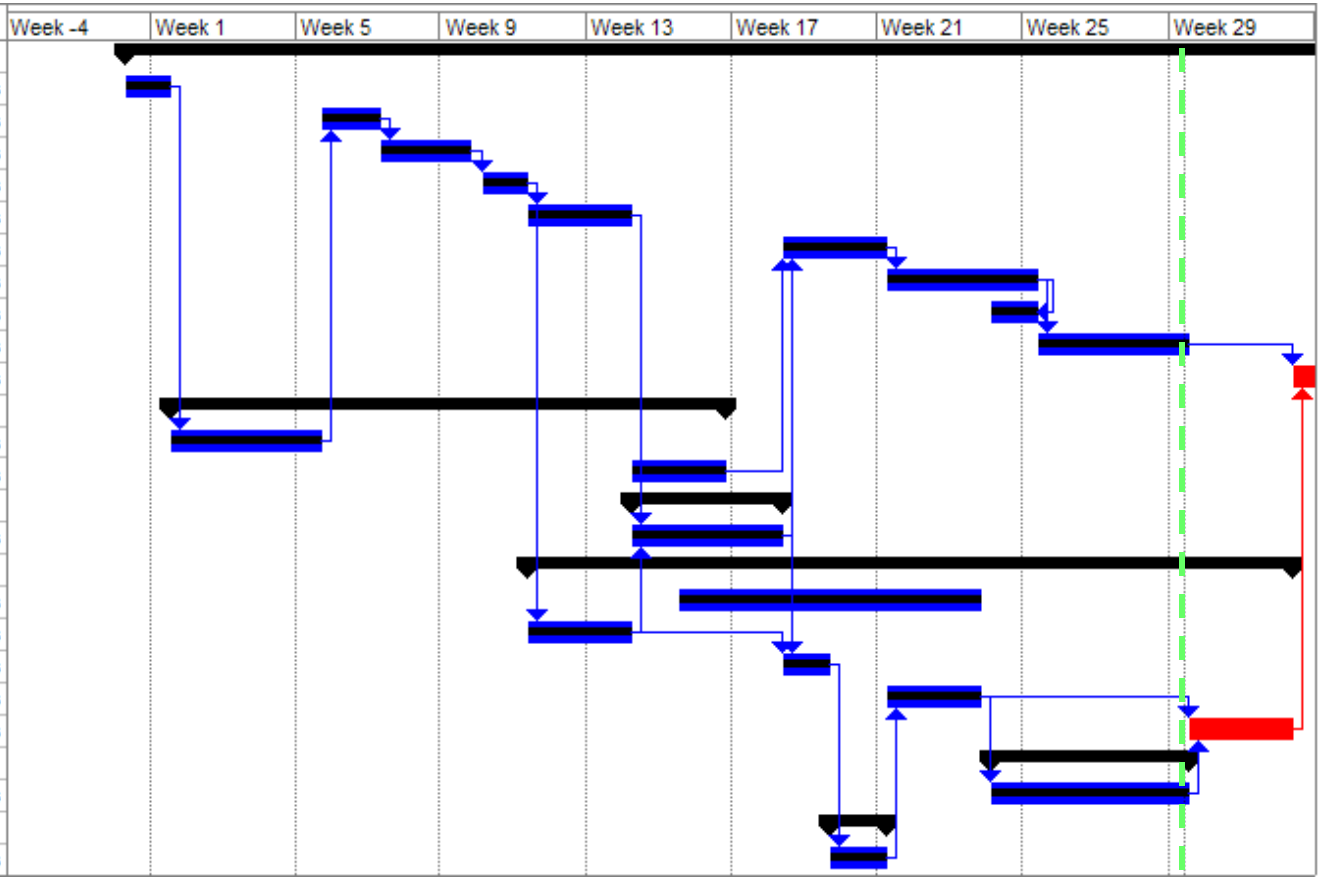
CPA Method – Window 4

Update Number	Schedule Date (Week No.)	Project Completion (days)	Delay During Period	Delays			Comments
				Non Excusable	Excusable Noncompensable	Excusable Compensable	
0	0	112	0	0	0	0	
1	4	133	21	0	0	21	Unforseen site condition
2	8	133	0	0	0	0	No delay
3	12	154	21	7	14	0	Subcontractor left job; Owner changed window design
4	16	154	0	0	0	0	Garage walls delay; not on critical path.

- Contractor-caused delay not on critical path.
- As long as the delay is within available float there is no effect on the final completion date.

CPA Method – Window 5

ID	Task Name	Duration
1	**House**	**168 days**
2	Excavation	7 days
3	Excavation	7 days
4	Foundation	14 days
5	Joining Wall	7 days
6	House Walls	14 days
7	House Walls	14 days
8	House Roof	21 days
9	Select Finishes	7 days
10	Interior Finishes	21 days
11	Clean-up	7 days
12	**Owner Delay**	**77 days**
13	Excavation Delay	21 days
14	Design Changes	14 days
15	**Contractor Delay**	**21 days**
16	Replace subcontractor	21 days
17	**Garage**	**105 days**
18	Fab/Del Garage Doors	42 days
19	Garage Walls	14 days
20	Garage Walls	7 days
21	Garage Roof	14 days
22	Garage Doors	14 days
23	**Owner Delay**	**28 days**
24	Revise Garage Door	28 days
25	**Contractor Delay**	**7 days**
26	Garage Walls Delay	7 days



CPA Method – Window 5

Update Number	Schedule Date (Week No.)	Project Completion (days)	Delay During Period	Delays			Comments
				Non Excusable	Excusable Noncompensable	Excusable Compensable	
0	0	112	0	0	0	0	
1	4	133	21	0	0	21	Unforseen site condition
2	8	133	0	0	0	0	No delay
3	12	154	21	7	14	0	Subcontractor left job; Owner changed window design
4	16	154	0	0	0	0	Garage walls delay; not on critical path.
5	20	168	14	0	0	14	Owner's revision to Garage doors
TOTALS			56	7	14	35	

- Owner's delay of 4 weeks in Garage door revision.
- Net change to the project is only 2 weeks; other 2 weeks absorbed by available float.

Contemporaneous Period Analysis (Windows) Discussion

Benefits:

- Most accurate results
- Considers dynamic nature of the critical path

Shortcomings

- Time consuming
- Costly to prepare

Comparison of Results

Method	Delays		
	Non Excusable	Excusable Noncompensable	Excusable Compensable
Comparison Method (Total Time) [1]	56 (0)		0 (56)
Impacted As-Planned (Owner Delays)	14		42
Impacted As-Planned (Contractor Delays)	28		28
Collapsed As-Built (But For)	35		21
Contemporaneous Period (Windows) Analysis	7	14	35

1. *Schedule comparison itself does not indicate which party is responsible for the delay.*

Method Selection Criteria

METHOD	Data Required	Effort/Cost	Accuracy Expected
Comparison Method (Total Time)	Low	$	Poor
Impacted As-Planned (Owner Delays)	Moderate	$$	Good
Impacted As-Planned (Contractor Delays)	Moderate	$$	Good
Collapsed As-Built (But For)	Above Moderate	$$$	Very Good
Contemporaneous Period (Windows) Analysis	Extensive	$$$$$	Excellent