Reston Station Phase 1 Garage

Reston, Virginia

Penn State Architectural Engineering Senior Thesis

Jon Fisher Construction Option Advisor: Dr. Robert Leicht

OUTLINE

COMSTOCK PARTNERS

COUNTY OF FAIRFAX 1742 VIRGINIA

DAVIS

Project Overview

Location
- Reston, Virginia

Size
- 1.3 Million Square Feet
- 7 Underground Levels
- 5 Additional Buildings in Future Phases

Function
- 2300 Public Parking Spaces
- Silver Line Metrorail

Schedule
- April 2011 – July 2013
- 27 Months

Reston Station Phase 1 Garage

Reston, Virginia

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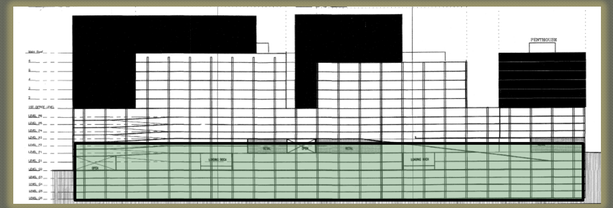
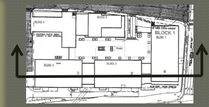
Project Overview

Cost
- $92 Million

Delivery Method
- Guaranteed Maximum Price
- CM at Risk – Davis Construction

Owner
- Fairfax County and Comstock Partners





OUTLINE

Public-Private Partnerships

Goal of Analysis #1

- To understand the public-private partnership used on the project and determine the implications partnerships have on construction as a whole

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Public-Private Partnerships

Public-Private Partnership: "A government service or private business venture funded and operated through a partnership of government and one or more private sector companies."

- When government and the private sector work together

PPP's In Construction

Simple Example: Toll Roads

- Sharing risk and reward

OUTLINE

Public-Private Partnerships

PPP At Reston Station

- County given development funds from VDOT
- Fairfax approached by Comstock for future building rights
- Virginia Public-Private Partnership Act
- 99-year lease
- Proffer agreement contains terms
- Price tag divided by parking ratio

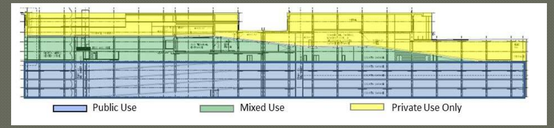
Advantages of Public Private Partnerships	
Public Owner	*Private Owner*
● Reduced Cost ● Delivery Method Freedom ● Possible Increase in Revenue ● Increased Efficiency	● Operation in New Markets ● New Revenue Opportunity ● Government Relationship

OUTLINE

Public-Private Partnerships

Challenges

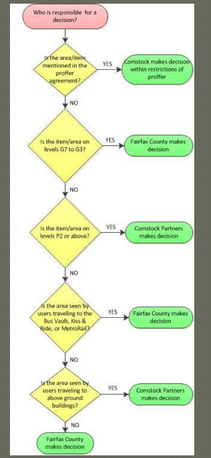
Usage of Garage Area



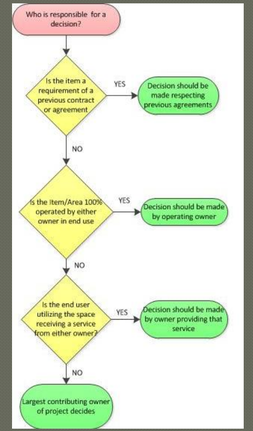
Decision Making

- Limited conflicts in separated areas
- Decision making paralysis on shared spaces
- Decision making flow chart

Reston Station Decision Making



Generalized Decision Making



OUTLINE

Public-Private Partnerships

Conclusion

- PPP's are great in theory but still untested with general building construction
- Best to proceed in a PPP with critical awareness
- Large variance between different levels and states

Long Beach Courthouse

- Not a transportation example
- Long Beach Judicial Partners LLC
  - Clack Design-Build
  - AECOM
  - Johnson Controls
- $490 Million Design-Build-Operate-Maintain
- Performance based service fee
- Funding source complications

OUTLINE

Equipment Staging and Bonded Warehouses

Goal of Analysis #2

- To investigate an alternative option for the storage of construction materials utilizing off-site bonded warehouses

Equipment Staging and Bonded Warehouses

OUTLINE

Current Situation

- Escalator frames, ventilation fans, and stone façade
- Escalators originally to be stored on finished slab
- Design delay caused complications
- 140 fans and 2 escalators stored on slabs for extended period of time

Intended Storage of Escalators

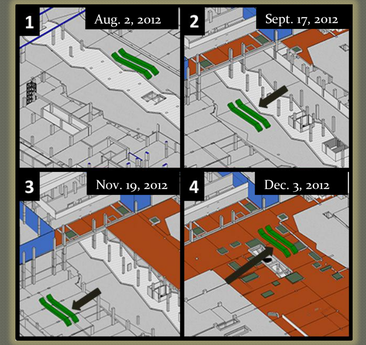
OUTLINE

Equipment Staging and Bonded Warehouses

Current Situation

- Escalator frames, ventilation fans, and stone façade
- Escalators originally to be stored on finished slab
- Design delay caused complications
- 140 fans and 2 escalators stored on slabs for extended period of time

Actual Storage of Escalators



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Equipment Staging and Bonded Warehouses

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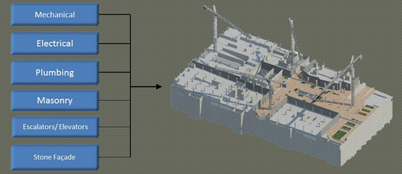
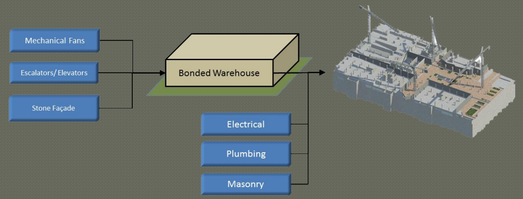
How Bonded Warehouses Could Help

Typical Method of Equipment Delivery
- Delivered directly to the site
- Stored on site
- Good for projects site freedom

