

Components logistics, manipulations, lowering

Dimitar MLADENOV - CERN EP/NU

LBNF Cryostat, final design review

SURF, 21-22 August 2017

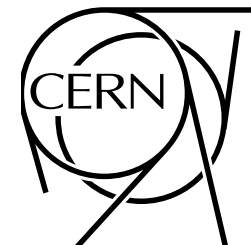


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Who Am I and Where Have I Been?

Chief Project Engineer of the CERN Neutrino Platform.
Member of the LBNF/DUNE Collaboration.

Mechanical Engineer at the ATLAS LHC project at CERN during construction and operation.

Experience includes 17 years as a project engineer for support structures for large scale physics detectors, from its conceptual stage to the final commissioning.

Large experience on design, manufacturing, underground installation, assembly and logistics.

Education as Mechanical Engineer (PhD).

List of components

We need to transport 1'800 components

600 pcs with weight	0.1t ÷ 0.5t	Cage Load	240 x 60min 240 hours 10 days
900 pcs with weight	0.5t ÷ 1.0t		
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120 pcs with weight	1.0t ÷ 5.0t	Skip Load	300 x 60 min 300 hours 13 days
120 pcs with weight	5.0t ÷ 7.0t		
60 pcs with weight	7.0t ÷ 7.5t		

In addition to this:

