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EXECUTE AS PLANNED

Predicting & Accounting for Weather Impacts on Construction Projects

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PRIMAVERA®

Purpose

- Demonstrate a technique to more accurately reflect the impact weather may have on your construction project when you are planning the project
- Demonstrate how to properly account for the impact of adverse weather and seasonal differences

The Problem

- Contractors intuitively know that you can do more work during the summer months than winter months
- The problem has been convincing owners, mediators, arbitrators, and the courts that you can measure this difference using something better than a Ouija Board

The Problem

- Weather Impacts Construction
- Impact most noticeable on
  - Heavy / Highway
  - Site Work
  - Utilities
  - Industrial

Activities Affected Differently

- Not all activities are affected to the same extent on the same job
  - Earthwork vs. Paving
  - Hanging Steel vs. Electrical Rough-In
  - Painting vs. Landscaping

The Problem

- Work delayed for whatever reason pushed from one season into another season will be impacted
- Favorably – (winter into summer)
- Unfavorably – (summer into winter)
  - Exceptions noted (ice roads / offshore seasons for platforms & pipelines)

The Problem

- Time allowed for projects seems to be decreasing despite increasing size and complexity of projects
- Increasing preference for Calendar Day contracts instead of Working Days
- Shifting of weather risk from Owner or Project to the Contractor

The Problem

- All months are not created equally
- A day of work planned for one calendar day in August could be equivalent to three calendar days in February

Typical Contract Language

"*No delay for weather shall be considered, except that for unusually severe weather.*"

So what is "Unusually Severe"?

Typical Contract Language

Common for owners to include a chart and note similar to the ones below on calendar day jobs:

"Contractor should anticipate normal inclement weather historically and plan their work to complete the project within the contract time. The average number of days with measurable precipitation are provided for the contractor's information only."

Average Days of Precipitation											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
7	8	5	3	4	3	2	2	6	4	6	8

Weather is Predictable

- A review of historical information over many years provides evidence that weather can be predicted within a range that is acceptable for planning purposes

Data Available

- NOAA Weather Records
  - Stations all across the nation
  - Annual, Monthly, Daily, and even Hourly records are available for almost every station
  - Records go back for years
  - Data available for most stations back to at least WW-II, some for more than 100 years

NOAA Data

- Weather Observations
  - Temperature
  - Cloud Cover
  - Precipitation
  - Wind

NOAA Data

- Sunrise / Sunset (hours of daylight available)
- Cloud Cover
- % of Sunshine

Other Data Available

- State DOT (work days by month)
- Local AGC office (rain days)
- Airport records (wind & rain)
- State Meteorologist
- US Dept of Agriculture
- State departments of agriculture
- Parks & Wildlife / Game & Fish Records

Other Data Available

- Your Own Company's History of Days and Hours Worked by Month

Examples of Data

- Simplest form on the internet is a recap from NOAA
- Gives you the bare bones information
- Limited value
- It's FREE!

Houston, Texas View in: U.S. | Metric

Month	Avg. High	Avg. Low	Record High	Record Low	Avg. Precip.	Rain/Snow Days
January	61°	40°	84°	12°	3.29 in.	10 days
February	65°	43°	91°	20°	2.96 in.	8 days
March	71°	50°	91°	22°	2.92 in.	9 days
April	78°	58°	95°	31°	3.21 in.	7 days
May	85°	64°	99°	44°	5.24 in.	8 days
June	90°	71°	103°	52°	4.96 in.	9 days
July	93°	72°	104°	62°	3.60 in.	9 days
August	93°	72°	107°	60°	3.49 in.	9 days
September	88°	68°	109°	48°	4.89 in.	9 days
October	82°	58°	96°	29°	4.27 in.	8 days
November	72°	50°	89°	19°	3.79 in.	8 days
December	65°	42°	85°	7°	3.45 in.	9 days

Choose another city *Source: National Climate Data Center*

Averages are computed from data recorded during the period 1961-1990. Records are through 2000.

Find a City [ ] go U.S. States [select one]

Enter a city or select a state to find weather conditions for over 1,000 cities.

LOCAL WEATHER | NATIONAL OUTLOOK
SATELLITE & RADAR MAPS | AVERAGES & RECORDS

NOAA

- Year in Review
- NOAA summarizes highlights of the year
- Good for dramatic deviations from the norm
- Hurricanes / floods / etc.

1999 YEAR IN REVIEW

1999 started out with a bang! Several supercells roared across southeast Texas on New Years Day producing tornadoes across Walker and Trinity counties. Later New Years Night... a squall line moved across the area producing another round of gusty winds and very heavy rain. The remainder of the month was much warmer than normal...averaging 6 to 7 degrees above normal. The region was slightly drier than usual with rainfall totals about an inch below normal.

February was much warmer than normal with temperatures averaging 8 to 9 degrees above normal. Rainfall was 1 to 2 inches below normal. The only significant weather to occur during the month was a round of severe thunderstorms which developed on the 27th and produced large hail from Apple Springs to Edna.

The warmer than normal temperature trend continued in March as temperatures averaged around a degree warmer than normal. Rainfall was near or slightly above normal over the northern half of the area...but around a half inch below normal over the south. A series of thunderstorms moved across the northern half of the region through the 8th...12th and 19th. These storms produced gusty winds which blew trees down near Livingston...Magnolia and Sebastopol. Flooding occurred in southwest Houston on the 19th as 4 to 5 inches of rain fell in that area in a 4 hour period.

April was another in a string of unusually warm months. Stormy weather started and ended the month with a severe weather outbreak on both the 3rd and 26th. Severe flooding occurred in Polk county on the 3rd with as much as three feet of water covering parts of US Highway 59. Temperatures averaged 2 to 5 degrees above normal for the month.

May was again slightly warmer than normal and rainfall was very close to normal. The month was puntcuated by several episodes of severe weather. On May 10th...an early morning squall line ripped through southeast Texas. These storms produced wind gusts in excess of 60 mph and blew down trees...powerlines and billboards. On May 30th...a cluster of severe thunderstorms developed just south of Houston. These storms dumped very heavy rain and golf ball to baseball sized hail from the Houston area westward to Columbus. Temperatures averaged 0.5 to 2.0 degrees above normal across the region.

A surge of tropical moisture affected southeast Texas in June. Scattered showers and thunderstorms affected the region almost daily through the middle of the month. Some locally heavy rainfall totals were reported on the 15th including 4.50 inches in Dickinson and 4.14 inches in Pearland. More heavy rain fell on the 25th...especially over the eastern half of the region. 8 to 10 inches of rain fell over parts of Polk and Trinity counties and flooding was reported from Livingston to Galveston. The monthly rain total in Pearland was in excess of 13 inches. Despite the rainfall and increased cloud cover...monthly temperatures across the region were still above normal...averaging 1 to 2 degrees

NOAA

- Year in Summary
- Departures from Normal by month
- Supports claims for “excessive” rainfall type claims
- Still very basic, historic, minimal support for claim, no help for forecasting

and snow did not affect the region either. All in all...another very warm year with below normal rainfall.

Here is a monthly breakdown of climate data for Houston... Galveston and College Station. Temperature is in degrees Fahrenheit and rainfall is measured in inches.

Houston Intercontinental Airport

Month	Average High	Average Low	Daily	Departure	Rainfall	Rainfall Departure
January	69.0	45.1	57.1	+6.7	2.12	-1.17
February	73.5	49.4	61.5	+7.6	0.80	-2.16
March	74.5	52.9	63.7	+3.1	3.44	+0.52
April	83.7	62.2	73.0	+4.7	1.06	-2.15
May	87.4	65.8	76.6	+2.1	4.13	-1.11
June	90.5	73.2	81.9	+1.5	5.26	+0.30
July	92.6	73.6	83.1	+0.5	5.11	+1.51
August	98.5	75.1	86.8	+4.5	0.50	-2.99
September	91.6	64.3	78.0	-0.2	1.37	-3.52
October	83.1	54.8	69.0	-0.6	0.56	-3.71
November	77.1	47.3	62.2	+1.2	1.53	-2.26
December	67.1	40.3	53.7	+0.2	2.20	-1.25
1999	82.4	58.7	70.6	+2.6	28.08	-17.99
Normals	78.6	57.3	68.0		46.07	

Galveston Scholes Field

Month	Average High	Average Low	Daily	Departure	Rainfall	Rainfall Departure
January	65.6	51.7	58.7	+6.0	2.22	-1.04
February	69.9	57.0	63.5	+8.0	1.14	-1.12
March	70.7	59.6	65.2	+3.5	1.85	-0.38
April	78.4	68.0	73.2	+3.7	0.32	-2.11
May	82.7	72.3	77.5	+1.7	3.56	-0.03
June	87.7	78.1	82.9	+1.8	2.35	-2.09
July	87.9	78.3	83.1	-0.2	7.54	+3.58
August	92.0	80.3	86.2	+2.7	0.26	-4.21
September	87.0	73.8	80.4	+0.4	3.95	-1.98
October	79.2	66.0	72.6	-0.2	3.00	+0.16
November	73.2	59.6	66.4	+2.2	1.59	-1.78
December	65.4	50.8	58.1	+1.7	5.81	+2.31
1999	78.3	66.3	72.3	+2.6	33.59	-8.69
Normals	74.3	65.0	69.7		42.28	

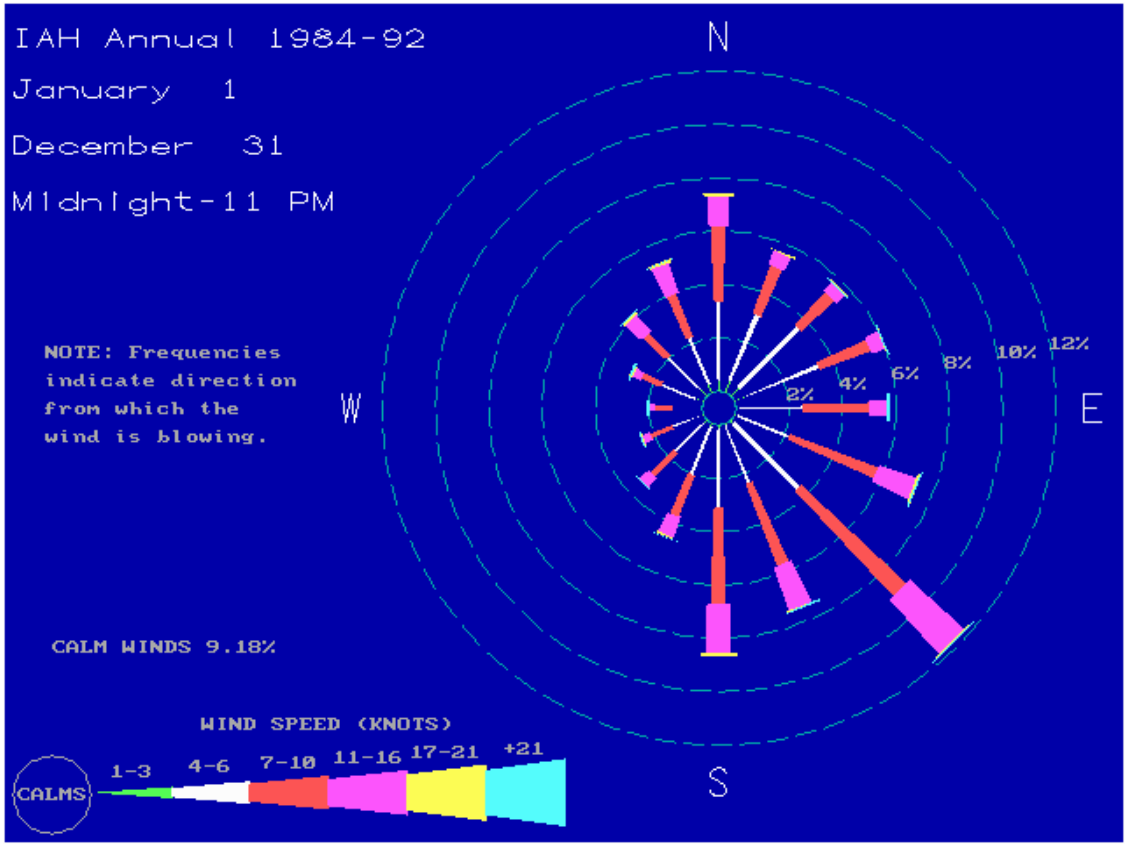
Special Situations…

Wind

Wind is also predictable

(within a range)

Monthly and Annual Wind Roses are available on-line for most major airports



Info from State

office of the state climatologist

TEXAS CLIMATIC BULLETIN

Office of the Texas State Climatologist
College of Geosciences and Maritime Studies
Department of Meteorology
Texas A&M University

Volume 13 Number 3

MARCH 2000

March was an exciting month for storm enthusiasts as severe weather rocked the state. Numerous tornadoes and large hail accompanied these storms, doing considerable damage to portions of Texas. Amarillo experienced its wettest March this year by recording 4.14 inches of rain. Warm temperatures also dominated, with every major station reporting above normal average temperatures. Galveston took the lead this month with four new high temperature records, while Brownsville was a close second with three.