Using Bonded Warehouses for Short Term
- Logistics services company
- Month-to-month storage
- No long term contract
- Sites with some restrictions



The Traditional Method



Limited Bonded Warehouse Use

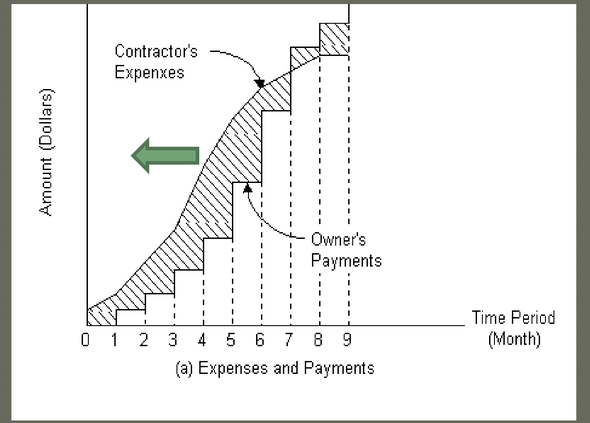
OUTLINE

Difference from Subcontractor "Yard"

Cash Flow

*"**§9.3.2** Unless otherwise provided in the contract document, payments shall be made on account of materials and equipment delivered and suitably store at the site for subsequent incorporation in the work.* ***If approved in advance by the owner, payment may similarly be made for materials and equipment suitably stored off the site*** *at a location agreed upon in writing."*

-General Conditions of the Contract for Construction (AIA A201)



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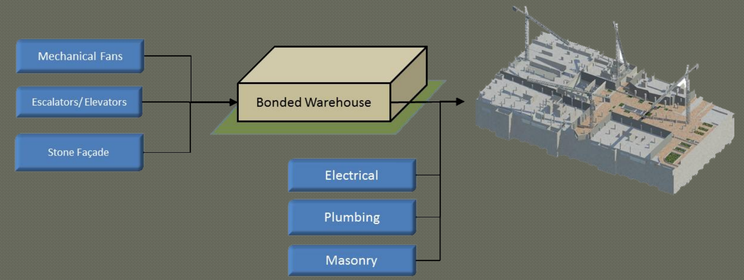
Equipment Staging and Bonded Warehouses

Costs

- Added stage of transportation
- Month-to-Month storage
- Insurance of materials

Total Cost of Off Site Storage of Limited Items	
Storage Cost	$ 20,600.00
Transportation Cost	$ 7,600.00
Bonding (1% Value of Goods)	$ 8,036.00
TOTAL	$ 36,236.00

Data from England Logistics & Innerspace



Limited Bonded Warehouse Use

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Equipment Staging and Bonded Warehouses

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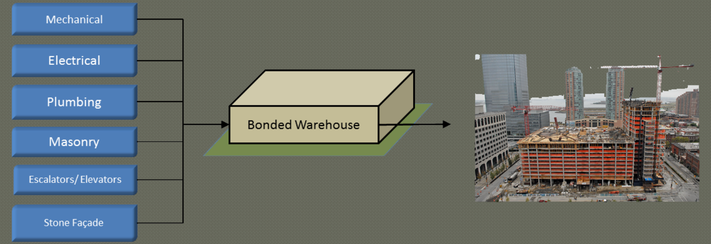
Using Bonded Warehouses as a HUB

- All deliveries to bonded warehouse
- Could be used for multiple projects
- Long-term lease
- Pentagon Renovation Example

PENTAGON RENOVATION PROGRAM



Bonded Warehouses as HUBs

OUTLINE

I. Project Overview
II. Analysis #1: Public-Private Partnerships
III. Analysis #2: Bonded Warehouses
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V. Analysis #4: Mechanical Chases
VI. Summary and Conclusions
VII. Acknowledgements

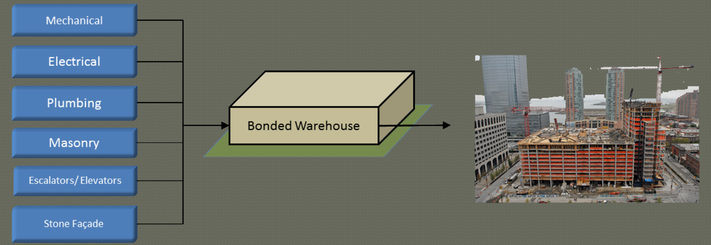
Equipment Staging and Bonded Warehouses

Costs

- Added staff and equipment
- 36 month lease
- Bonding on warehouse

Total Cost of Off Long Term Off Site Storage	
Storage Cost	$ 896,019.48
Transportation Cost	$ 162,020.00
Staff	$ 660,000.00
TOTAL	$ 1,718,039.48

Compared to $36,000 for short term use



Bonded Warehouses as HUBs

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Equipment Staging and Bonded Warehouses

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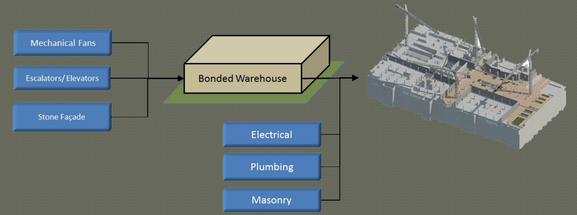
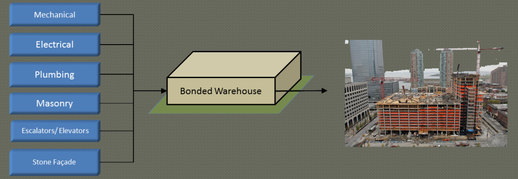
Comparing Costs

Per Month Comparison of Bonded Warehouse Use			
Scenario	*Time Span (mo.)*	*Cost*	*Cost/Mo*
Warehouse Leasing	36	$ 1,718,039.48	$ 47,723.32
Short Term Warehouse Space Usage	6	$ 36,236.00	$ 6,039.33

- Short term time span from construction schedule
- Warehouse leasing option = 1.5% project budget
- Minimized impact if used by several projects



Limited Bonded Warehouse Use



Extensive Bonded Warehouse Use

OUTLINE

Equipment Staging and Bonded Warehouses

Comparing Costs

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Scenario	*Time Span (mo.)*	*Cost*	*Cost/Mo*
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Short Term Warehouse Space Usage	6	$ 36,236.00	$ 6,039.33

- Short term time span from construction schedule
- Warehouse leasing option = 1.5% project budget
- Minimized impact if used by several projects

Advantages

- Reduced Risk
- Consolidated Delivery
- Early Subcontractor cash flow
- Eliminates delays in Production

Value of Goods Being Stored and Transported					
Item	*Cost*	*Quantity*	*Unit*		*Total*
Granite Stone Façade	$ 18.00	10200	SF		$ 183,600.00
Garage Supply Air Fans	$ 3,140.00	50	Ea		$ 157,000.00
Garage Exhaust Air Fans	$ 2,700.00	90	Ea		$ 243,000.00
Escalator Trusses	$ 110,000.00	2	Ea		$ 220,000.00
				TOTAL	$ 803,600.00

$800,000 OF MATERIALS

OUTLINE

Equipment Staging and Bonded Warehouses

Conclusion

Recommendation: Implementation of warehouse as month-to-month storage for escalators, stone, and fans will mitigate risk and help site production at Reston.

- Leasing warehouse as HUB space is cost prohibitive
- Better suited for when required or serving multiple projects

Advantages

- Reduced Risk
- Consolidated Delivery
- Early Subcontractor cash flow
- Eliminates delays in Production

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$800,000 OF MATERIALS

OUTLINE

Short Interval Production Scheduling

Goal of Analysis #3

- To utilize Short Interval Production Scheduling (SIPS) and matrix scheduling to accelerate and illustrate garage finish sequence

OUTLINE

Short Interval Production Scheduling

Reston Station Phase 1 Garage
Reston, Virginia
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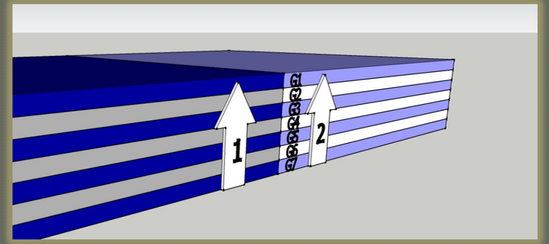
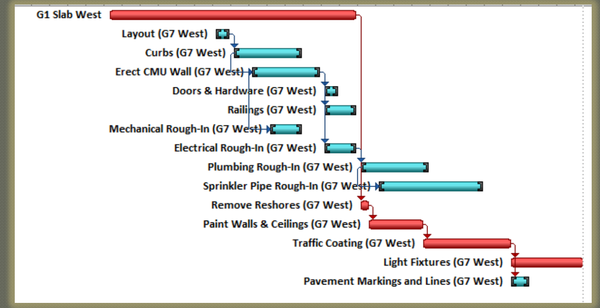
Original Finish Sequence



- Each level divided by East and West
- Original zones = 99,000 SF
- Concrete sequence determined finish sequence

Original Finish Sequence



Reshore restrictions defined finish schedule

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Short Interval Production Scheduling

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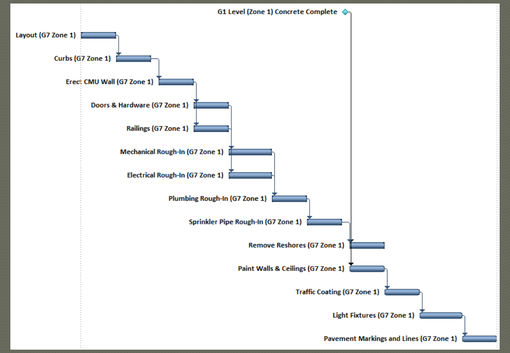
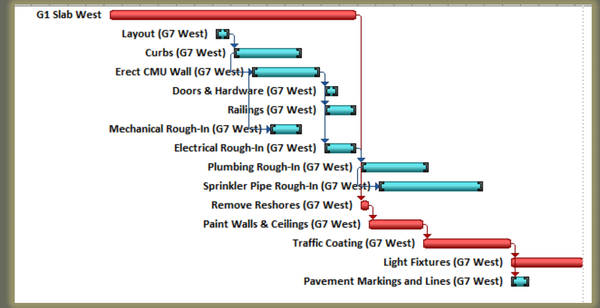
Adjusted Sequence



- Simplified sequence
- Includes co-location of certain trades

Original Finish Sequence



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OUTLINE

Short Interval Production Scheduling

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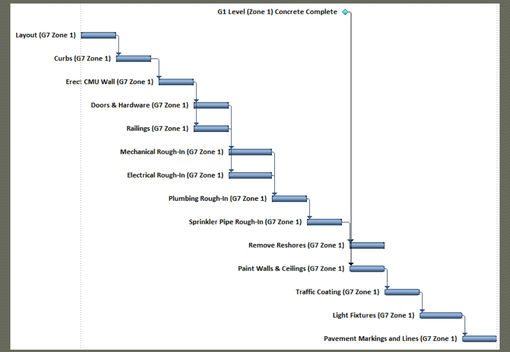

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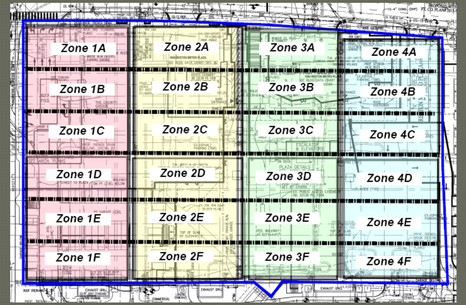
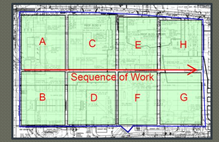
Redefined Zones





- Takes most advantage of concrete sequence
- Each Subzone = 8,250 Square Feet

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Short Interval Production Scheduling

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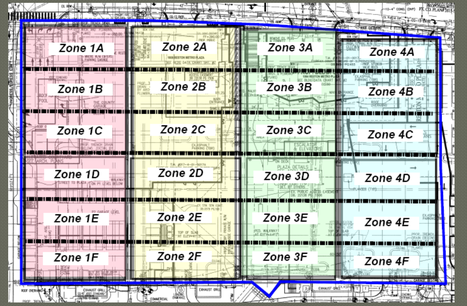
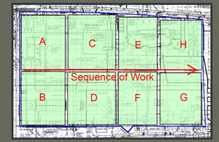
Productivity Rates and Crew Adjustment