125t of Bolts 1 day

4'000 boxes of insulation

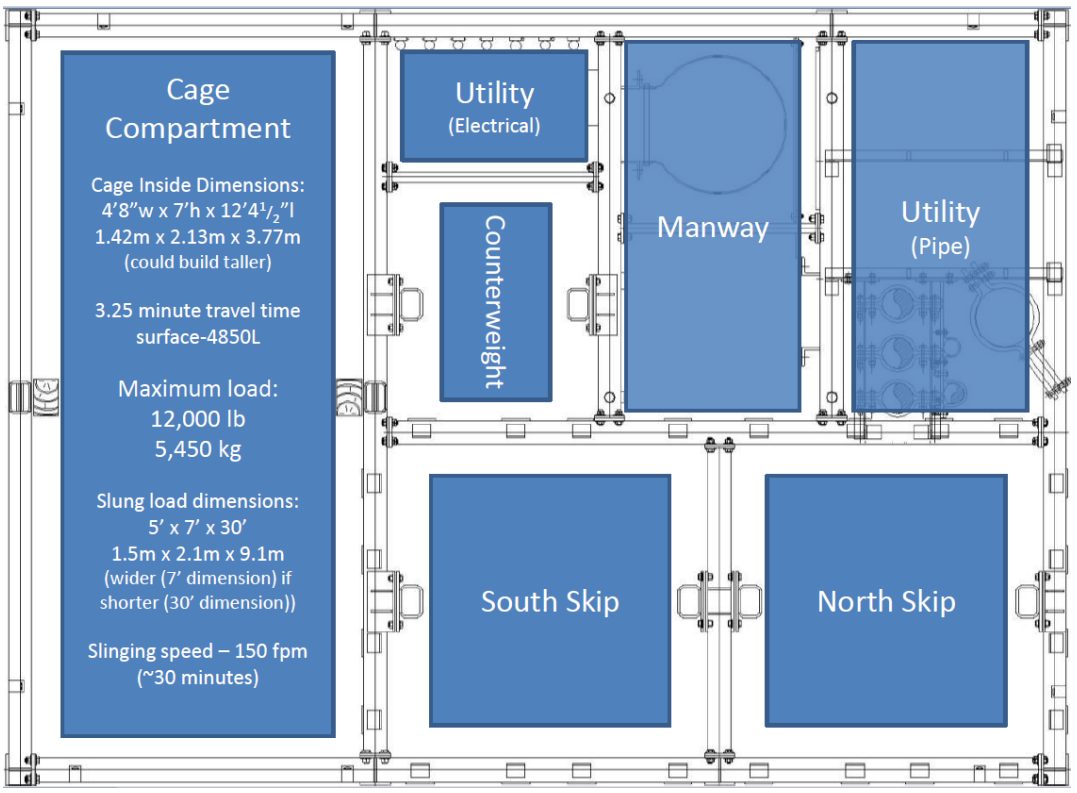
List of components

LBNF - Structural warm skin concept			
	Quantity	Weight (kg)/unit	Total weight (kg)
Long side Corner beam , HL1100M (5.495x3.608x0.492)	78	5495	428610
Central beam , HL100M (8x1.108x0.492)	39	5519	215241
Short side Corner beam , HL1100M (3.608x2.299x0.452)	18	3375	60750
Portal spacer beam , HL1100M (1.108x1.108x0.402)	240	645	154800
Ground bracing, long and short sides (1.148x0.775x0.4)	92	235	21620
12mm Warm membrane with welded ribs - central module (3.2x1.6x0.162)	34	662	22508
12mm Warm membrane with welded ribs -intermediate module (1.6x1.6x0.162)	68	315	21420
12mm Warm membrane with welded ribs -external module (4.66x1.6x0.162)	68	957	65076
12mm Warm membrane with welded ribs -central for portals 2 and 3 (3.2x1.6x0.162)	8	629	5032
12mm Warm membrane with welded ribs -external for portals 2 and 3 (4.66x1.6x0.162)	8	925	7400
12mm Warm membrane with welded ribs -central for extremity portals (3.2x0.91x0.162)	4	383	1532
12mm Warm membrane with welded ribs -external for extremity portals (4.66x0.91x0.162)	4	564	2256
Floor	1		1006245
Main roof beam , HL1100M (9.495x1.108x0.402)	78	4517	352326
Portal spacer beam , HEB600 (1.578x0.650x0.300)	228	406	92568
Extremity beam, link to short wall toward X, HEB600 (1.401x0.650x0.300)	12	370	4440
12mm Warm membrane with welded ribs - central short module (3.6x1.6x0.162)	38	775	29450
12mm Warm membrane with welded ribs - central long module (4x1.6x0.162)	38	862	32756
12mm Warm membrane with welded ribs -external module (4.06x1.6x0.162)	76	873	66348
12mm Warm membrane with welded ribs -short central for extremity portals (3.6x0.91x0.162)	2	482	964
12mm Warm membrane with welded ribs -long central for extremity portals (4x0.91x0.162)	2	537	1074
12mm Warm membrane with welded ribs -external for extremity portals (4.06x0.91x0.162)	4	544	2176
Roof	1		582102
Vertical beam , HL1100M (13.637x1.133x0.492)	9	7533	67797
Horizontal spacer beam with access hole (moment connection), HL1100M (1.518x1.108x0.402)	7	645	4515
Horizontal spacer beam without access hole (moment connection), HL1100M (1.518x1.108x0.402)	17	732	12444
Horizontal L Corner beam, Linked to long wall HL1100M (2.849x2.274x0.452)	6	2832	16992
Top Horizontal L Corner beam, Linked to long wall HL1100M (2.349x2.479x0.427)	2	2476	4952
Horizontal top beam link to the roof(Central), HL1100M (2.4x1.108x0.600)	1	1536	1536
Horizontal top beam link to the roof(long), HL1100M (5.946x1.108x0.600)	2	3710	7420
Vertical pillar for L corner, ground to Level 1 (5.384x0.5x0.5)	2	657	1314
Vertical pillar for L corner, intermediate Levels (3.548x0.5x0.5)	4	258	1032
Vertical pillar for L corner, Level 3 to Level 4 (3.224x0.5x0.5)	2	423	846
12mm Warm membrane with welded ribs - central module ground to level 1 (4.5x1.6x0.658)	8	965	7720
12mm Warm membrane with welded ribs - central module intermediate level (4x1.6x0.162)	16	835	13360
12mm Warm membrane with welded ribs - central module top level (3.12x1.6x0.658)	8	652	5216
12mm Warm membrane with welded ribs - extremity module ground to level 1 (4.5x1.21x0.658)	2	767	1534
12mm Warm membrane with welded ribs - extremity module intermediate level (4x1.21x0.162)	4	665	2660
12mm Warm membrane with welded ribs - extremity module top level (3.12x1.21x0.658)	2	514	1028
12mm Warm membrane with welded ribs - Corner SW-LW ground to level 1 (3.9x1.21x0.334)	2	692	1384
12mm Warm membrane with welded ribs - Corner SW-LW intermediate level (4x1.21x0.334)	4	703	2812
12mm Warm membrane with welded ribs - Corner SW-LW top level (2.52x1.21x0.334)	2	450	900
12mm Warm membrane with welded ribs - Corner SW-LW-Floor/Roof (1.06x0.7x0.6)	4	64	256
Short wall without opening	1		155718

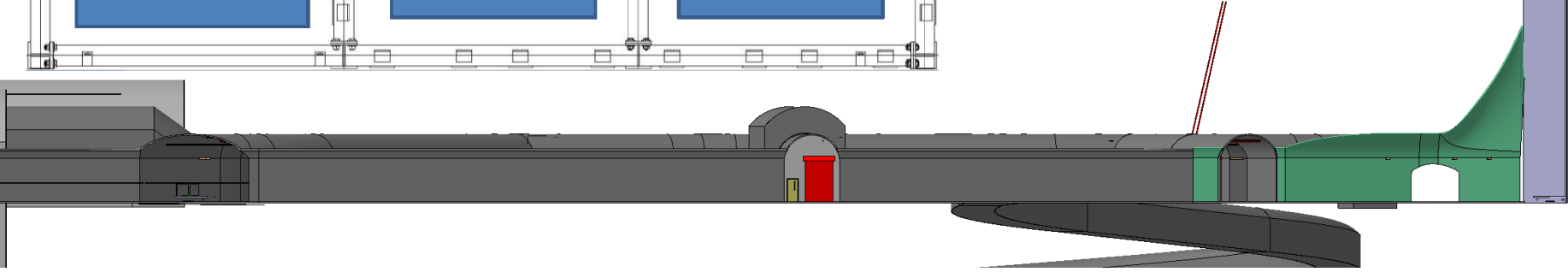
List of components

Vertical beam , HL1100M (13.637x1.133x0.492)	9	7622	68598
Horizontal spacer beam with access hole (moment connection), HL1100M (1.518x1.108x0.402)	7	645	4515
Horizontal spacer beam without access hole (moment connection), HL1100M (1.518x1.108x0.402)	17	732	12444
Horizontal L Corner beam, Linked to long wall HL1100M (2.849x2.274x0.452)	6	2832	16992
Top Horizontal L Corner beam, