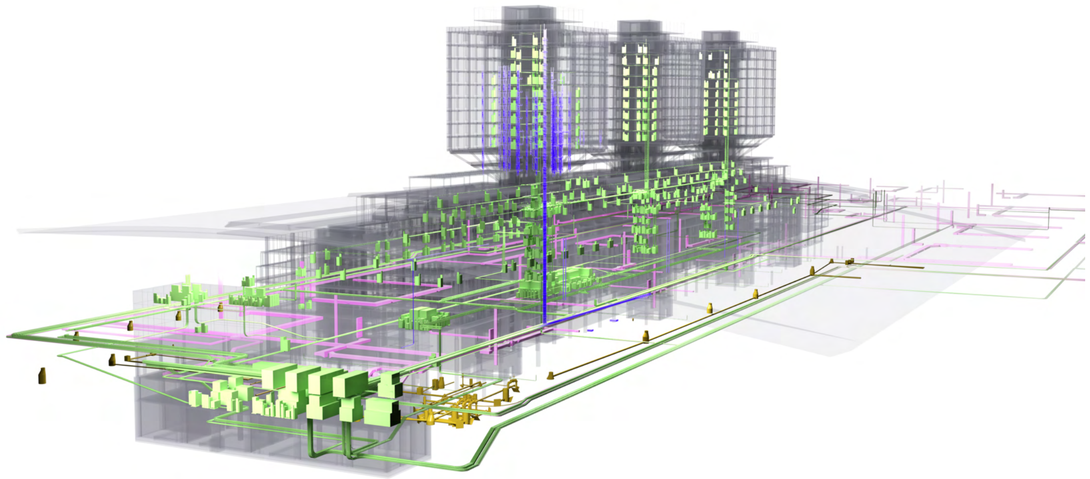
ENHANCED DESIGN

Statement of Qualifications



CONTENT

Design Optimization Exhibits

EXECUTIVE SUMMARY

Over the course of four weeks our team performed an initial review of a confidential multi-billion dollar project in search of design and constructability optimizations. Our goal was to demonstrate to the Owner that by engaging our team throughout the remaining design stage we can provide significant and quantifiable cost and time savings. This is achieved by applying our Model-Based Design Validation & Optimization process. This process enables us to validate design constructability, propose VE design alternates, identify and collaboratively resolve design conflicts and omissions, spatially coordinate all systems, and deliver an enhanced construction-ready bid package. Without implementing this model-based process during the design stage the Owner misses out on a huge opportunity to identify and capture savings and mitigate risk.

Work Performed:

Due to the short period of time allocated for this initial effort, we selected this exhibit and proceeded as follows:

1. Review the 50% CD plans, specs, and design models to identify 20+ areas of focus that could have potential savings.
2. Develop MEP System models and coordinate them with the design models
3. Cut the areas of focus in half by removing items that were either lacking in design clarity necessary to complete our analysis or could not be completed within the time allocated.
4. Complete model-based analysis and provide quantities and drawing exhibits. For review with the construction manager; incorporate feedback; select five examples to share with the Owner
5. Finalize quantities and drawing exhibits and support of the CM firm with the cost savings estimate

Total VEC Investment: approx. $150,000 in fees

Results:

Design Optimization Savings: $15,096,050 = 100x ROI

Although we have only scratched the surface with this initial effort, I hope we have succeeded in demonstrating the value our team could bring to the Owner if our process and team was applied project-wide in parallel with the remaining design schedule. I look forward to sharing more about our process and expected results, our team, and how we help the best build better. Thank you for the opportunity to provide this initial review and analysis; I look forward to speaking with you soon.

Better Together,

Shane Saltzgiver

Founder & CEO

Design and construction experience combined with the meticulous application of technology deliver results that caused one of our clients to admit ‘this shouldn’t feel this easy’

Shane Saltzgiver,
Founder & CEO

COMPANY OVERVIEW

VEC is paving the way in digital transformation for the AEC industry. As a **BIM/VDC service provider**, we have deep roots woven with first-hand **construction** and **engineering** project delivery backgrounds. That provides us with a construction-first, technology-second mindset. We love what we do, our VEC community, and **helping the best build better**.

With vast **expertise in BIM, virtual design, and construction technologies**, VEC is a constantly growing business working with leading architects and contractors. Our company is among **the most experienced BIM and VDC vendors in the United States**. That allows us to assist customers in designing, building, and managing projects more effectively, leverage BIM advantages, and ensure the proper project lifecycle.

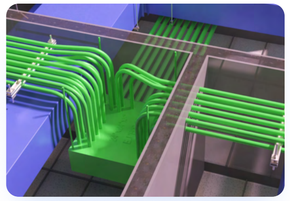
CERTIFICATIONS

MBE LBE DBE SBE

CORE SERVICES

Enhanced Design

We help bridge the gap between design and construction by leveraging our proprietary process and vast experience in preconstruction for our owner and developer clients. Partnering with VEC early during design produces enhanced construction documents that can deliver accurate material quantities at bid time, identify and resolve installation risk during preconstruction, and accelerate installation to deliver incredible project results.

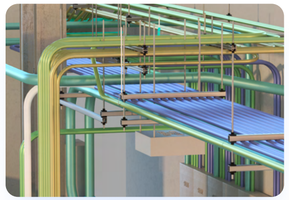


VDC Coordination Management

Built from the field, our team leverages prior experience in field management and real-world MEP trade coordination to deliver the highest possible value. Leveraging this knowledge, VEC addresses the demand for better processes to provide all stakeholders with a project-specific BIM Execution Plan (BEP). We manage coordination on a simple platform providing our clients with precise data to keep the team on schedule.

Onsite Quality Control

Despite the project stage or type, there can always be some critical gaps to realize. But with our onsite quality service and onsite technologies, clients will obtain the required clarity. By establishing a streamlined process, VEC's specialists can effectively assess the existing site conditions, identify potential issues or risks, recommend solutions, and work collaboratively with your team.

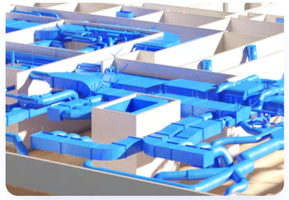


Electrical BIM & VDC

Since the electrical scope presents one of the most significant challenges regarding design and installation, our electrical BIM/VDC specialists strive to eliminate risks and deliver projects successfully. From project kickoff to installation, we provide customers with the most optimized system possible, coordinating our electrical 3D modeling with their project teams.

Civil Underground BIM & VDC

VEC offers both Wet and Dry Utility Modeling & Coordination, both of which are complex in their own right. It is important to make sure what is going into the ground is coordinated properly to avoid costly field rework. Once coordinated our model can be utilized to create layout points for installation. Also, installation drawings can be provided which can be used in the field to verify that installation is going to plan.

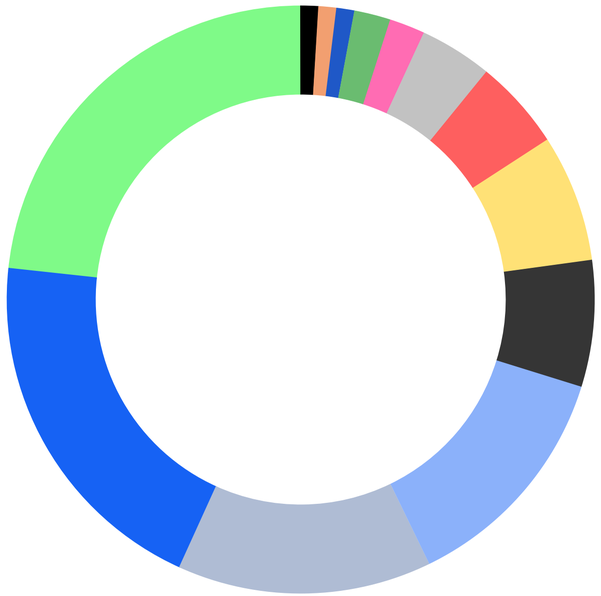


Mechanical and Plumbing BIM & VDC

We keep the mechanical systems installer in mind at each design stage: 3D modeling, coordination, and drawing production. Bringing the field installation to the forefront enables our mechanical BIM specialists to reduce different productivity deterrents and to allow for significant time and material savings.