Garage Activity Productivity Rates					
Schedule Indicator	*Activity*	*Baseline Duration (Days)*	*Productivity (SF/Man/Day)*	*SIPS Subzone Area*	# of Workers (SIPS)
A	Layout	5	9900	8250 SF	2
B	Curbs	20	413		20
C	CMU Walls	20	620		14
D	Doors & Hardware	5	9900		2
	Railings	10	3300		3
E	Mech Rough In	10	2475		4
	Electrical Rough In	10	1650		6
F	Plumbing Rough In	20	495		17
G	Sprikler Rough In	30	825		10
H	Remove Reshores	3	8250		4
	Paint Walls and Ceilings	15	660		13
I	Traffic Coating	24	1094		8
J	Light Fixtures	20	825		10
K	Pavement Markings	5	3300		6

- Crew sizes adjusted to achieve 1 subzone/day
- Some crew sizes were “irreducible”

Redefined Zones





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Short Interval Production Scheduling

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“Perfect” Matrix

Level	Subzone	14-Feb	15-Feb	16-Feb	17-Feb	20-Feb	21-Feb	22-Feb	23-Feb	24-Feb	27-Feb	28-Feb	29-Feb	1-Mar	2-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	12-Mar	13-Mar
G7	1A	A	B	C	D	E	F	G	H	I	J	K										
G7	1B		A	B	C	D	E	F	G	H	I	J	K									
G7	1C			A	B	C	D	E	F	G	H	I	J	K								
G7	1D				A	B	C	D	E	F	G	H	I	J	K							
G7	1E					A	B	C	D	E	F	G	H	I	J	K						
G7	1F						A	B	C	D	E	F	G	H	I	J	K					
G7	2A							A	B	C	D	E	F	G	H	I	J	K				
G7	2B								A	B	C	D	E	F	G	H	I	J	K			
G7	2C									A	B	C	D	E	F	G	H	I	J	K		
G7	2D										A	B	C	D	E	F	G	H	I	J	K	
G7	2E											A	B	C	D	E	F	G	H	I	J	K

168 Zones
Duration: 178 Days

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Short Interval Production Scheduling

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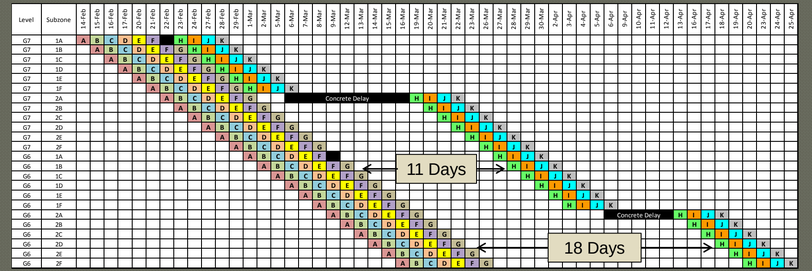
Concrete Impact



- 2 framed + 4 reshored levels required
- Painting and traffic coating delayed by reshores

"Perfect" Matrix

Level	Subzone	14-Feb	15-Feb	16-Feb	17-Feb	20-Feb	21-Feb	22-Feb	23-Feb	24-Feb	27-Feb	28-Feb	29-Feb	1-Mar	2-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	12-Mar	13-Mar
G7	1A	A	B	C	D	E	F	G	H	I	J	K										
G7	1B		A	B	C	D	E	F	G	H	I	J	K									
G7	1C			A	B	C	D	E	F	G	H	I	J	K								
G7	1D				A	B	C	D	E	F	G	H	I	J	K							
G7	1E					A	B	C	D	E	F	G	H	I	J	K						
G7	1F						A	B	C	D	E	F	G	H	I	J	K					
G7	2A							A	B	C	D	E	F	G	H	I	J	K				
G7	2B								A	B	C	D	E	F	G	H	I	J	K			
G7	2C									A	B	C	D	E	F	G	H	I	J	K		
G7	2D										A	B	C	D	E	F	G	H	I	J	K	
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Short Interval Production Scheduling

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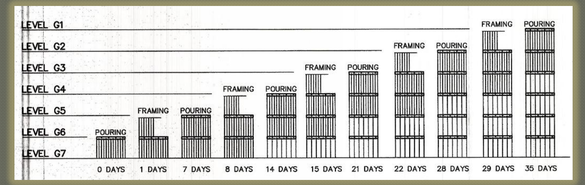
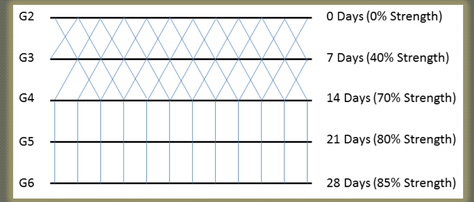
Structural Breadth



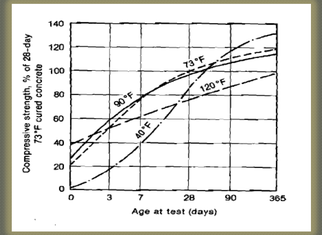
- Original 2+4 Requirement
- Redesign of slab to achieve 2+2
- ACI 318-11
  - Deflections
  - Punching Shear



Combined Capacity > Combined Loading

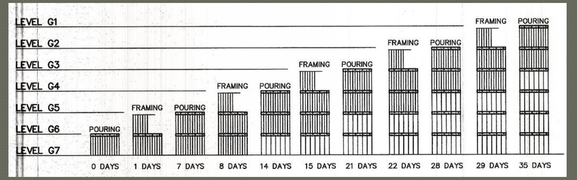
ASCE 37

Slab Dead Load (10” slab) = 125 PSF
Formwork = 10 PSF
Reshores = 5 PSF
Construction Live Load = 75 PSF



OUTLINE

Structural Breadth



- Original 2+4 Requirement
- Redesign of slab to achieve 2+2
- ACI 318-11
  - Deflections
  - Punching Shear

10” Slab with 5.5” Drop Panel Meets Requirements

5.5” drop panel allows for dimensional 2x6 form work
- Saves time and labor

OUTLINE

I. Project Overview
II. Analysis #1: Public-Private Partnerships
III. Analysis #2: Bonded Warehouses
IV. Analysis #3: SIPS Scheduling
V. Analysis #4: Mechanical Chases
VI. Summary and Conclusions
VII. Acknowledgements

Conclusion

- SIPS REQUIRES COORDINATION
- Concrete progress had big impact on finishes
- Early completion means lower general conditions
- Crew size adjustments impact cost curve

SIPS Schedule Results

Finish Scenario	*Start*	*Finish*	*Duration*	*Saved Duration*	*Days Complete Before BL Finish*	*Cost Increase*
Baseline Schedule	14-Feb-12	5-Feb-13	256	-	-	$ -
"Perfect" Matrix	14-Feb-12	18-Oct-12	178	78	78 Days	$ -
SIPS w/ 4+2 Shoring	14-Feb-12	13-Nov-12	196	60	60 Days	$ -
SIPS w/ 2+2 Shoring	2-Jan-12	10-Oct-12	203	53	85 Days	$ 200,000.00

- Slab redesign with SIPS = $2,350/saved day
- Liquidated Damages = approx. $10,000/day after Substantial Completion
- Financially beneficial to owner

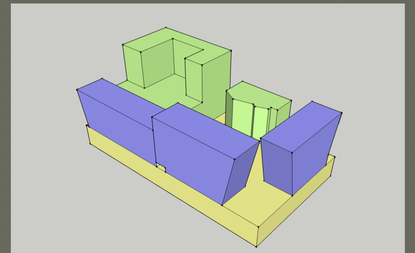
Mechanical Chases and Design Coordination

OUTLINE

Goal of Analysis #4

- To assess the impacts of adding mechanical pipe chases to the garage on design coordination and project cost.

Design Coordination



Architect - Hickok Cole Structural - Structura MEP - Hoffman Borowski	Architect – Davis, Carter, Scott Structural – Luis Fernandez MEP – Jordan & Skala	Architect – Murphy/Jahn Structural – Thorton Thomasetti MEP – GHT Chartered

- 3 Separate Design Teams
- Penetration Coordination difficult with varying stages of design

OUTLINE

Mechanical Breadth

Roof Drains

Reston 100 Year Storm = 3”/hour

Flat Roof Slope = ¼” / Ft.

Assumes Consolidation to 1 Pipe

Building	Total Roof Area (SF)	Largest Roof Drain Pipe Size
Office Building 1	30000	10"
Office Building 2	40000	12"
Office Building 3	35400	10"
Apartment 4	58125	12"
Hotel 5	14400	8"

Size of Pipe in.	Flow at ¼ in./ft Slope gpm	*Maximum Allowable Horizontal Projected Roof Areas Square Feet at Various Rainfall Rates*				
		1 in./h	2 in./h	3 in./h	4 in./h	5 in./h
3	48	4640	2320	1546	1160	928
4	110	10,600	5300	3533	2650	2120
5	196	18,880	9440	6293	4720	3776
6	314	30,200	15,100	10,066	7550	6040
8	677	65,200	32,600	21,733	16,300	13,040
10	1214	116,800	58,400	38,950	29,200	23,350
12	1953	188,000	94,000	62,600	47,000	37,600
15	3491	336,000	168,000	112,000	84,000	67,250

OUTLINE

Mechanical Breadth

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12	1953	188,000	94,000	62,600	47,000	37,600
15	3491	336,000	168,000	112,000	84,000	67,250

Sanitary Drains

Slope of Drain Pipe = 1/8" / ft

Assumes Consolidation to 1 Pipe

Exception: 2 Pipes in Apartment due to excessive drop

Building	DFU's	Building Sainitary Drain Size
Office Building 1	468.5	6"
Office Building 2	244	5"
Office Building 3	202	5"
Apartment 4 (A)	3116	12"
Apartment 4 (B)	3116	12"
Hotel 5	1478	8"

Table of Drainage Fixture Unit Values	
Automatic Clothes Washer	2
Shower	2
Dishwashing Machine	2
Lavatory	1
Kitchen Sink	2
Service Sink	2
No-Flush Urinal	0.5
Water Closet (Private)	3
Water Closet (Public)	4

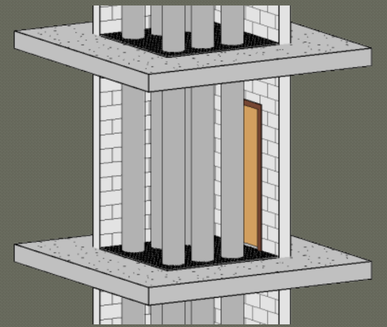
TABLE 22.5 Building Drains and Sewers

Diameter of Pipe		*Maximum Number of dfu Connected to Any Portion of the Building Drain or Building Sewer, Including Branches of the Building Drain* *Fall, in. per ft (% slope)*				
in.	mm[b]	¼ (0.5%)	⅜ (1.04%)	½ (2.1%)	⅝ (4.2%)	
2	51			21	26	
2½	64			24	31	
3	76		36	42	50	
4	102		180	216	250	
5	127		390	480	575	
6	152		700	840	1000	
8	203	1400	1600	1920	2300	
10	254	2500	2900	3500	4200	
12	305	3900	4600	5600	6700	
15	381	7000	8300	10,000	12,000	

OUTLINE

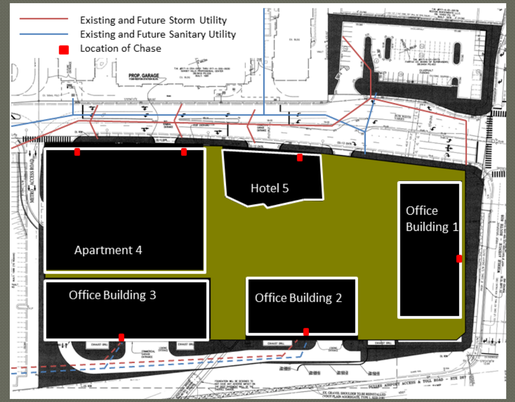
Chase Design

- 8” CMU Partition Walls
- Outward Swinging Doors
- Steel Grating
- 6’ x 8’



OUTLINE

Mechanical Chases and Design Coordination



Location For Chases

The Good

- Perimeter locations simplify connection to exterior
- Could coincide with stairwell or elevator shaft location

The Bad

- 10 Public and 12 Private Parking Spaces lost

OUTLINE

Mechanical Chases and Design Coordination

Reston Station Phase 1 Garage
Reston, Virginia
Jon Fisher | Construction Management

Recommendation

- Cost prohibitive
- Further investigation needed for achieving better design coordination efforts

The Ugly

Cost of Chases

Item	Unit	Quantity	Labor (Unit Cost)	Material (Unit Cost)	Equipment	Total Labor	Total Material	Total Equipment
Steel Grating	SF	1008	$ 14.85	$ 4.50	$ 2.49	$ 14,968.80	$ 4,536.00	$ 2,509.92
Steel Angles	Ea	56	$ 56.00	$ 29.50	$ -	$ 3,136.00	$ 1,652.00	$ -
HM Doors	Ea	28	$ 560.00	$ 39.00	$ -	$ 15,680.00	$ 1,092.00	$ -
HM Frames	Ea	28	$ 199.00	$ 44.00	$ -	$ 5,572.00	$ 1,232.00	$ -
CMU Block	SF	6688	$ 2.40	$ 4.34	$ -	$ 16,051.20	$ 29,025.92	$ -
Concrete Expansion Anchors	Ea	280	$ 2.38	$ 3.07	$ -	$ 666.40	$ 859.60	$ -
					Total	$ 56,074.40	$ 38,397.52	$ 2,509.92
					Tax		$ 2,303.85	
					Total	**$ 99,285.69**		

Chase Cost = $99,000

12" Core Drills

unit	Quantity	Material	Labor	Equipment	Total Cost
Ea	132	$ 2.75	$ 71.02	$ 12.16	$ 11,001.54

Core Drill Cost = $11,000

OUTLINE

Final Conclusions

Public-Private Partnerships: Good research, caution needed when working with a PPP

Bonded Warehouses: Shows benefit for month-to-month short term needs but leasing is cost prohibitive for Reston

SIPS Scheduling: Biggest impact on schedule comes from design delays. SIPS could have helped in hindsight.

Mechanical Chases: Cost prohibitive

OUTLINE

Acknowledgements

Penn State Architectural Engineering Faculty

Friends, Family and God

Industry Members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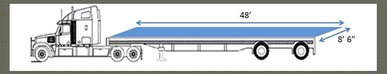
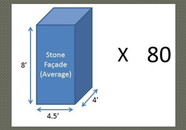
Questions?

Appendix (Bonded Warehouses)





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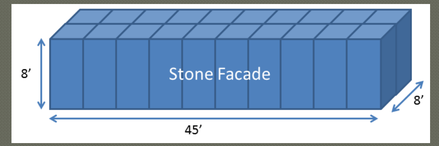

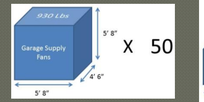

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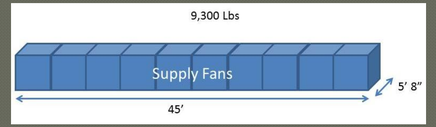

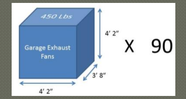

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Cost of Renting Bonded Warehouse Space (Short Term Limited Use)

Storage Costs

Item	Cost	Quantity	Unit	Duration (mo)	Total	Notes
Oversize Pallets For Fans	$ 20.00	220	/pallet/m	2	$ 8,800.00	Transwestern Estimate
Drop Trailer Rental	$ 150.00	4	/mo	6	$ 3,600.00	England Logistics Quote
Drop Trailer Drop off/ Pick up	$ 125.00	8	Ea		$ 1,000.00	England Logistics Quote
40 foot drop trailer storage	$ 300.00	4	/drop trail	6	$ 7,200.00	Transwestern Estimate
				TOTAL	$ 20,600.00	

Transportation Costs

Item	Cost	Quantity	Unit		Total	Notes
"Live Load" delivery of fans and stone	$ 400.00	14	/ Load		$ 5,600.00	England Logistics Quote
"Live Load" delivery of escalator drop trailers	$ 500.00	4	/Load		$ 2,000.00	England Logistics Quote
				TOTAL	$ 7,600.00	

Value of Goods Being Stored and Transported

Item	Cost	Quantity	Unit		Total	Notes
Granite Stone Façade	$ 18.00	10200	SF		$ 183,600.00	
Garage Supply Air Fans	$ 3,140.00	50	Ea		$ 157,000.00	
Garage Exhaust Air Fans	$ 2,700.00	90	Ea		$ 243,000.00	
Escalator Trusses	$ 110,000.00	2	Ea		$ 220,000.00	
				TOTAL	$ 803,600.00	

Total Cost of Off Site Storage of Limited Items

Storage Cost	$ 20,600.00
Transportation Cost	$ 7,600.00
Bonding (1% Value of Goods)	$ 8,036.00
TOTAL	$ 36,236.00

Cost of Renting Bonded Warehouse Space (Long Term Extensive Use)

Storage Costs

Item	Cost	Quantity	Unit	Duration (Yr)	Total	Notes
Lease on Warehouse Space	$ 12.00	24,643	/SF/Year	3	$ 887,148.00	Minimum 3-year Lease, Transwestern
Bonding	$ 8,871.48				$ 8,871.48	1% of Lease Value
				TOTAL	$ 896,019.48	

Staffing Costs

Team Member	Cost	Quantity	Unit	Duration	Total	Notes
Warehouse Manager	$ 80,000.00	1	/Year	3	$ 240,000.00	Includes Phone + Computer + Benefits
Drivers	$ 70,000.00	2	/Year	3	$ 420,000.00	Includes Phone + Benefits
				TOTAL	$ 660,000.00	

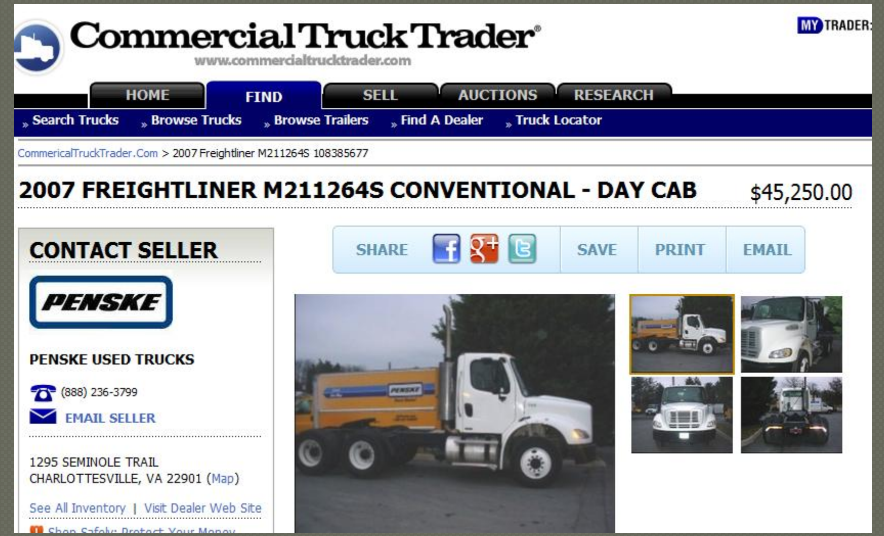
Transportation Costs

Item	Cost	Quantity	Unit	Duration	Total	Notes
Truck (Class 8)	$ 45,000.00	2	Ea		$ 90,000.00	
Flatbed Trailer	$ 15,000.00	1	Ea		$ 15,000.00	
Dry Van Trailer	$ 5,000.00	1	Ea		$ 5,000.00	
Diesel Gas	$ 4.25	16	Gal/Day	765	$ 52,020.00	Duration = Workdays in 3 Years
				TOTAL	$ 162,020.00	

Total Cost of Off Long Term Off Site Storage

Storage Cost	$ 896,019.48
Transportation Cost	$ 162,020.00
Staff	$ 660,000.00
TOTAL	$ 1,718,039.48

Appendix (Bonded Warehouses)



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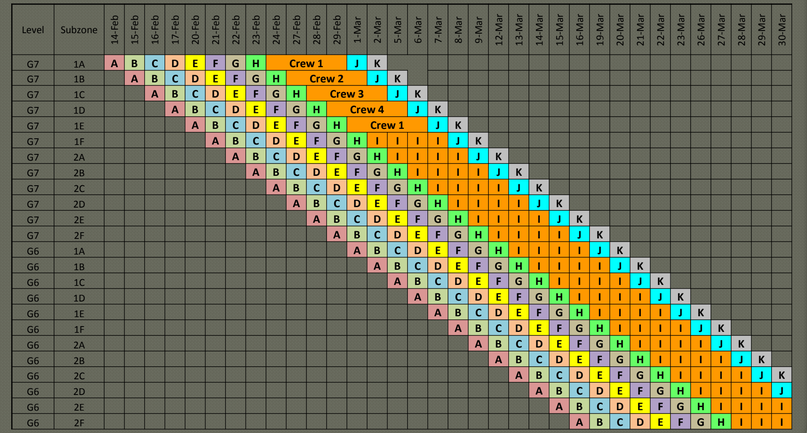
Appendix (SIPS)

Garage Activity Productivity Rates							
Schedule Indicator	Activity	Baseline Duration (Days)	Baseline Sequence Zone Area	Productivity (SF/Man/Day)	SIPS Subzone Area (SF)	# of Workers (Baseline)	# of Workers (SIPS)
A	Layout	5	99,000 SF	9900	8250	2	2
B	Curbs	20	99,000 SF	413	8250	12	20
C	CMU Walls	20	99,000 SF	620	8250	8	14
D	Doors & Hardware	5	99,000 SF	9900	8250	2	2
	Railings	10	99,000 SF	3300	8250	3	3
E	Mech Rough In	10	99,000 SF	2475	8250	4	4
	Electrical Rough In	10	99,000 SF	1650	8250	6	6
F	Plumbing Rough In	20	99,000 SF	495	8250	10	17
G	Sprinkler Rough In	30	99,000 SF	825	8250	8	10
H	Remove Reshores	3	99,000 SF	8250	8250	4	4
	Paint Walls and Ceilings	15	99,000 SF	660	8250	10	13
I	Traffic Coating	24	99,000 SF	1094	8250	8	8
J	Light Fixtures	20	99,000 SF	825	8250	6	10
K	Pavement Markings	5	99,000 SF	3300	8250	6	6



Appendix (SIPS)

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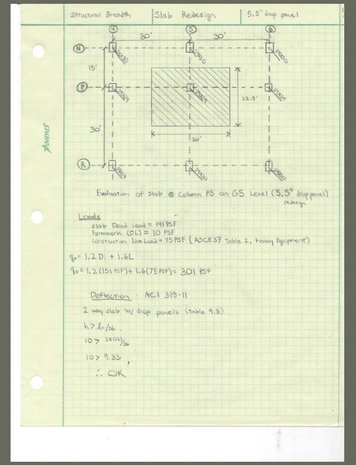

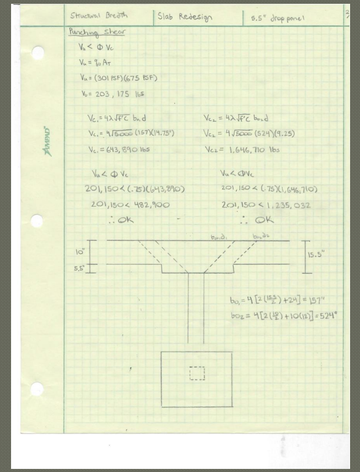

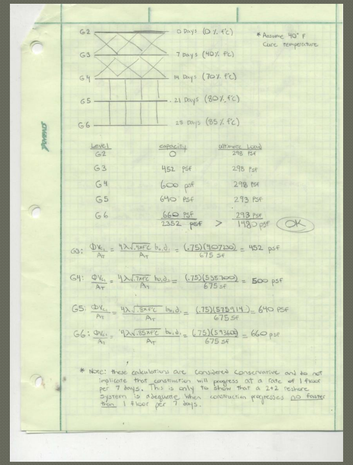

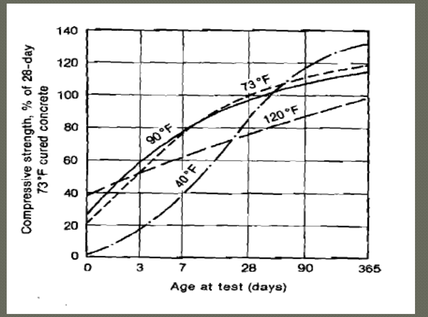

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Appendix (Mechanical Chases)

Apartment 4

Floor	Area	Classification	Area/Occupant (SF)	Studios	1 BR	2 BR	3BR	Water Closets	Lavatories	Showers	Sinks	Dishwashers	Clotheswashers	Service Sink
P1	2700	Assembly	10					8	6					1
	7600	Residential	200	2	3	2		9	9	9	7	7	7	1
	1600	Bussiness	150					2	2					1
P2	10600	Residential	200	2	3	2		9	9	9	7	7	7	1
P3	18150	Residential	200	5	9	3		20	20	20	17	17	17	1
P4	18100	Residential	200	5	9	3		20	20	20	17	17	17	1
P5	17850	Residential	200	5	9	3		20	20	20	17	17	17	1
P6	17850	Residential	200	5	9	3		20	20	20	17	17	17	1
P7	17800	Residential	200	6	8	3		20	20	20	17	17	17	1
P8	17800	Residential	200	6	8	3		20	20	20	17	17	17	1
R9	17800	Residential	200	8	14	8		38	38	38	30	30	30	1
R10	29000	Residential	200	8	14	7		36	36	36	29	29	29	1
R11	29000	Residential	200	5	14	9		37	37	37	28	28	28	1
R12	29000	Residential	200	7	14	9		39	39	39	30	30	30	1
R13	29000	Residential	200	7	14	9		39	39	39	30	30	30	1
R14	29000	Residential	200	7	14	9		39	39	39	30	30	30	1
R15	29000	Residential	200	7	14	9		39	39	39	30	30	30	1
R16	29000	Residential	200	7	14	9		39	39	39	30	30	30	1
R17	28000	Residential	200	7	14	9		39	39	39	30	30	30	1
R18	28000	Residential	200	7	14	9		39	39	39	30	30	30	1
R19	25000	Residential	200		2	7	5	31	41	26	14	14	14	1
R19	25000	Residential	200		2	7	5	31	41	26	14	14	14	1
							Total Fixtures	594	612	574	441	441	441	22
							dfu's	1782	612	1148	882	882	882	44
							Building dfu's	6232						

Office Building 1

Floor	Area	Classification	Area/Occupant (SF)	# of Occupants	Public Water Closets	Urinals	Lavatories	Service Sink
L1	7700	Mercantile	66	117	2	2	2	1
L2	12900	Bussiness	150	86	4	3	4	1
L3	16600	Bussiness	150	111	6	4	4	1
L4	17150	Bussiness	150	114	6	4	4	1
L5	17690	Bussiness	150	118	6	4	4	1
L6	23470	Bussiness	150	156	6	4	4	1
L7	24000	Bussiness	150	160	6	4	4	1
L8	24600	Bussiness	150	164	6	4	6	1
L9	25000	Bussiness	150	167	6	4	6	1
L10	25600	Bussiness	150	171	6	4	6	1
L11	26100	Bussiness	150	174	6	4	6	1
L12	26600	Bussiness	150	177	6	4	6	1
L13	27200	Bussiness	150	181	6	4	6	1
L14	27700	Bussiness	150	185	6	4	6	1
L15	28400	Bussiness	150	189	6	4	6	1
				Total Fixtures	84	57	74	15
				dfu's	336	28.5	74	30
				Building dfu's	468.5			

Office Building 2

Floor	Area	Classification	Area/Occupant (SF)	# of Occupants	Public Water Closets	Urinals	Lavatories	Service Sink
L1	14000	Mercantile	66	212	2	2	2	1
L10	25720	Bussiness	150	171	6	4	6	1
L11	26150	Bussiness	150	174	6	4	6	1
L12	26535	Bussiness	150	177	6	4	6	1
L13	38070	Bussiness	150	254	8	6	6	1
L14	38500	Bussiness	150	257	8	6	6	1
L15	38900	Bussiness	150	259	8	6	6	1
				Total Fixtures	44	32	38	7
				dfu's	176	16	38	14
				Building dfu's	244			

Office Building 3

Floor	Area	Classification	Area/Occupant (SF)	# of Occupants	# Water Closets	Urinals	# Lavatories	Service Sink
L1	7000	Mercantile	66	106	2	2	2	1
L10	25600	Assembly (A-4)	25	1024	20	12	7	1
L11	26100	Assembly (A-4)	25	1044	20	12	7	1
				Total Fixtures	42	26	16	3
				dfu's	167	13	16	6
				Building dfu's	202			

Hotel 5

Floor	Area	Classification	Area/Occupant (SF)	Hotel Rooms	Water Closets	Lavatories	Showers	Service Sink
P1	15000	Assembly	25		12	8	0	1
P2	15000	Residential	200	20	20	20	20	1
P3	15000	Residential	200	20	20	20	20	1
P4	15000	Residential	200	20	20	20	20	1
P5	15000	Residential	200	20	20	20	20	1
P6	15000	Residential	200	20	20	20	20	1
P7	15000	Residential	200	20	20	20	20	1
P8	15000	Residential	200	20	20	20	20	1
P9	15000	Residential	200	20	20	20	20	1
P10	15000	Residential	200	20	20	20	20	1
P11	15000	Residential	200	20	20	20	20	1
				Total Fixtures	212	208	200	11
				dfu's	848	208	400	22
				Building dfu's	1478			