The month began as a cold front associated with a low pressure system in the Panhandle moved through Texas on the 2nd, bringing severe weather to the northern parts of the state. Abilene had 1" hail fall early that morning, and Dallas/Fort Worth received up to 2" hail that afternoon. Warm temperatures followed a brief cool spell resulting from this front. On the 7th, a Pacific cold front interacted with the dry line in West Texas to produce more severe weather. Hurricane force winds up to 80 mph were reported in portions of the Panhandle, as well as hail up to 1" in diameter. A cold front extending from Michigan to Texas moved through on the 10th, which fueled more severe storms. A tornado was reported in Bell County on the 10th, and 1 person was injured in a tornado in Burleson County later that evening.

Fair weather returned to much of Texas as high pressure settled in over the state. However, a stationary front in northern Mexico brought storms which dumped large amounts of rain on Southern Texas. On the 14th, Corpus Christi received 3.66 inches of rain, and Brownsville received 2.62 inches on the 15th. A low pressure system developed over the Red River area on the 16th and brought snow to the Panhandle and thunderstorms to central Texas. A tornado was spotted in the Pflugerville area between Georgetown and Austin, and hail was reported along the I-35 corridor from San Antonio to Dallas/Fort Worth. Another low pressure system moved into Texas on the 22nd, bringing more rain and a tornado northwest of Del Rio in Val Verde County.

As March ended, severe weather once again struck the state. A low pressure system developed in Wyoming and moved southeast into northern Texas. This system, with its associated cold and warm fronts, combined with the dry line in West Texas to produce what turned out to be devastating weather in North Central Texas. Around 6:00 p.m. CST on the 28th, a thunderstorm formed just west of Fort Worth which quickly turned severe, and within the next hour at least two tornadoes formed, one of which sliced through downtown Fort Worth. Arlington also received heavy residential damage from a tornado associated with this same storm. The storm left 4 people dead and the total damage in Fort Worth and Arlington has been estimated to be around $450 million. This low pressure system also affected other areas of Texas as portions of Bexar County received hail up to 2.75" in diameter and a funnel cloud was spotted near Driftwood in Hays County.

Kerry Meyer (Undergraduate Assistant)

Rick Scott (Graduate Assistant)

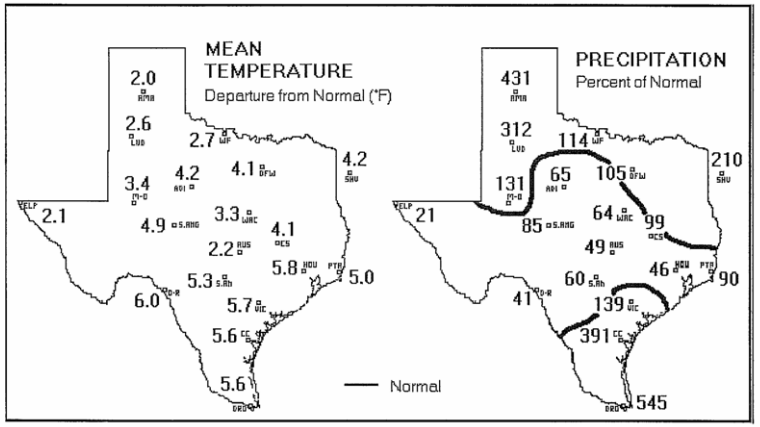
MARCH 2000

Station	Avg Max Temp	Dep	Avg Min Temp	Dep	Mean Temp	Dep	Abs Max Temp	Abs Min Temp	No. of Days Precip.	Total Pcpn (In)	% of Avg Pcpn	Gr'st 24 hr Pcpn	HDD*	CDD*
Abilene	73.7	4.8	46.9	3.6	60.3	4.2	91	30	4	0.88	65%	0.33	180	40
Amarillo	63.5	1.9	34.8	2.1	49.1	2.0	82	23	7	4.14	431%	1.84	482	0
Austin	76.0	4.1	51.4	0.3	63.7	2.2	91	30	11	0.92	49%	0.62	136	103
Brownsville	83.0	4.6	65.8	6.7	74.4	5.6	96	52	5	2.89	545%	2.64	1	300
College Station	75.4	4.4	53.5	3.8	64.4	4.1	87	34	13	2.56	99%	1.14	124	108
Corpus Christi	79.2	3.5	63.2	7.9	71.2	5.6	92	50	2	3.68	391%	3.66	21	222
Dallas/Ft. Worth	71.2	3.4	50.3	4.7	60.8	4.1	85	37	12	2.92	105%	1.23	168	47
Del Rio	82.0	6.3	56.6	5.7	69.3	6.0	94	41	6	0.28	41%	0.12	33	174
El Paso	71.9	2.0	42.4	2.2	57.2	2.1	80	33	1	0.06	21%	0.06	242	4
Houston	77.9	6.8	54.8	4.8	66.4	5.8	88	34	10	1.35	46%	0.50	72	126
Lubbock	68.6	2.6	39.0	2.6	53.8	2.6	82	25	6	2.78	312%	1.28	341	0
Midland	73.7	2.5	44.5	4.3	59.1	3.4	86	27	5	0.76	131%	0.33	195	18
Port Arthur	76.3	4.8	56.4	5.1	66.4	5.0	82	41	6	2.90	90%	1.22	70	119
San Angelo	77.8	5.2	48.2	4.7	63.0	4.9	91	30	3	0.77	85%	0.71	130	75
San Antonio	77.6	4.1	56.4	6.7	67.0	5.3	94	34	8	0.91	60%	0.31	79	147
Victoria	79.1	5.4	59.0	6.2	69.0	5.7	91	38	3	2.16	139%	1.96	51	183
Waco	72.1	2.5	50.9	4.1	61.5	3.3	84	35	7	1.49	64%	0.43	143	48
Wichita Falls	68.8	2.4	43.5	2.9	56.2	2.7	86	31	7	2.51	114%	1.60	281	12
Shreveport, LA	72.2	3.0	51.2	5.4	61.7	4.2	85	34	13	7.90	210%	2.36	149	55

* Complete temperature data were unavailable. Temperatures are rounded to the nearest whole degree.

*HDD - Heating degree-day: Refer to the Monthly Average chart for a definition T = Trace (<0.005")

*CDD - Cooling degree-day: Refer to the Monthly Average chart for a definition M: Information not available.



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		ORDER TOTAL:	**$70.00**

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		Subtotal:	$70.00
		Service Charge:	$0.00
		Total:	$70.00

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Customer Number: 160893
Marketing Code: WEB
Bill To:
Mike Stone
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1104

http://ols.ncdc.noaa.gov/onlinestore.html
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NOAA Data Dump – ASCII File

"COOPID,WBANID,Prelim,year,month,day,Tmax,Tmin,Tobs,Tmean,Cdd,Hdd,Prcp,Snow,Snwd,
meanTmean,meanTmax,meanTmin,highTmax,lowTmin,sumCdd,sumHdd,sumprcp,sumsno
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1941 Data

(22 thousand observations not shown)

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"414307,12918,*,2003,02,28,54,47, ,51,0,14,0, , ,54.9,62.6,47.2,78,33,9,285,2.80, "

2003 Data

Convert ASCII to Something Useful

Coop COOPID	WBAN ID WBANID	Field3 Prelim	Year	Month	Day	Max Temp	Min Temp	Temp Obs Tobs	Temp Mea	CDD	HDD	Precip Prcp	Snow	Snwd	
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414307	12918		1941	11	4	75	57		66	1	0	0.75	0	0	
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414307	12918		1941	11	26	65	38		52	0	13	0.03	0	0	
414307	12918		1941	11	27	66	50		58	0	7	0	0	0	

Percent Sunshine

DATA THROUGH 1993	YRS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
BIRMINGHAM C.O.,AL	10	48	48	62	61	64	63	60	62	57	63	49	52	57
BIRMINGHAM AP,AL	34	42	50	55	63	66	65	59	63	61	66	55	46	58
MONTGOMERY, AL	43	47	53	59	65	63	63	62	63	62	65	55	49	59
ANCHORAGE, AK	38	36	43	51	51	52	47	44	39	40	37	33	28	42
JUNEAU, AK	33	32	32	37	39	39	34	31	32	26	19	23	20	30
NOME, AK	39	40	55	53	54	50	42	37	32	36	35	31	35	42
FLAGSTAFF, AZ	14	76	74	76	83	88	86	75	76	81	79	75	73	79
PHOENIX, AZ	98	78	80	84	89	93	94	85	85	89	88	84	78	86
TUCSON, AZ	46	80	82	86	92	93	93	78	80	87	88	85	79	85
YUMA, AZ	42	84	87	90	94	95	97	91	91	93	92	87	82	90
FORT SMITH, AR	48	50	55	56	60	62	69	73	72	65	65	55	51	61
LITTLE ROCK, AR	32	46	54	57	62	68	73	71	73	68	69	56	48	62
NORTH LITTLE ROCK, AR	16	65	65	72	77	72	81	83	81	79	74	61	60	73
EUREKA, CA.	83	43	46	52	57	58	59	55	50	54	50	44	41	51
FRESNO, CA	44	47	65	78	85	90	95	97	96	94	88	66	46	79
LOS ANGELES C.O., CA	32	69	72	73	70	66	65	82	83	79	73	74	71	73
REDDING, CA	7	75	83	84	91	92	94	97	97	93	91	84	76	88

Sunrise / Sunset

- Several Sources
- Use the whichever one has the data in the most convenient format

Victoria County, TX
Time Zone : CST(GMT -6)

1/1/2003 to 2/1/2003			28.796000 N / 96.970943 W			
Date	Day of Week	1/2 Hour before sunrise	1/2 Hour after sunset	Sunrise to sunset Time(H:M)	Sunrise	Sunset
1/1/2003	Wednesday	06:51 am	06:11 pm	10:20	7:21 am	5:41 pm
1/2/2003	Thursday	06:51 am	06:12 pm	10:21	7:21 am	5:42 pm
1/3/2003	Friday	06:51 am	06:13 pm	10:22	7:21 am	5:43 pm
1/4/2003	Saturday	06:51 am	06:13 pm	10:22	7:21 am	5:43 pm
1/5/2003	Sunday	06:52 am	06:14 pm	10:22	7:22 am	5:44 pm
1/6/2003	Monday	06:52 am	06:15 pm	10:23	7:22 am	5:45 pm
1/7/2003	Tuesday	06:52 am	06:16 pm	10:24	7:22 am	5:46 pm
1/8/2003	Wednesday	06:52 am	06:16 pm	10:24	7:22 am	5:46 pm
1/9/2003	Thursday	06:52 am	06:17 pm	10:25	7:22 am	5:47 pm
1/10/2003	Friday	06:52 am	06:18 pm	10:26	7:22 am	5:48 pm
1/11/2003	Saturday	06:52 am	06:19 pm	10:27	7:22 am	5:49 pm
1/12/2003	Sunday	06:52 am	06:20 pm	10:28	7:22 am	5:50 pm
1/13/2003	Monday	06:52 am	06:20 pm	10:28	7:22 am	5:50 pm
1/14/2003	Tuesday	06:52 am	06:21 pm	10:29	7:22 am	5:51 pm
1/15/2003	Wednesday	06:52 am	06:22 pm	10:30	7:22 am	5:52 pm
1/16/2003	Thursday	06:52 am	06:23 pm	10:31	7:22 am	5:53 pm
1/17/2003	Friday	06:51 am	06:24 pm	10:33	7:21 am	5:54 pm
1/18/2003	Saturday	06:51 am	06:24 pm	10:33	7:21 am	5:54 pm
1/19/2003	Sunday	06:51 am	06:25 pm	10:34	7:21 am	5:55 pm
1/20/2003	Monday	06:51 am	06:26 pm	10:35	7:21 am	5:56 pm
1/21/2003	Tuesday	06:51 am	06:27 pm	10:36	7:21 am	5:57 pm
1/22/2003	Wednesday	06:50 am	06:28 pm	10:38	7:20 am	5:58 pm
1/23/2003	Thursday	06:50 am	06:29 pm	10:39	7:20 am	5:59 pm
1/24/2003	Friday	06:50 am	06:29 pm	10:39	7:20 am	5:59 pm
1/25/2003	Saturday	06:49 am	06:30 pm	10:41	7:19 am	6:00 pm
1/26/2003	Sunday	06:49 am	06:31 pm	10:42	7:19 am	6:01 pm

Putting it all together…(a really giant spreadsheet)

Houston Hobby Historical Weather
Data 1941 thru 2002

								Observation
							0.175	
Number of Observations	Average - Precipitation / Rain Days	Total Preciptation	Rain Days	Average - Inches / Observations	Rain Days	Probability	**0.185**	**Day**
21086	**299.1257387**	**2942.159**	**3644**	**51.31**	**97**		**130**	
59	1.30	13.04	10	0.22	1	16.95%	0	Jan-1
59	0.67	8.04	12	0.14	0	20.34%	1	Jan-2
59	0.44	4.39	10	0.07	0	16.95%	0	Jan-3
59	0.46	5.04	11	0.09	0	18.64%	1	Jan-4
59	0.56	7.29	13	0.12	0	22.03%	1	Jan-5
59	0.66	10.57	16	0.18	1	27.12%	1	Jan-6
59	0.54	8.66	16	0.15	0	27.12%	1	Jan-7
59	0.45	4.08	9	0.07	0	15.25%	0	Jan-8
59	0.86	11.20	13	0.19	1	22.03%	1	Jan-9
59	0.65	6.52	10	0.11	0	16.95%	0	Jan-10

Precipitation in Inches by day by year

Observation	61	151	151	152	151	181	365	366	365	365	365	366
Day	**1941**	**1942**	**1943**	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
Jan-1		0.02	0	3.61	0	0	0.54	0	0.01	3.22	2.27	0.06
Jan-2		0	0	0.18	0	0	0.07	0	0.7	0	0.08	0.04
Jan-3		0.13	0	0	0.01	0	0	0	0	0	0.12	0.1
Jan-4		0	0	0	0	1.86	0	0	0	0.14	0	0.08
Jan-5		0	0	0	0.12	0.1	0.09	0	0	0.09	0	0
Jan-6		0.19	1.31	0.09	0.19	0.01	0.01	0	0	0.05	0.43	0
Jan-7		0.43	0.16	0.38	0	0.43	0.22	0.01	0	0	0	0
Jan-8		0	0	0	0	0.49	0.13	0.01	0	0	0	0
Jan-9		0.11	0	0	0	0	0.48	0	0	0	0	0
Jan-10		0	0	0	0	0.4	0.21	0	0	0.62	0.04	0

Identify "Significant" Rain Days

Rain Days = Days with more than ….. **0.10** inches of Rain

Avg rain days (1947 thru 1997) **62.4** Days

Day	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
1/1	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0
1/2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
1/3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
1/4	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0
1/5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1
1/6	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1
1/7	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
1/8	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0
1/9	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0

0.01 inches – minimal rainfall

Rain Days = Days with more than ….. **0.01** inches of Rain

Avg rain days (1947 thru 1997) **91** Days

Day	1941	1942	1943	1944	1945	1946	1947	1948	1949	2001	2002	2003
1/1	0	1	0	1	0	0	1	0	0	1	1	0
1/2	0	0	0	1	0	0	1	0	1	0	0	0
1/3	0	1	0	0	0	0	0	0	0	0	0	0
1/4	0	0	0	0	0	1	0	0	0	0	0	0
1/5	0	0	0	0	1	1	1	0	0	0	1	0
1/6	0	1	1	1	1	0	0	0	0	0	0	0
1/7	0	1	1	1	0	1	1	0	0	1	0	0
1/8	0	0	0	0	0	1	1	0	0	0	0	0
1/9	0	1	0	0	0	0	1	0	0	0	0	0
1/10	0	0	0	0	0	1	1	0	0	1	0	0

Determining Probability of Rain

Day	Number of Observations	Average Precipitation	Total Preciptation	Rain Days	Probability	0.3
Jan-1	59	0.22	13.04	19	32.20%	1
Jan-2	59	0.14	8.04	19	32.20%	1
Jan-3	59	0.07	4.39	15	25.42%	0
Jan-4	59	0.09	5.04	16	27.12%	0
Jan-5	59	0.12	7.29	21	35.59%	1
Jan-6	59	0.18	10.57	23	38.98%	1
Jan-7	59	0.15	8.66	20	33.90%	1
Jan-8	59	0.07	4.08	15	25.42%	0
Jan-9	59	0.19	11.20	15	25.42%	0
Jan-10	59	0.11	6.52	16	27.12%	0
Jan-11	59	0.09	5.26	14	23.73%	0
Jan-12	59	0.17	10.15	20	33.90%	1
Jan-13	59	0.12	6.85	19	32.20%	1
Jan-14	59	0.11	6.23	16	27.12%	0
Jan-15	59	0.05	2.91	9	15.25%	0

19 / 59 = 32.20%

Probability

"Rain Day"

Annualized

Probable Rain Days

This solves only ½ of the problem

Find threshold where probability is near historic observation

1947-1997 Averages

Month	Precip	Rain Days	Probability	Days Probability
January	3.76	8.7	28.02%	14
February	3.47	7.7	27.52%	5
March	2.83	7.0	22.52%	2
April	3.57	6.6	21.96%	2
May	4.99	7.3	23.47%	5
June	5.85	7.4	24.71%	7
July	4.18	8.0	25.68%	7
August	4.38	8.7	27.96%	11
September	4.95	8.3	27.58%	15
October	4.76	5.9	19.17%	2
November	3.93	7.2	23.99%	5
December	3.82	8.2	26.50%	12
	50.5	90.9		87

Available Work Hours

Date	Hours	Min	Decimal Hours	Sunshine	Sunshine in Dec. Hrs	Work Day
6/25/2003	13	58	13.97	72.00%	10.06	1
6/26/2003	13	58	13.97	72.00%	10.06	1
6/27/2003	13	58	13.97	72.00%	10.06	1
6/28/2003	13	58	13.97	72.00%	10.06	0
6/29/2003	13	58	13.97	72.00%	10.06	0
6/30/2003	13	58	13.97	72.00%	10.06	1
7/1/2003	13	57	13.95	80.00%	11.16	1
7/2/2003	13	57	13.95	80.00%	11.16	1
7/3/2003	13	57	13.95	80.00%	11.16	1
7/4/2003	13	56	13.93	80.00%	11.14	0
7/5/2003	13	56	13.93	80.00%	11.14	0
7/6/2003	13	54	13.90	80.00%	11.12	0
7/7/2003	13	54	13.90	80.00%	11.12	1
7/8/2003	13	53	13.88	80.00%	11.10	1
7/9/2003	13	53	13.88	80.00%	11.10	1
7/10/2003	13	53	13.88	80.00%	11.10	1

Combining Data…(Example from recent claim)

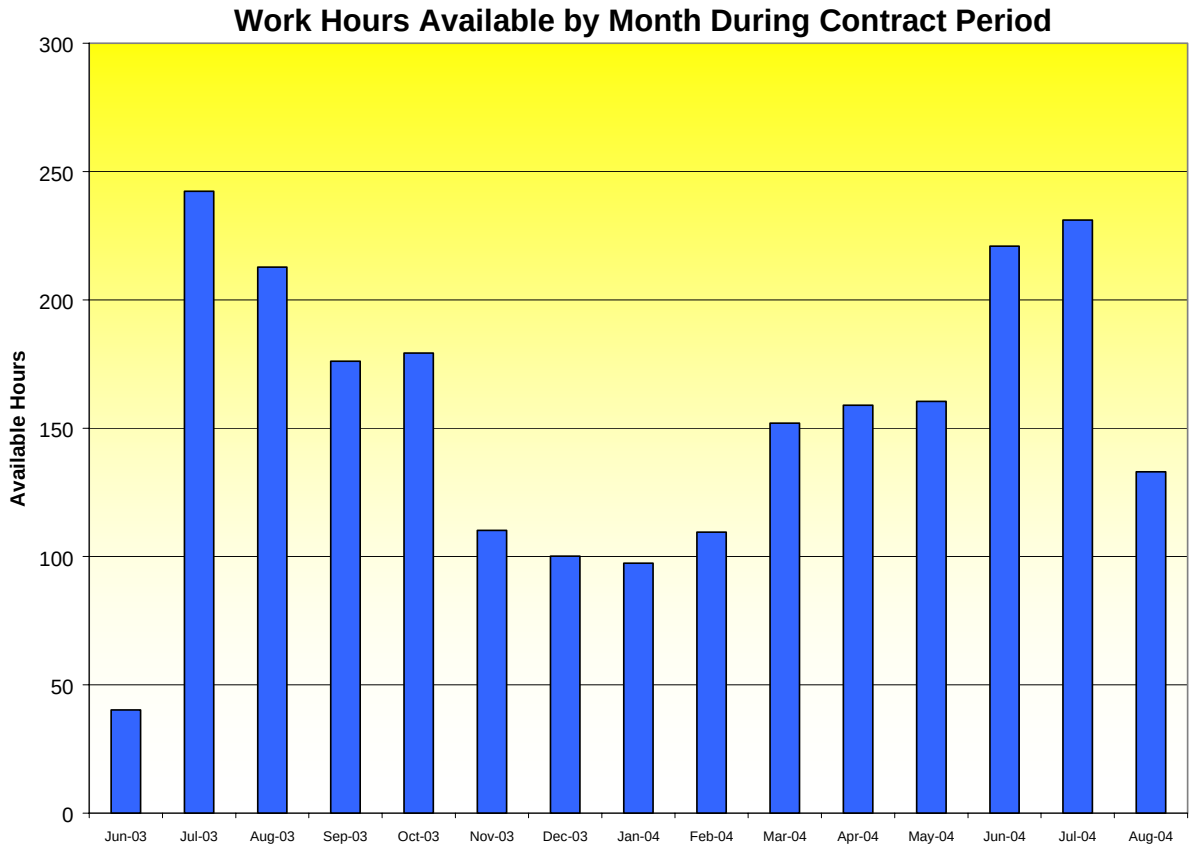
Average Percent Possible Sunshine
Obtained from NOAA
Data for nearest station - Corpus Christi

Average Days of Precipitation, .01 Inches or More
Obtained from NOAA
Data for nearest station - Victoria Airport