COMPANY EXPERTISE

Diverse project types



21%	Data Centers	4%	Energy
20%	Aviation	2%	Tech-Commercial
14%	Healthcare	2%	Education
13%	Commercial	1%	Residentinal
7%	Public Works	1%	Education/Health Care
7%	Residential	1%	Institutional
5%	Pharma &Life Science		

WHO WE WORK FOR

Meta

TESLA

EQUINIX

Microsoft

Google

amazon

WHITING-TURNER

LAX

AECOM

CLARK CONSTRUCTION

WHO WE WORK WITH

ROSENDIN

REDWOOD ELECTRIC GROUP

PRIME ELECTRIC

Spiig

McMillan ELECTRIC

OG Power On

M.C. DEAN BUILDING INTELLIGENCE

TAFT ELECTRIC Since 1946

GETTING TO KNOW THE TEAM

Shane Saltzgiver

Founder & CEO

- 23 years of AEC industry experience —
  14 years as BIM/VDC consultant (Founder of VEC in 2011),
  6 years as electrical subcontractor (St. Francis Electric),
  3 years as general contractor (Pankow, Straub)
- BS Degree: Construction Management,
  Cal Poly San Luis Obispo
  Minor Degree: CRP Real Property Development

Ivana Gery

Director - Finance & Administration

- 13 years of AEC industry experience —
  5 years in Financing (VEC), 8 years in Financing
  (St. Francis Electric)
- BS Degree: Masters of Business Administration,
  California State University of East Bay

Oleg Osadchyi

Vice President of VDC Operations

- 13 years of AEC industry experience —
  6 years as BIM/VDC consultant (VEC), 4 years as GC
  (James R. Thompson, Inc.), 3 years of field experience
  (Tufco Flooring LLC)
- BS Degree: Construction Management,
  Northern Kentucky University
  Minor Degree: Business Administration

Kharlo Barcenas

Head of Sales & Marketing

- 17 years of AEC industry experience —
  3 years as BIM/VDC consultant (VEC), 14 years as GC
  (Turner, BCCI, STO Build Group)
- BS Degree: Civil Engineering,
  San Jose State University

Don Interdonato

Director of Development

- 25 years of AEC industry experience —
  9 years as BIM/VDC consultant (VEC, Microdesk), 11 years
  as MEP Engineering Consultant (WSP Group Lincolne
  Scott), 5 years as electrical subcontractor
  (Cupertino Electric Inc.)
- BS Degree: Business Administration,
  Centenary University

Kevin Williams

Senior Project Manager - VDC Coordination Management

- 14-years in the Construction Industry —
  <1 year as BIM/VDC consultant (VEC), 4 years as general
  contractor (McCarthy Building Company), 10 years as GC
  (MATT Construction)
- BS Degree: Construction Management,
  Cal Poly San Luis Obispo

Britton Eberts

Project Executive - Electrical VDC

- 9 years of AEC industry experience —
  6 years as BIM/VDC consultant (VEC), 2 years as GC
  (Tutor Perini Building Corp.), 1 year as architect
  (Crockett Architects Inc.)
- BS Degree: Architecture, University of Miami
  Minor: Human and Social Development

Rob Ohata

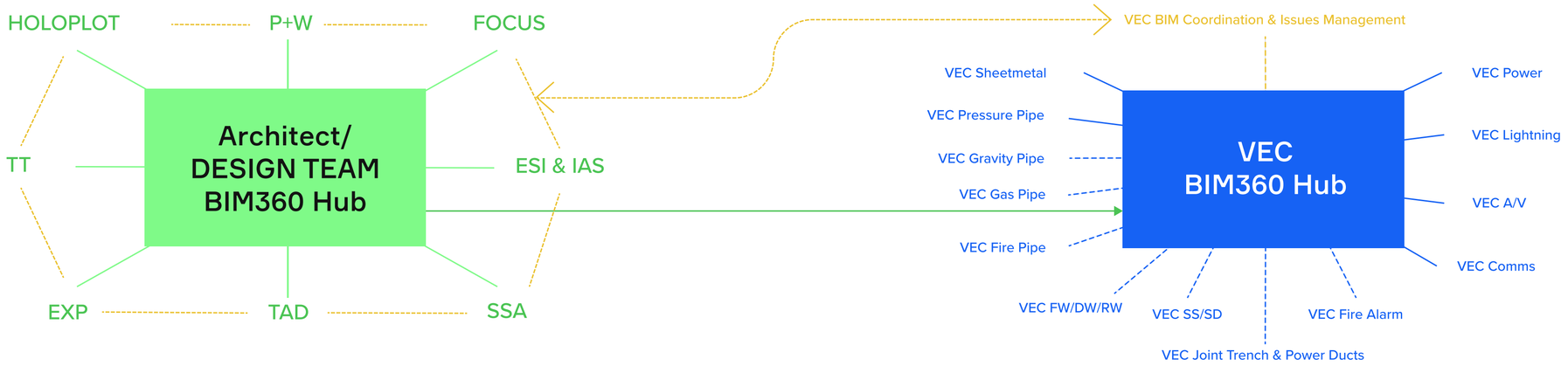
Senior Project Manager - Onsite Quality Control

- 13 years of AEC industry experience —
  5 years as BIM Coordinator & BIM/VDC consultant (VEC)
  8 years of scanning survey technology experience
  (DPSI, Stantec, Sandis)
- BS Degree: Industrial Design,
  California State University of Long Beach

HOW WE WORK WITH A&E DESIGNERS

DESIGN BIM, COORDINATION & PRODUCTION

ENHANCED VDC, COORDINATION & PRODUCTION



CONSTRUCTION DELIVERABLES

- ✓ 100% CD's
- ✓ Specifications
- ✓ Design BIM Models

+

ADDITIONAL OPPORTUNITY FOR CONSTRUCTION BENEFIT

- ✓ Enhanced VDC Models
- ✓ Shop Drawing Templates
- ✓ Preliminary Bill of Materials
- ✓ Preliminary Material Take-Offs
- ✓ Issues Data, Responses & (partial) Resolutions

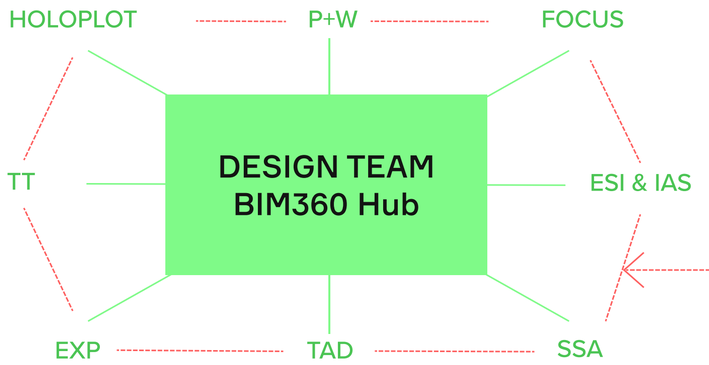
Build Better System

LEGEND

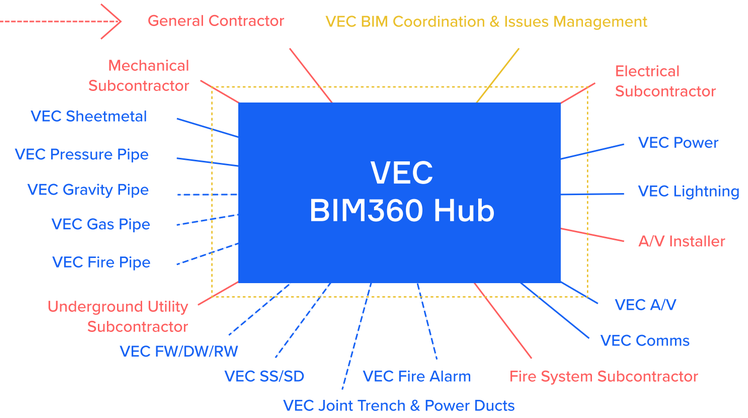
- LOD 300 Models
- Model Copy*
- LOD 400 Models
- Not in Contract
- Issues Creation
- Issues Responses

HOW WE WORK WITH CONTRACTORS

DESIGN BIM, COORDINATION & PRODUCTION



CONSTRUCTION PRECON BIM COORDINATION



CONSTRUCTION DELIVERABLES

- ✓ Resolved Issues
- ✓ Open Issues & Data Tracking
- ✓ Fully Coordinated Models
- ✓ MEP Treade Shop Drawings
- ✓ MEP Treade Install Drawings

+

ADDITIONAL OPPORTUNITY FOR CONSTRUCTION BENEFIT

- ✓ Compressed Coordination Time Period***
- ✓ MEP Trade Model-Based Procurement
- ✓ MEP Trade Model-Based Layout
- ✓ Onsite Installation Validation
- ✓ Change Order Validation from Field Conflicts

***Schedule compression subject to Design Team engagement and responses to issues in prior stage

Build Better System

LEGEND

- Means & Methods
- LOD 400 Models
- Not in Contract
- Issues Creation
- Issues Responses
- RFI
- RFI Responses

WHAT DOES IT LOOK LIKE?

VEC Enhanced coordination management expected itinerary

Expected Activity	Approximate Start	Approximate Stop	Approximate Duration	Legends	P+W	TT	EXP	Focus	Holoplot	ESI & IAS	TAD	VEC	Power GC	Electrical Subcontractor	Mechanical Subcontractor	A/V Installer	Fire Suppression Subcontractor
Architecture BOD Review Meeting	Start of CD phase	1 Meeting	1-1.5 hours	O	P							P					
Structural BOD Review Meeting	Start of CD phase	1 Meeting	1-1.5 hours	O	O	P						P					
Mechanical BOD Review Meeting	Start of CD phase	1 Meeting	1-1.5 hours	O	O		P					P					
Electrical BOD Review Meeting	Start of CD phase	1 Meeting	2 hours	O	O		P					P					
Lighting BOD Review Meeting	Start of CD phase	1 Meeting	2 hours	O	O		P	P				P					
A/V/Comms BOD Review Meeting	Start of CD phase	1 Meeting	2 hours	O	O				P	P	P	P					
Design BIM Issue Responses	Start of CD phase	End of PreCon	As Needed	O	P	P	P	P	P	P	P	P	O				
Design BIM Coordination Meetings	Start of 50% CD's	End of 100% CD's	4-6 Weeks	O	O*	O*	O*	O*	O*	O*	O*	P	O				
Construction BIM Coordination Meetings	Start of PreCom	End of PreCon	2-4 Weeks	O	O**	O**	O**	O**	O**	O**	O**	P	P	P	P	P	P

LEGEND

O: Observer

P: Particapant

*Optional based on Issue Responses

**Dependent on Issues & RFI's

DESIGN OPTIMIZATION SAVINGS

Confidential Multi-Billion Dollar Project

Prepared by CM firm with VEC's support

50% Construction Documents
December 1, 2021

Electrical Feeders to Residential Units - Block 03

Element	50% CD Design			New			Variance	
1 1/4"	313	$54.73	$17,130	313	$54.73	$17,130	0	$0
2 1/2"	74	$108.86	$8,056	74	$108.86	$8,056	0	$0
1 1/2"	7,440	$58.88	$438,067	2,099	$58.88	$123,589	-5,341	-$314,478
1 1/4"	443	$54.73	$24,245	123	$54.73	$6,732	-320	-$17,514
2"	887	$67.24	$59,642	226	$67.24	$15,196	-661	-$44,446
	9,157		**$547,141**	**2,835**		**$170,703**	**-6,322**	**-$376,437**

70% overall reduction in LF of feeders

Mechanical Piping Mains Basement - Total Project

Element	50% CD Design			New			Variance	
HPWR/S Piping LF	4,001	$557.00	$2,228,557	2,998	$557.00	$1,669,886	-1,003	-$558,671
	4,001		**$2,228,557**	**2,998**		**$1,669,886**	**-1,003**	**-$558,671**

25% overall reduction in LF of piping

Residential Unit Overhead Piping - Total Project

Element	50% CD Design	New	Variance
Domestic Water (Excl 3" & 4" Piping)	$9,761,660	$7,809,328	-$1,952,332
Waste / Vent	$11,260,760	$9,008,608	-$2,252,152
	$21,022,421	**$16,817,936**	**-$4,204,484**

20% overall reduction in LF of piping

Modular Plumbing Fixture Walls - Residential Units - Total Project

Element	50% CD Design			New			Variance
Plumbing fixtures applicable to modular	9,380	$1,860.00	$17,446,800	9,380	$1,230.00	$11,537,400	-$5,909,400
			$17,446,800			**$11,537,400**	**-$5,909,400**

34% reduction in labor costs

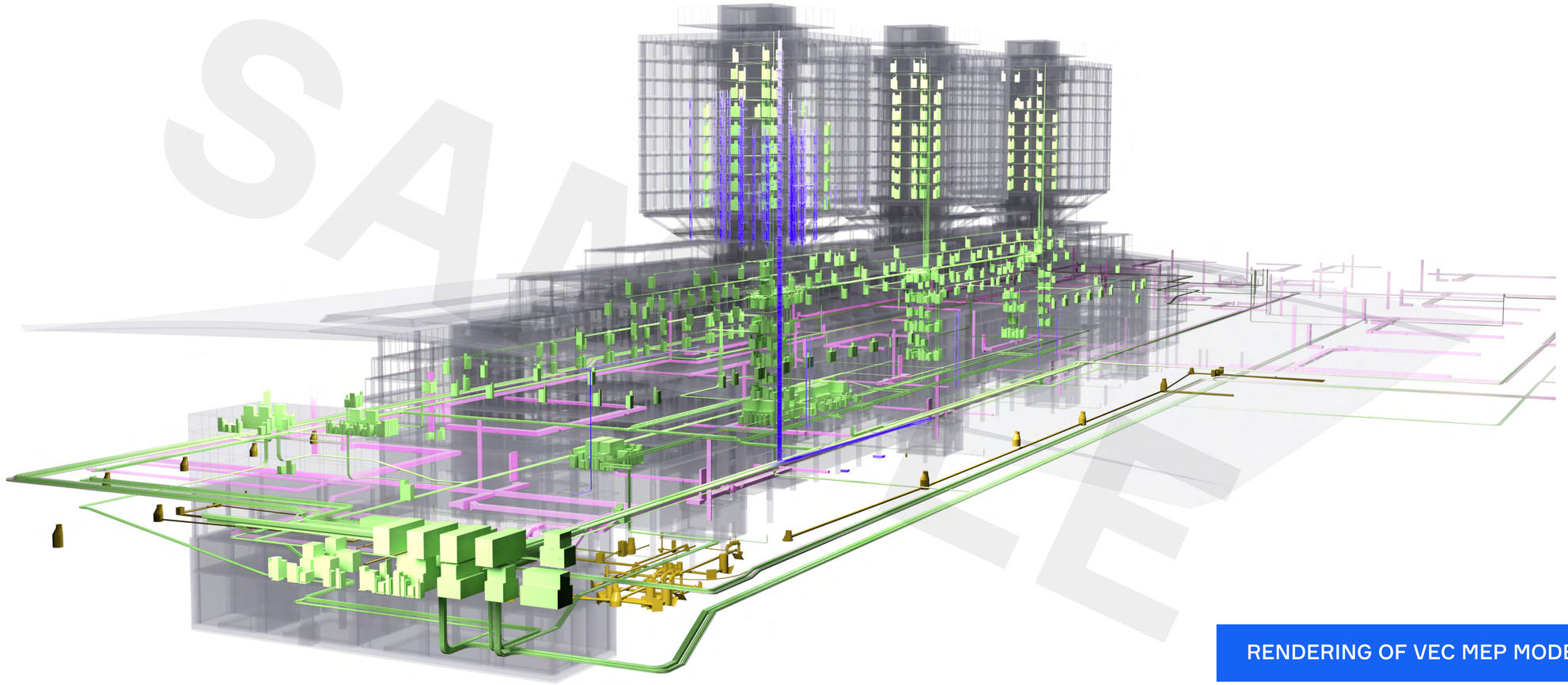
Residential Modular Piping Shaft Prefabrication - Total Project

Element	50% CD Design	New	Variance
Domestic Water (Labor Only)	$1,033,588	$516,794	-$516,794
Waste / Vent (Labor Only)	$1,192,316	$596,158	-$596,158
Natural Gas (Labor Only)	$739,232	$369,616	-$369,616
Hydronic Piping S&R (Labor Only)	$1,190,964	$595,482	-$595,482
	$4,156,100	**$2,078,050**	**-$2,078,050**

50% Reduction in labor costs for all items

Total Cost Savings	-$13,127,000
Total Cost Savings Incl Project Markups	**-$15,096,050**

MEP SYSTEMS MODEL - BLOCK 03



RENDERING OF VEC MEP MODEL

ELECTRICAL FEEDERS TO RESIDENTIAL UNITS

SYSTEM(S): ELECTRICAL FEEDERS SCOPE AREA: BLOCK 03 TOWERS - RESIDENTIAL UNIT FEEDERS AND EL ROOM EQRECOMMENDATION:

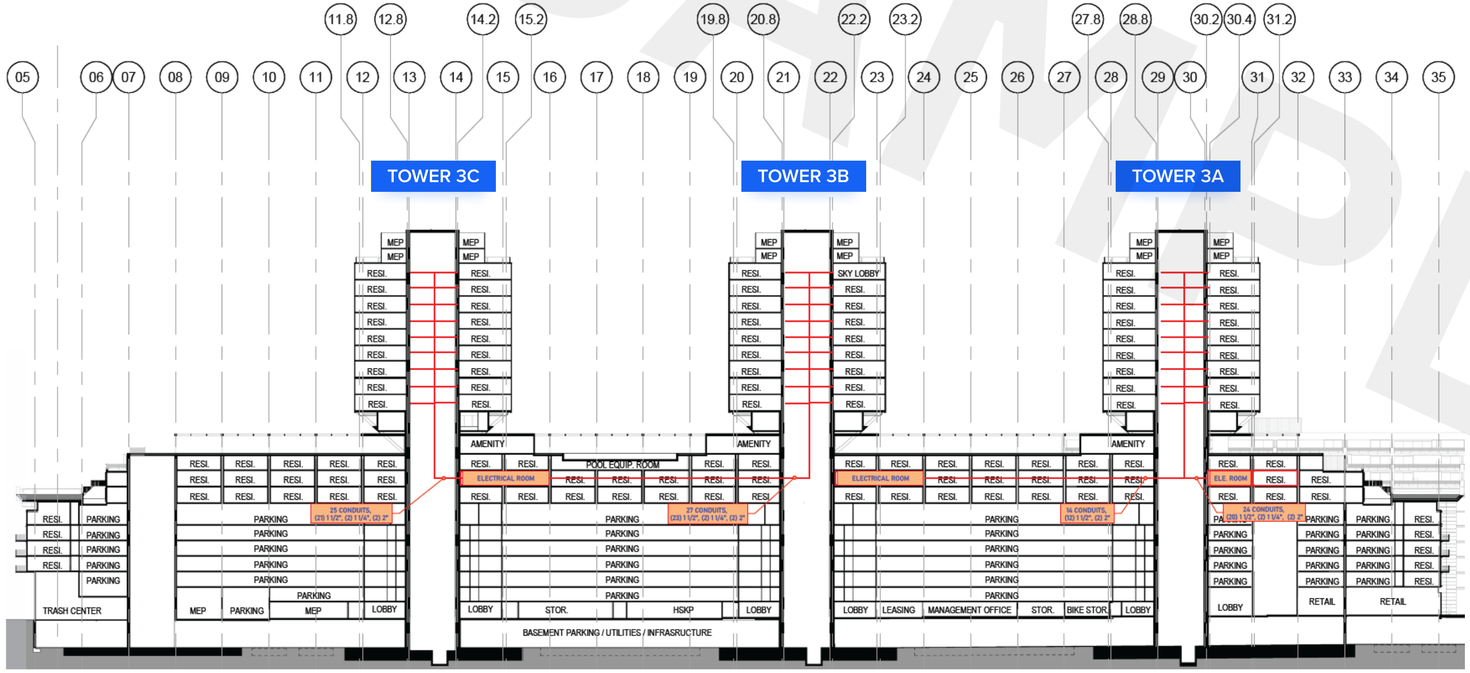
Upon review of the electrical room locations and modeling this distribution, we found that Towers 3B and 3C are being fed by electrical rooms located adjacent to a different tower.
If the equipment in the electrical rooms could be reorganized to feed each tower from the adjacent electrical room this would significantly reduce the feeder lengths and alleviate congestion in the corridors. Our next step would be to confirm equipment sizes (currently we sized the equipment based on amperage and prior experience) then evaluate the layout of each room.
We would also model any additional conduit feeding to/from these rooms so we could analyze the complete picture before suggesting the modified equipment configuration.

SAVINGS SUMMARY:

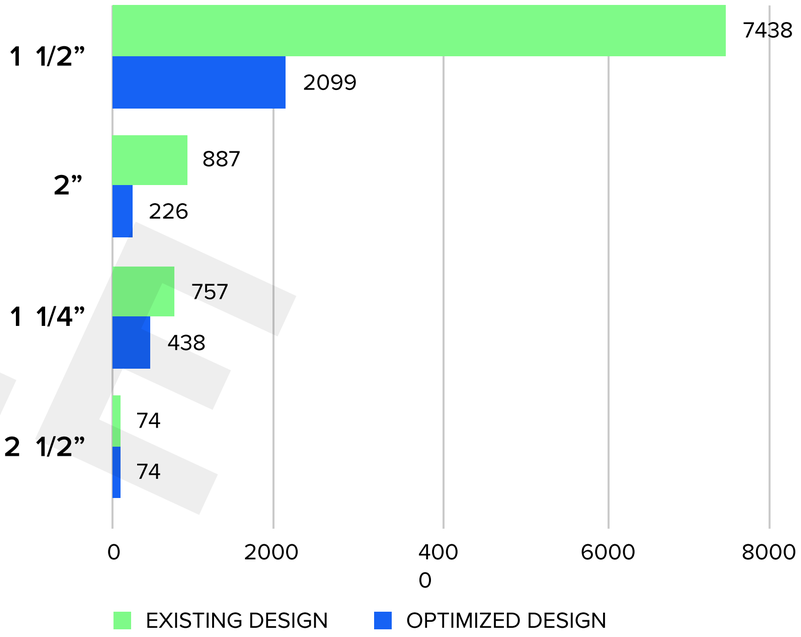
CONDUIT SAVINGS:

70% 6,322 LF

EXISTING DESIGN

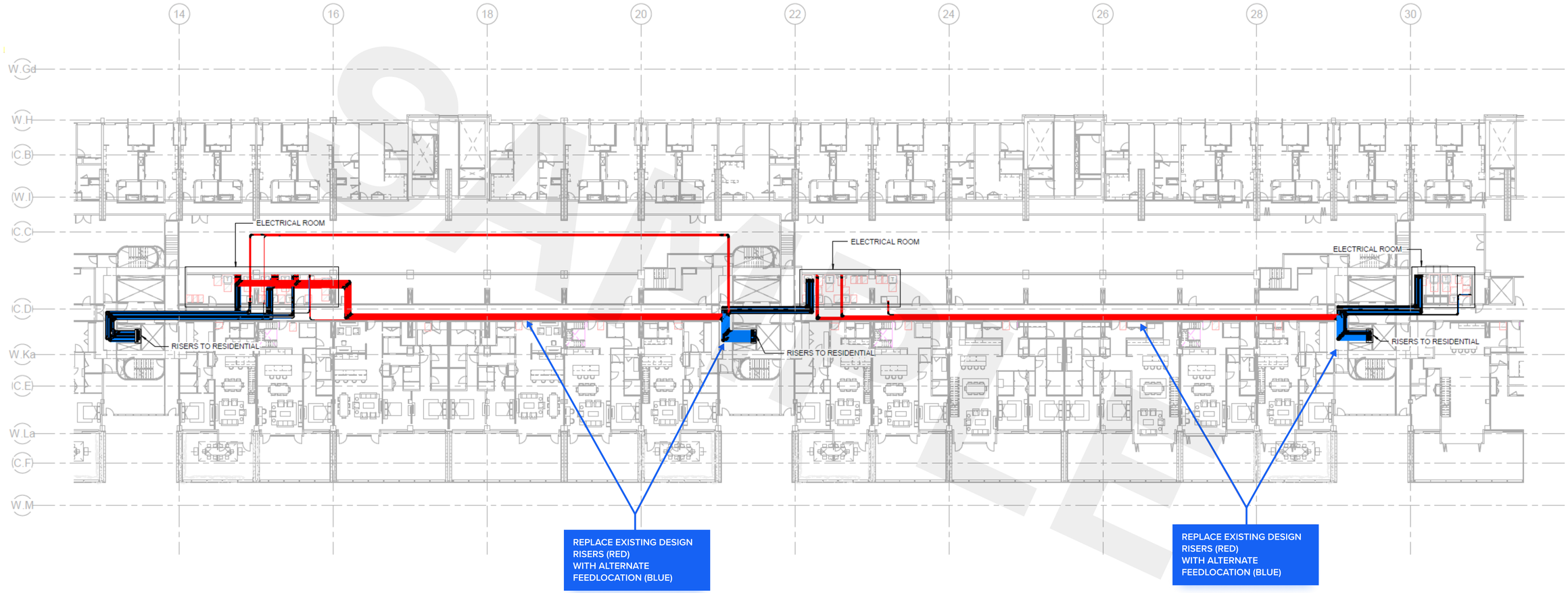


Total length of conduits



ELECTRICAL FEEDERS TO RESIDENTIAL UNITS

ELECTRICAL FEEDERS TO RESIDENTIAL UNITS



MECHANICAL PIPING MAINS - BASEMENT (SHEET 1 OF 3)

SYSTEM(S): MECHANICAL PIPING MAINS SCOPE AREA: BLOCK 03 - BASEMENT OVERHEAD RECOMMENDATION:

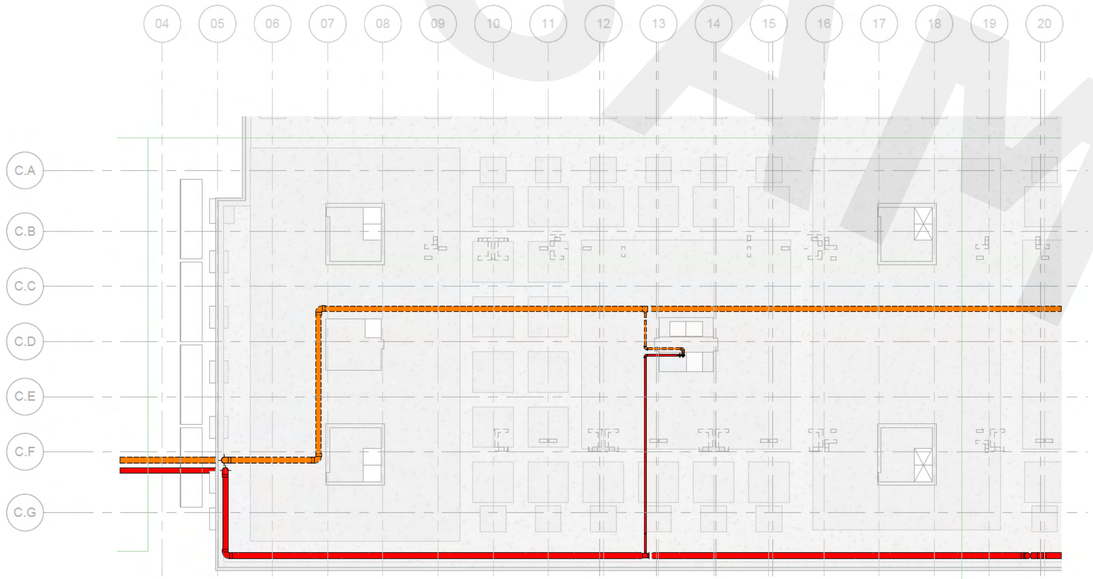
The basement main pipe routing was analyzed for spacing and constructability. We noticed the routing followed the general rule of thumb to support from the shear wall to support the load, while avoiding excessive seismic bracing. However, there is an elevation change which adds additional fittings and offsets. In order to optimize the routing, while also reducing supports and bracing, it was determined that the main 36" routing and supports can be designed with embeds, welded lugs and u-bolts during structural design phase. This would allow the runs to be direct through the shafts. The optimized routing also accounts for fish-mouth welding in lieu of tee fittings for additional cost savings.

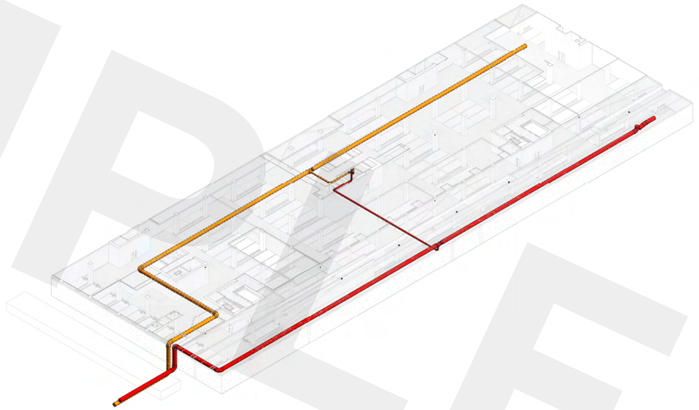
SAVINGS SUMMARY:

PIPE SAVINGS: **25%**

FITTINGS SAVINGS: **50%**

EXISTING BASEMENT ROUTING:





LEVEL B1 - BLOCK 3B - DESIGN PIPE SCHEDULE

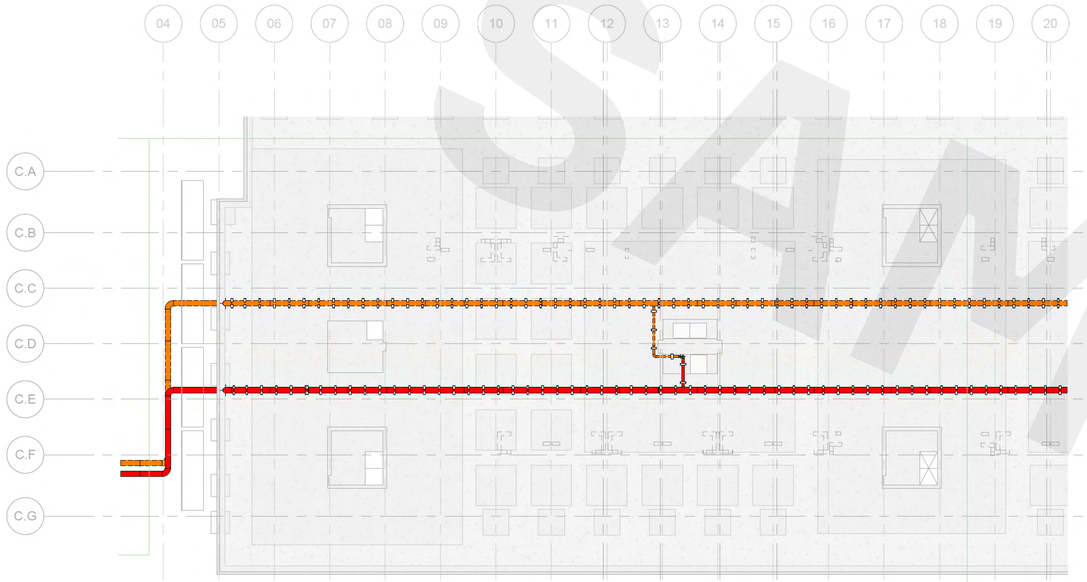
Element	Size	Length	Count
STRAIGHT PIPE	12"ø	13' - 11 5/32"	3
STRAIGHT PIPE	14"ø	166' - 4 21/32"	7
STRAIGHT PIPE	36"ø	1129' - 9 17/32"	14

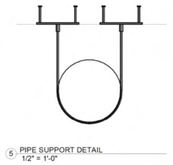
LEVEL B1 - BLOCK 3B - DESIGN FITTING SCHEDULE

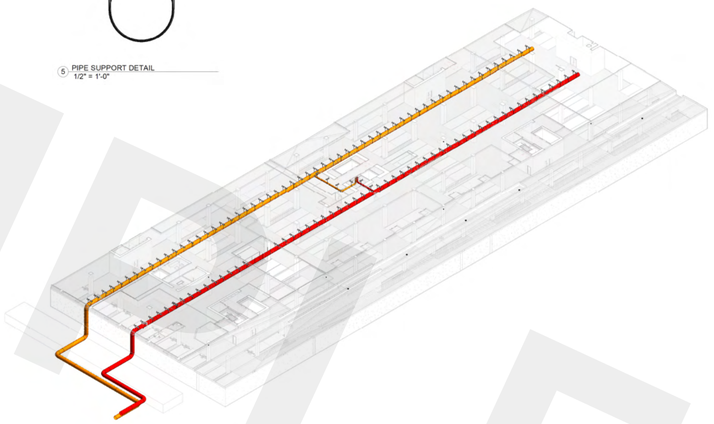
Element	Size	Count
ELBOW - SHORT RADIUS	12"ø-12"ø	1
ELBOW - SHORT RADIUS	14"ø-14"ø	5
ELBOW - SHORT RADIUS	32"ø-32"ø	1
ELBOW - SHORT RADIUS	36"ø-36"ø	8
REDUCER	14"ø-12"ø	2
REDUCER	32"ø-12"ø	1
REDUCER	36"ø-12"ø	1
REDUCER	36"ø-32"ø	5
TEE	32"ø-32"ø-32"ø	1
TEE	36"ø-36"ø-36"ø	1

MECHANICAL PIPING MAINS - BASEMENT (SHEET 2 OF 3)

OPTIMIZED BASEMENT ROUTING:







LEVEL B1 - BLOCK 3B - FABRICATION PIPE SCHEDULE

Element	Size	Length	Count
STRAIGHT PIPE	14"ø	69' - 9 25/32"	6
STRAIGHT PIPE	36"ø	1155' - 9 1/32"	61

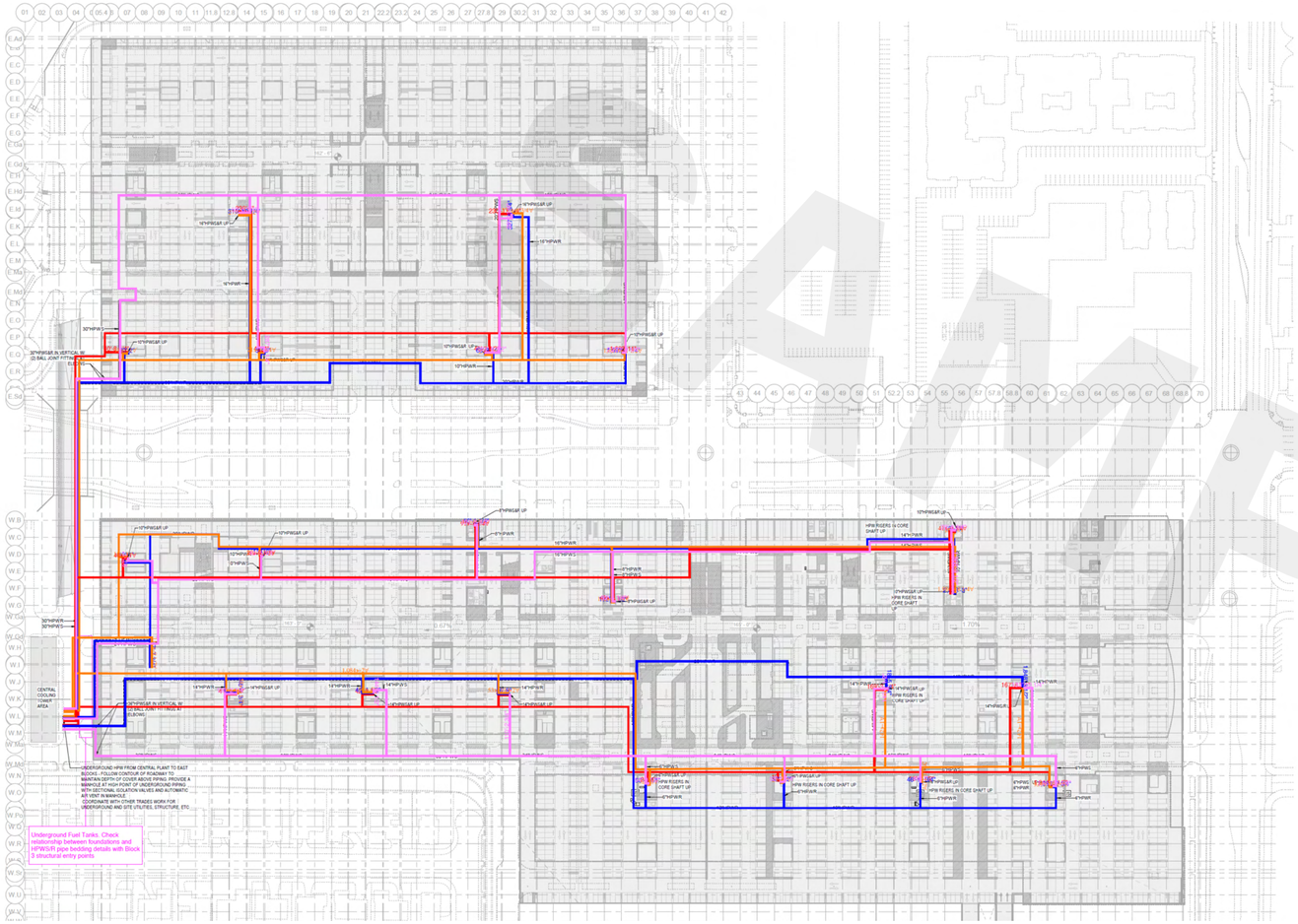
LEVEL B1 - BLOCK 3B - DESIGN FITTING SCHEDULE

Element	Size	Count
ELBOW - SHORT RADIUS	14"ø	3
ELBOW - SHORT RADIUS	36"ø	8
FISHMOUTH	36"ø-14"ø	2

NOTE: NOT FOR CONSTRUCTION. PENDINGSTRUCTURAL CALCULATIONS & THERMALANALYSIS FOR EXPANSION AND CONTRACTION

MECHANICAL PIPING MAINS - BASEMENT (SHEET 3 OF 3)

BLOCK 03 ANALYSIS EXTRAPOLATED PROJECT-WIDE



MECHANICAL PIPING MAINS - BASEMENT

SYSTEM(S): MECHANICAL PIPING MAINSSCOPE AREA:
BLOCK 03 - BASEMENT OVERHEAD RECOMMENDATION:

The basement main pipe routing was analyzed for spacing and constructability. We noticed the routing followed the general rule of thumb to support from the shear wall to support the load, while avoiding excessive seismic bracing. However, there is an elevation change which adds additional fittings and offsets. In order to optimize the routing, while also reducing supports and bracing, it was determined that the main 36" routing and supports can be designed with embeds, welded lugs and u-bolts during structural design phase. This would allow the runs to be direct through the shafts. The optimized routing also accounts for fish-mouth welding in lieu of tee fittings for additional cost savings.

SAVINGS SUMMARY:

PIPE SAVINGS: 25%

FITTINGS SAVINGS: 50%

OVERHEAD PLUMBING - RESIDENTIAL UNITS

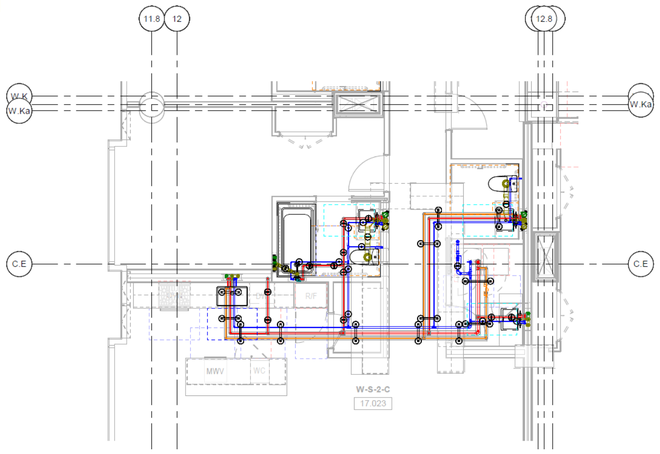
SYSTEM(S): PLUMBING SCOPE AREA: ALL RESIDENTIAL UNITS RECOMMENDATION:

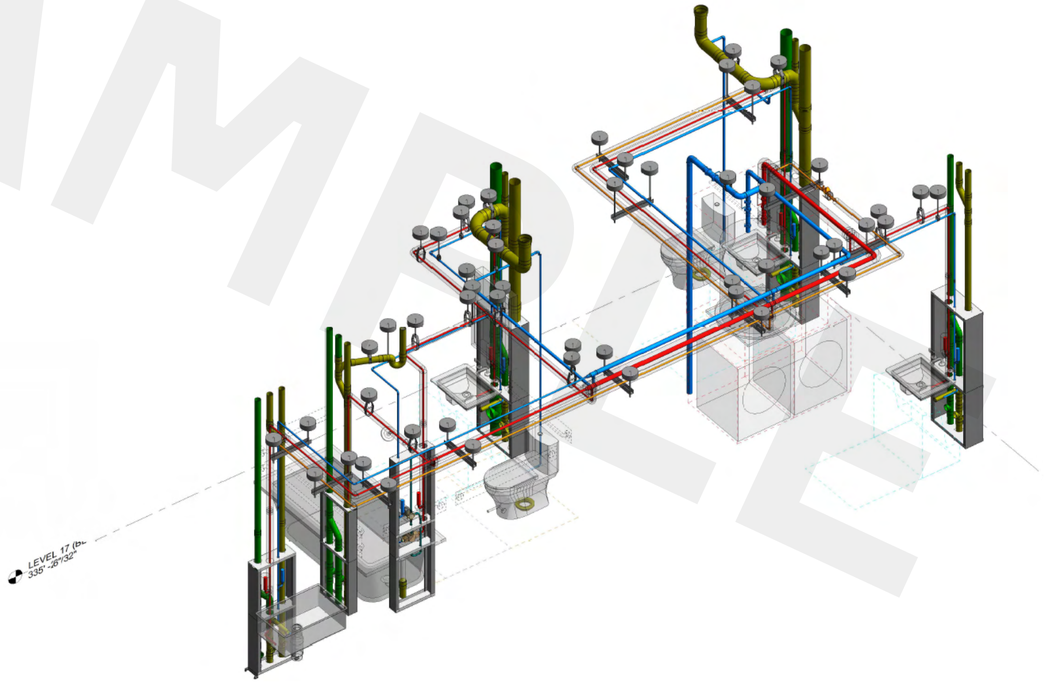
Following our review of typical residential units, it became apparent that the plumbing routing can be optimized to decrease pipe length, fittings and supports. The existing routing shown on the engineered drawings follow common engineering practice to avoid passing through plumbing walls in order to avoid potential conflicts. However, with a well coordinated design, these conflicts can be avoided during design development.

SAVINGS SUMMARY PER UNIT:

PIPE SAVINGS:	FITTINGS SAVINGS:	HANGER SAVINGS:
29%	5%	29%

EXISTING OVERHEAD ROUTING:





TYP. TOWER UNIT - EXISTING ROUTING PIPE

Element	Size	Length	Count
PIPE	1 1/2"ø	32' - 6 5/16"	14
PIPE	1"ø	6' - 6 7/16"	3
PIPE	1/2"ø	162' - 3 17/32"	51
PIPE	2"ø	11' - 4"	4
PIPE	3/4"ø	35' - 1 9/32"	9
		247' - 9 17/32"	
		Grand total	81

TYP. TOWER UNIT - EXISTING ROUTING FITTING SCHEDULE

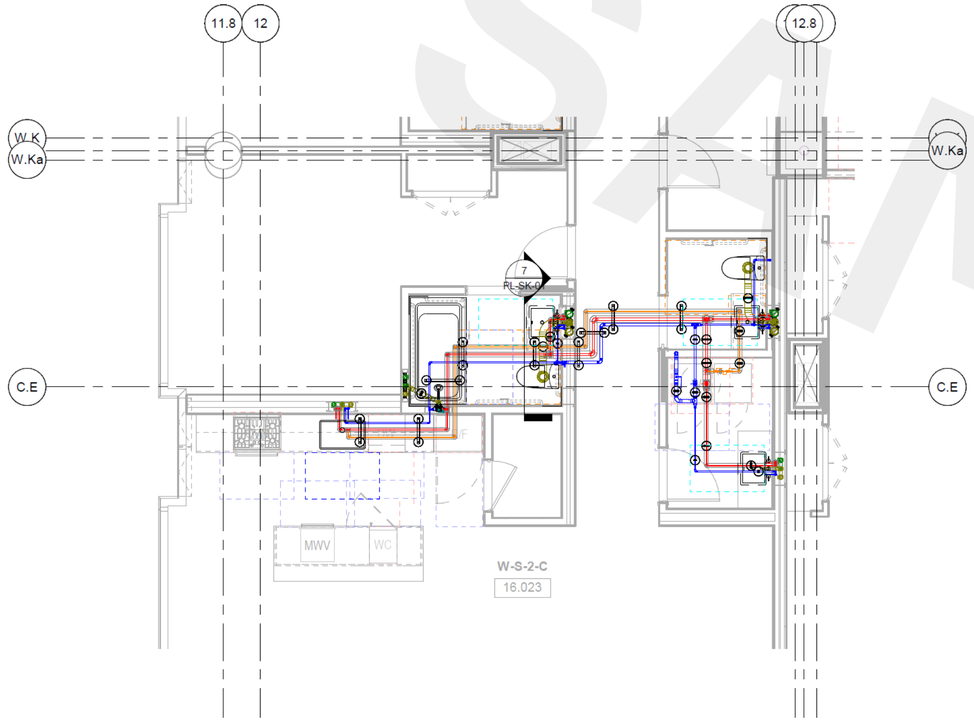
Element	Size	Count
AIR CHAMBER	1/2"ø	2
CIRCUIT SETTER	2"ø-1/2"ø	1
COUPLING	2"ø	1
ELBOW	1 1/2"ø	4
ELBOW	1"ø	1
ELBOW	1/2"ø	33
ELBOW	2"ø	2
ELBOW	3/4"ø	6
PIPE NIPPLE	1/2"ø	3
REDUCER	1 1/2"ø-3/4"ø	1
REDUCER	1"ø-1/2"ø	1
REDUCER	2"ø-1 1/2"ø	2
REDUCING ELBOW	3/4"ø-1/2"ø	1
TEE	1 1/2"ø-1"ø	1
TEE	1 1/2"ø-1/2"ø	5
TEE	1 1/2"ø-3/4"ø	1
TEE	1"ø-1/2"ø	1
TEE	1"ø-1/2"ø-3/4"ø	1
TEE	1/2"ø	4
TEE	2"ø	1
TEE	3/4"ø-1/2"ø	1
TEE	3/4"ø-1/2"ø-3/4"ø	1
UNION	1/2"ø	1
	Grand total	75

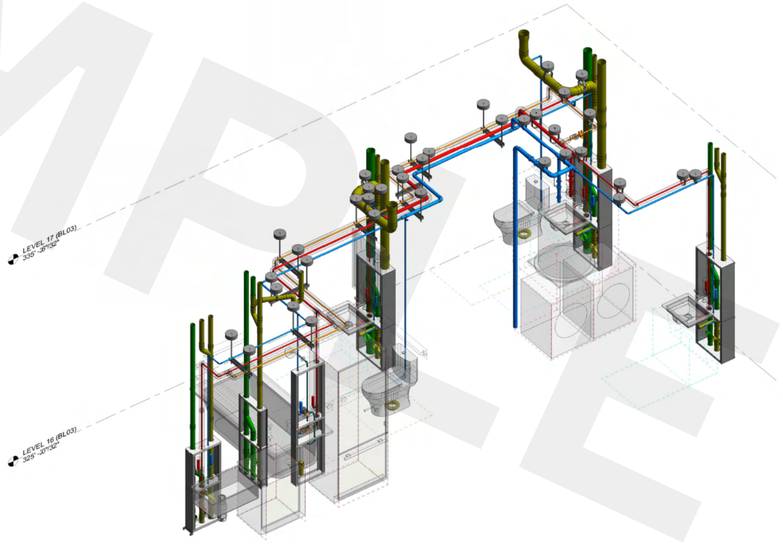
TYP. TOWER UNIT - EXISTING HANGERS SCHEDULE

Element	Count
CLEVIS HANGER	6
CLEVIS HANGER - FELT LINED	10
CLEVIS HANGER - INSULATED	11
UNISTRUT HANGER	13
Grand total	40

OVERHEAD PLUMBING - RESIDENTIAL UNITS

OPTIMIZED OVERHEAD ROUTING:





TYP. TOWER UNIT - EXISTING ROUTING PIPE

Element	Size	Length	Count
PIPE	1 1/2"ø	28' - 0 31/32"	15
PIPE	1"ø	0' - 2 1/2"	1
PIPE	1/2"ø	91' - 11 1/32"	38
PIPE	2"ø	12' - 9 5/32"	5
PIPE	3/4"ø	43' - 1 1/8"	14
		176' - 0 25/32"	
		Grand total	73

TYP. TOWER UNIT - EXISTING ROUTING FITTING SCHEDULE

Element	Size	Count
AIR CHAMBER	1/2"ø	2
CIRCUIT SETTER	2"ø-1/2"ø	1
ELBOW	1 1/2"ø	6
ELBOW	1/2"ø	26
ELBOW	2"ø	2
ELBOW	3/4"ø	8
PIPE NIPPLE	1/2"ø	3
REDUCER	1 1/2"ø-3/4"ø	4
REDUCER	1"ø-1/2"ø	1
REDUCER	3/4"ø-1/2"ø	1
REDUCING ELBOW	3/4"ø-1/2"ø	3
TEE	1 1/2"ø	2
TEE	1 1/2"ø-1"ø-1 1/2"ø	1
TEE	1 1/2"ø-1"ø-3/4"ø	1
TEE	1 1/2"ø-1/2"ø	2
TEE	1"ø-3/4"ø-1/2"ø	1
TEE	1/2"ø	1
TEE	2"ø-1 1/2"ø	1
TEE	2"ø-1 1/2"ø-2"ø	1
TEE	3/4"ø-1/2"ø	2
TEE	3/4"ø-1/2"ø-3/4"ø	1
UNION	1/2"ø	1
	Grand total	71

TYP. TOWER UNIT - EXISTING HANGERS SCHEDULE

Element	Count
CLEVIS HANGER	5
CLEVIS HANGER - FELT LINED	6
CLEVIS HANGER - INSULATED	8
UNISTRUT HANGER	9
Grand total	28

MODULAR PLUMBING FIXTURE WALLS - RESIDENTIAL UNITS

SYSTEM(S): PLUMBING SCOPE AREA: ALL RESIDENTIAL AREAS RECOMMENDATION:

As the drawings were being reviewed, it came to our attention that many residential units in the podium and tower were designed to be typical. This approach creates many prefabrication opportunities. Off-site prefabrication, crane-picking and rolling into place is becoming more common in construction where standardization is possible. It has been proven to decrease time in the construction schedule, while increasing productivity and safety. Our first attempt was to modularize entire residential units. However, given the current state of structural and architectural design, this would create a large impact to the design team. Our second attempt was to modularize plumbing fixture walls. We have experienced on other projects that this approach is less invasive to the current design, while still saving time in coordination and in the field.

SAVINGS SUMMARY PER INSTANCE:

TOTAL INSTANCES IN BLOCK 03: 2,395

Water Closet / Sink:	1059
Shower/Bath Tub:	444
Kitchen Sink:	642
Laundry Sink:	250

FIELD INSTALL METHOD

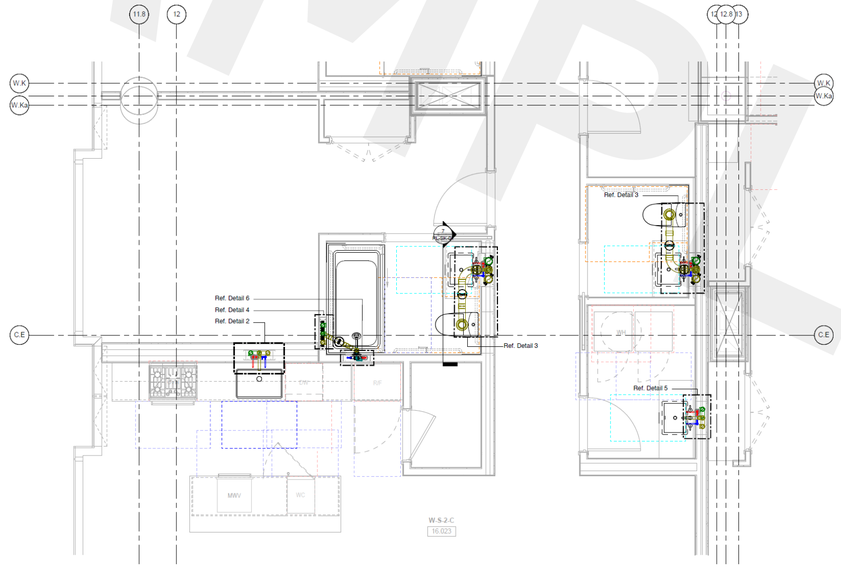
Task	Labor hours	Horly rate	Cost
Wall framing (track & end stubs)	2	$ 120.00	$ 240.00
Pipe cutting & assembly	5	$ 180.00	$ 900.00
Wall strapping at rough-in height	2	$ 180.00	$ 360.00
Insulation (requires re-mobilization)	1	$ 180.00	$ 180.00
Testing (requires re-mobilization)	1	$ 180.00	$ 180.00
Totals	11		$ 1,860.00

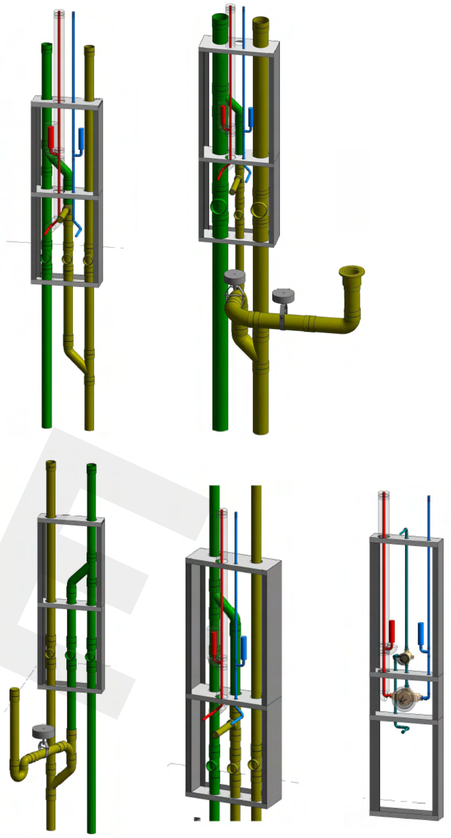
MODULAR PREFABRICATION METHOD

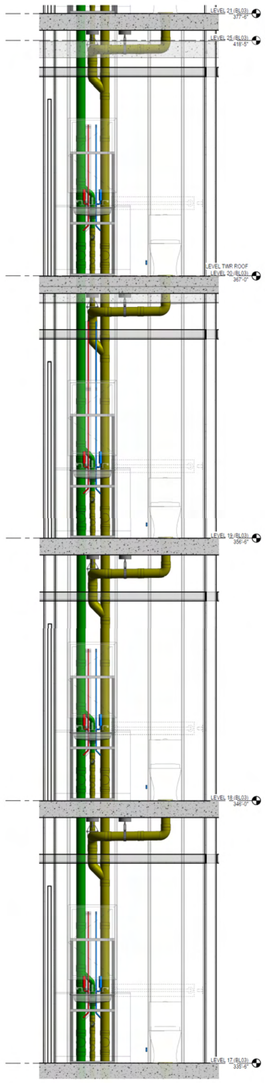
Task	Labor hours	Horly rate	Cost
Frame construction	0.5	$ 120.00	$ 60.00
Pipe cutting & assembly	4	$ 180.00	$ 720.00
Insulation	0.5	$ 180.00	$ 90.00
Testing	0.5	$ 180.00	$ 90.00
Insulation (prior to bottom track)	1.5	$ 180.00	$ 270.00
Totals	7		$ 1,230.00

AVERAGE LABOR SAVINGS PER MODULAR: **$630**

TOTAL INSTANCES PROJECT-WIDE: APPROX. 9,380







MODULAR PIPING SHAFT PREFABRICATION

SYSTEM(S): PLUMBING & MECHANICAL PIPING SCOPE AREA: ALL SHAFT RISERS RECOMMENDATION:

The shafts were reviewed for constructability and spacing. It was discovered that some piping shafts were under-sized and others are independent of shear walls. In addition, there is no current design validation to support the loads. This will lead to a trade coordination and installation means & methods free-for-all. Each trade will assume separate structural, seismic, acoustic and vib-iso engineering. It was determined that there would be considerable savings in engineering, coordination and field labor with a modular cage designed to be crane-picked and lowered into position. See conceptual modular shaft below. The data expressed was derived from the Building and Construction Authority and its (DfMA) Design for Manufacturing and Assembly guidebook.

SAVINGS SUMMARY PER UNIT:

LABOR SAVINGS:

45-60%

The flowchart below shows a possible workflow to implement prefabricated MEP modules in a project.
The next few chapters will explore the good practices for each phase of the flowchart.

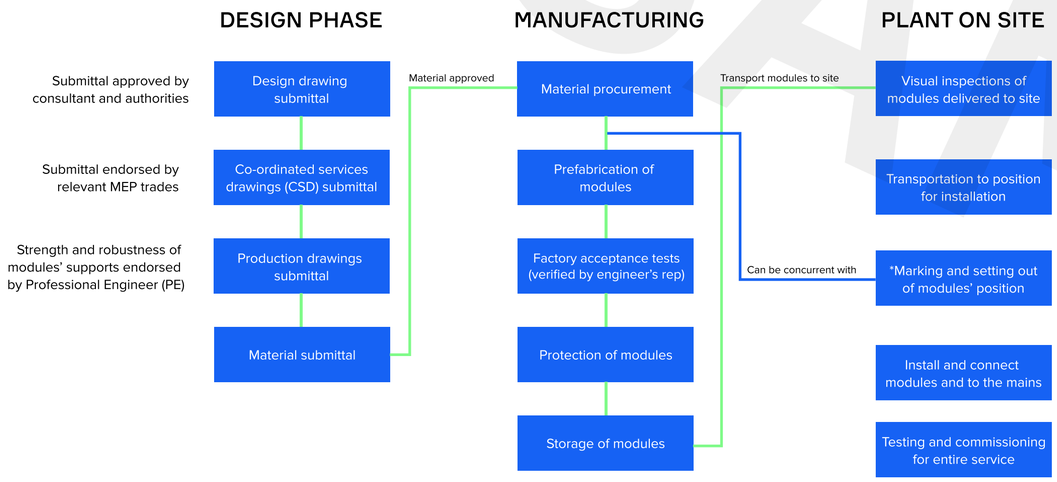


Figure 4: Workflow for prefabricated MEP modules. All the processes indicated are applicable to multiple trades that are integrated within the modules.

1.1. Benefits of prefabricated MEP modules

Increases productivity significantly

- Construction is faster as the production of prefabricated MEP modules/systems in the factory is done concurrently with other activities on site
- Installation of prefabricated MEP modules/ systems on site is easier and quicker, and leads to significant manpower and time savings of up to 60%, depending on the complexity of projects

Reduces impact to the environment

- Dust and noise pollution, as well as other dis-amenities to the surroundings are minimized as more activities are done off-site
- Less construction waste is generated as there is less rectification work

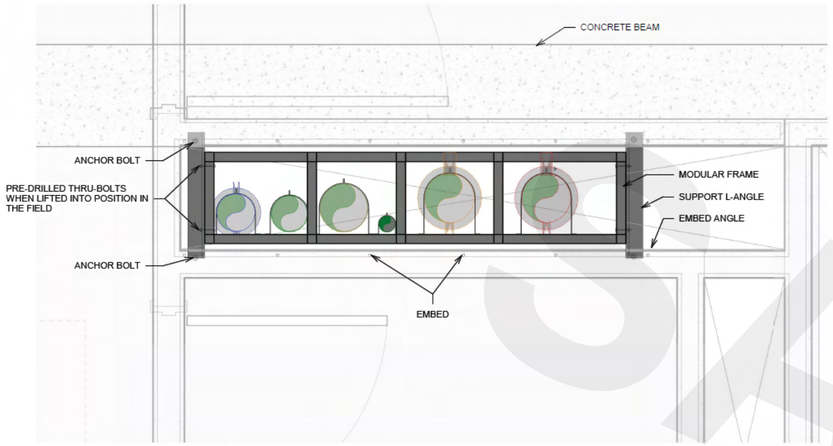
Enhances quality control

- Higher quality control is achieved as most work is done in a controlled factory environment
- Sequence of work can be planned more efficiently with better logistics co-ordination

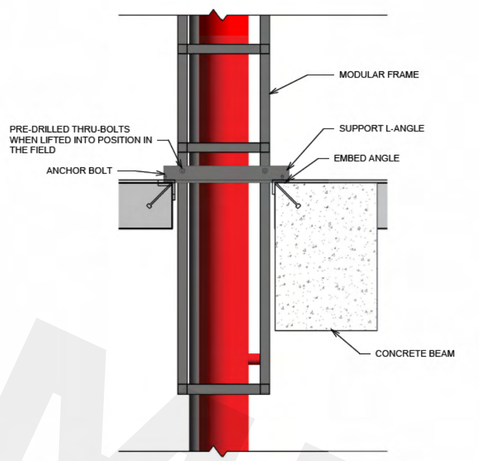
Improves workplace safety

- Construction sites are safer and more conducive as most work is done off-site, and less time is spent working at height

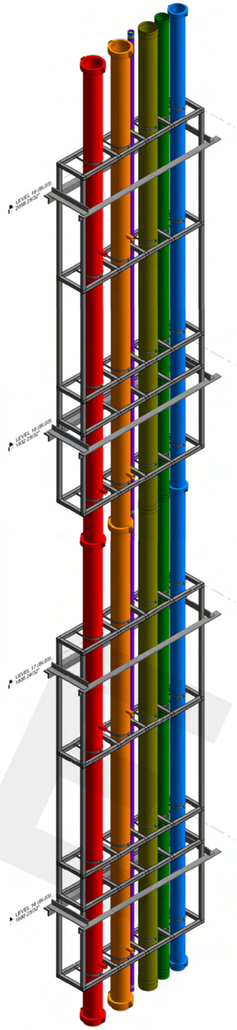
MODULAR PIPING SHAFT PREFABRICATION

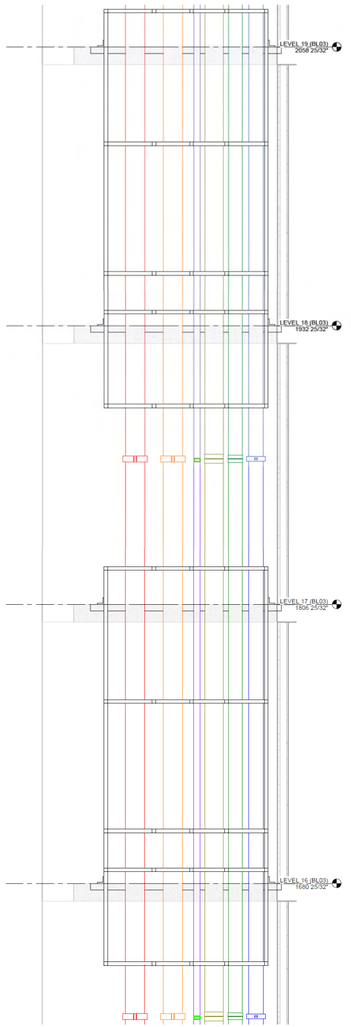


LEVEL 17 (BL03) - SHAFT VEC OPTIMIZATION
4 1" = 1'-0"



3 Modular Shaft Slab Installation
1" = 1'-0"





OVERALL SHAFT MODULE - OPTIMIZED FITTINGS SCHEDULE

Element	Size	Count
COUPLING	4"ø	4
COUPLING	6"ø	16
COUPLING	8"ø	20
COUPLING	14"ø	8
REDUCER	6"ø-4"ø	1
REDUCER	14"ø-8"ø	2
REDUCING TEE	6"ø-2"ø	1
TEE	2 1/2"ø	1
	Grand total	53

OVERALL SHAFT MODULE - OPTIMIZED PIPE SCHEDULE

Element	Size	Length	Count
PIPE	2 1/2"ø	240' - 2 1/4"	13
PIPE	4"ø	75' - 4 27/32"	5
PIPE	6"ø	407' - 1 5/16"	20
PIPE	8"ø	489' - 4 1/8"	23
PIPE	14"ø	224' - 4"	11
		1436' - 4 17/32"	
		Grand total	72

Helping the best build better.

Contact for more

sales@vec-us.com

vec-us.com

+1 (415) 888-1832