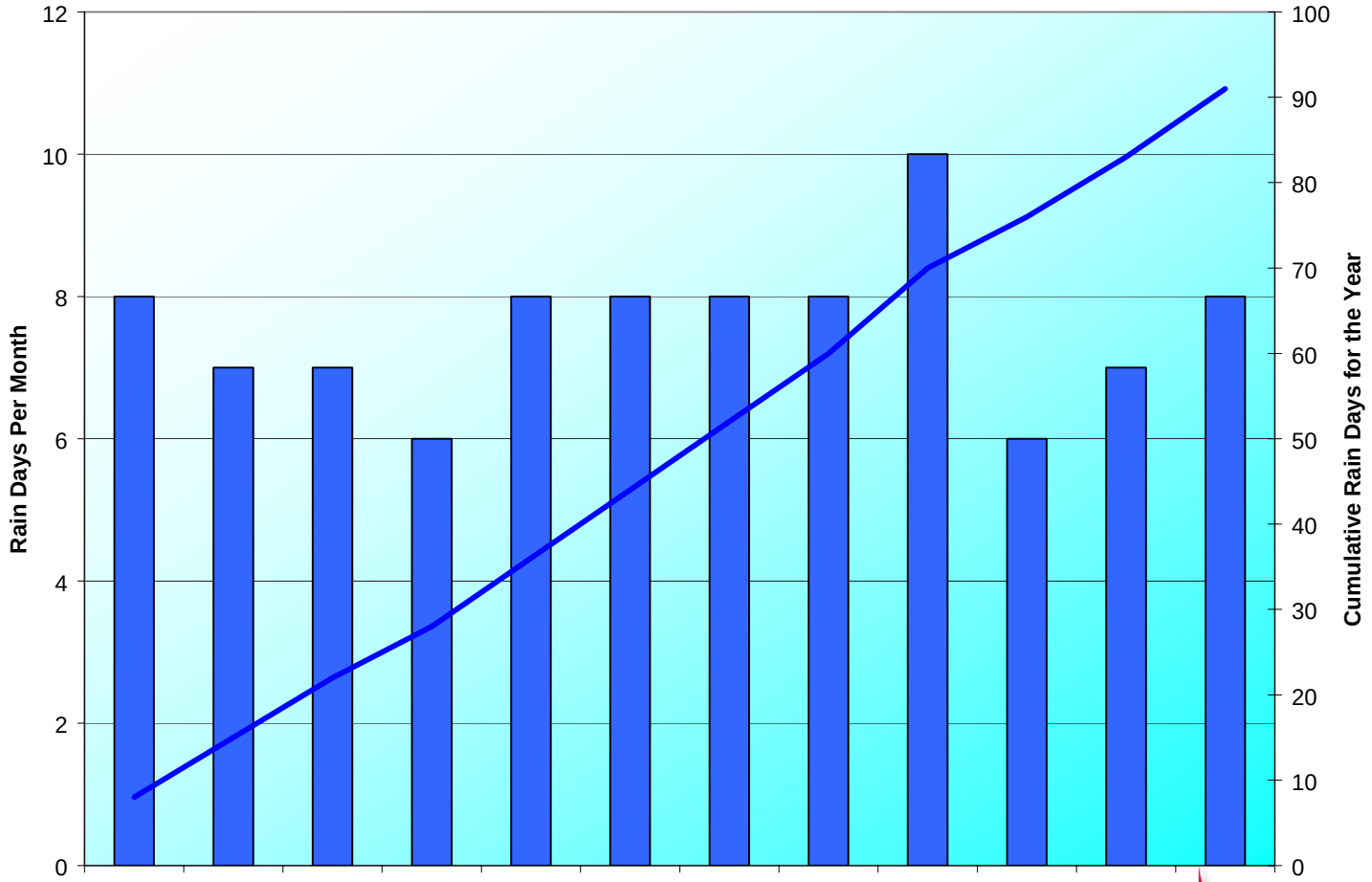
Normal Monthly Precipitation, Inches
Obtained from NOAA
Data for nearest station - Victoria Airport

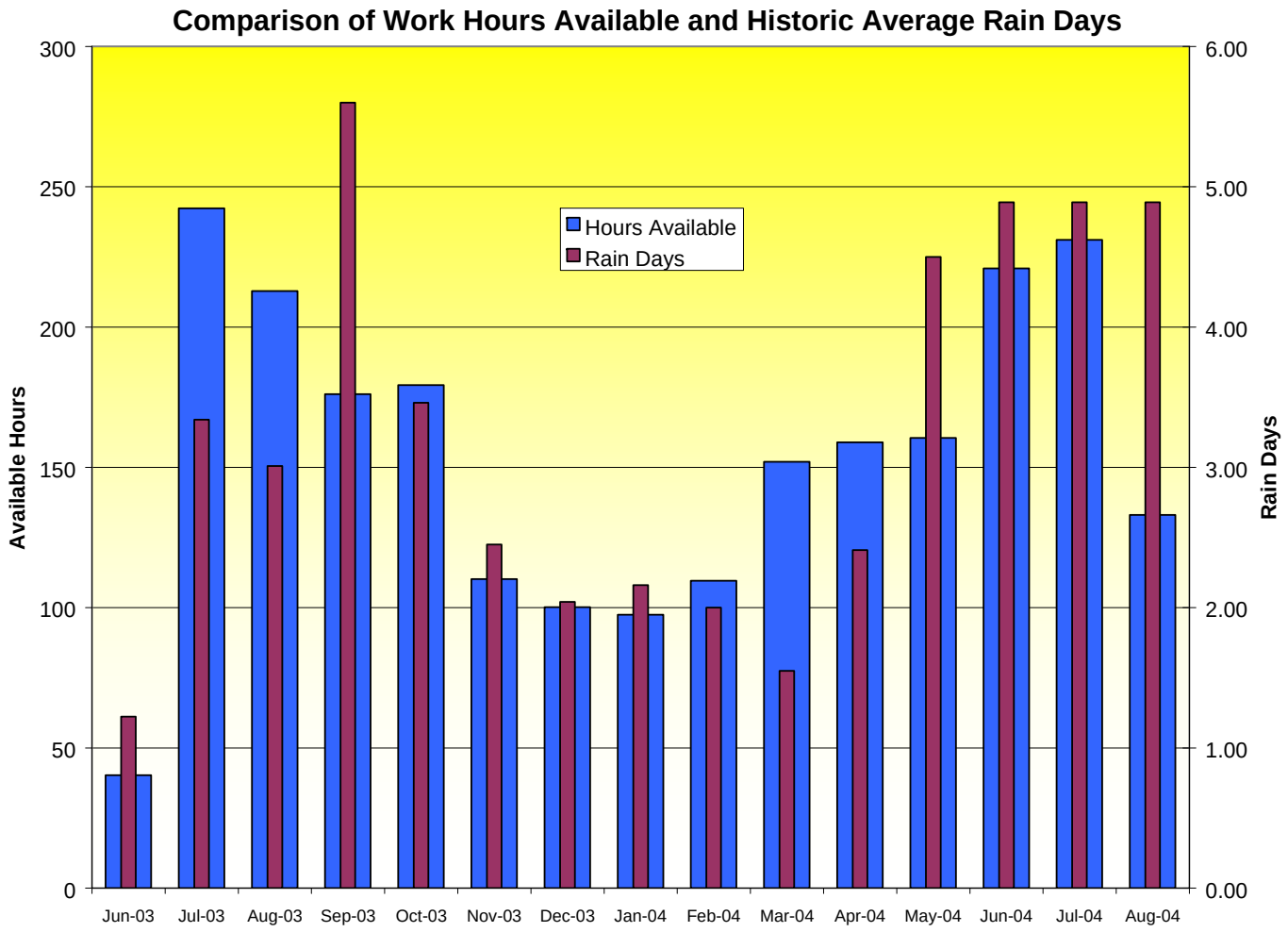
51 Years of Data		32 Years of Data		Cum	30 Years of Data		Cum
44%	January	8	January	8	2.16	January	2.16
49%	February	7	February	15	2.00	February	4.16
55%	March	7	March	22	1.55	March	5.71
56%	April	6	April	28	2.41	April	8.12
59%	May	8	May	36	4.50	May	12.62
72%	June	8	June	44	4.89	June	17.51
80%	July	8	July	52	3.34	July	20.85
77%	August	8	August	60	3.01	August	23.86
68%	September	10	September	70	5.60	September	29.46
68%	October	6	October	76	3.46	October	32.92
54%	November	7	November	83	2.45	November	35.37
44%	December	8	December	91	2.04	December	37.41
61	Annually Avg	91	Annually Avg	91	37.41	Annually Avg	37.41

Example of Difference in Seasons



Average Rain Days by Month From NOAA




Comparison of Work Hours Available and Historic Average Rain Days
Available Hours
Rain Days
Hours Available
Rain Days
300
250
200
150
100
50
0
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jun-03
Jul-03
Aug-03
Sep-03
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04

Interpreting the Data

- Long hours of daylight & warm weather allow work to resume work sooner after heavier rain in the summer months
- Shorter days, cool temperatures, and cloud cover prevent work from resuming as quickly in winter months even with less measurable rain

Correlate weather and work days

- For example:
  - USACE records over many years indicate 19 days are worked on average in April
  - And 212 days are worked on average in any given year
  - Use precipitation, cloud cover, probabilities to create a calendar

P3 Calendar Non-Work

REPORT DATE 29MAY04 CAL-2 Std Hou Weather PAGE NO. 2

JANUARY 2002

SUN	MON	TUE	WED	THUR	FRI	SAT
		1 WP=-1	2 R	3 WP=0	4 R	5 R
6 R	7 R	8 WP=1	9 R	10 WP=2	11 WP=3	12 R
13 R	14 R	15 WP=4	16 R	17 R	18 R	19 R
20 WP=5	21 R	22 R	23 WP=6	24 WP=7	25 WP=8	26 WP=9
27 R	28 WP=10	29 R	30 R	31 R		

FEBRUARY 2002

SUN	MON	TUE	WED	THUR	FRI	SAT
					1 WP=11	2 R
3 R	4 R	5 R	6 WP=12	7 R	8 R	9 WP=13
10 R	11 R	12 R	13 WP=14	14 R	15 R	16 WP=15
17 R	18 WP=16	19 WP=17	20 R	21 R	22 WP=18	23 WP=19
24 R	25 R	26 WP=20	27 WP=21	28 WP=22		

PRIMAVERA®

Create Non-Work Calendar

January						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

**** Note: The calendar above shows the "expected" rain days in a typical year. This is not the actual weather that occurred during this year. Includes 91 predicted rain days and 60 "too wet" days based upon probabilities derived from weather observations from 1941 to 2003 at Hobby Airport, Houston.

Note from Previous Calendar

**** Note: The calendar above shows the "expected" rain days in a typical year. This is not the actual weather that occurred during this year. Includes 91 predicted rain days and 60 "too wet" days based upon probabilities derived from weather observations from 1941 to 2003 at Hobby Airport, Houston.

- 365 less “rain days” does not equal the average number of days available to work because it may not be possible to resume work for several days after a rain. “TOO WET”
- You have to interpret and determine how many days after a rain are non-work for each month to fit the historic average of non-work vs work days for each month.

Hours Available to Work

- The number of hours available to work varies significantly from month to month.
- Not an easy way to show this difference in P3 month to month in a single calendar

Published papers…

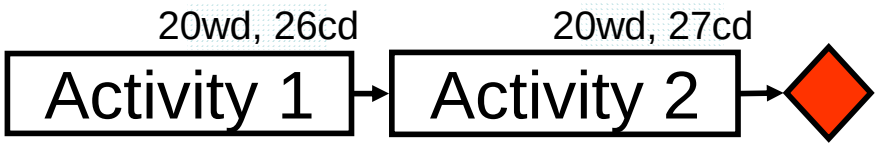
- Complex formulas trying to calculate drying time for various soil types, temperature, humidity, evaporation…
- Too complex, not practical, requires a PhD to interpret or perform the calculation

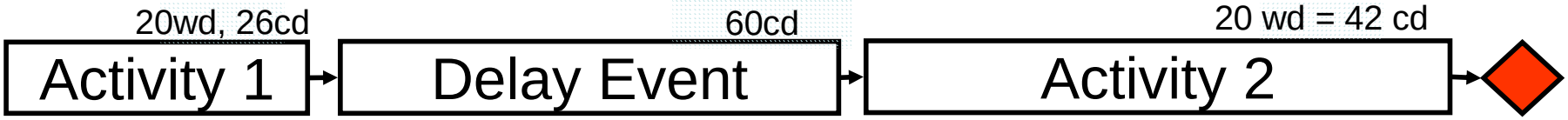
Inserting delays or potential delays

- By breaking an activity or logic chain and inserting a delay event you can now accurately present the true impact of moving work from one period or season into another season.

Simple Demonstration of Impact

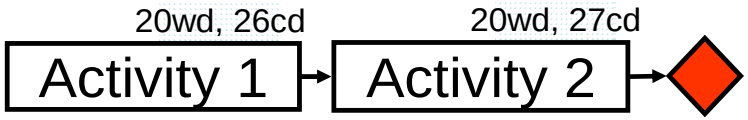
July	August	Sept	Oct	Nov	Dec
24	23	21	19	14	11





Simple Demonstration of Impact

July	August	Sept	Oct	Nov	Dec
24	23	21	19	14	11



Delay Event was 60 days but because it pushed Activity 2 from Summer into the Fall which caused its Calendar Day duration to increase from 27 days to 42 days.

Simple Demonstration of Impact

60 days for delay event
\+ 15 days due to shift seasons
75 Calendar Days

60 Day Delay Event Actually Requires 75 Calendar Day Adjustment to Completion Date to Fully Compensate the Contractor for the Delay

Weather & Seasonal Impacts…

- Acceptable because the method is based upon best information available
- Accounts for variations in seasons and days
- No better method readily available

How this could be better…

- Not only are all months not created equal, not all days are created equal…
- Software could allow us not only to identify work vs. non-work days but also work hours for each specific day or at least for each month

Questions?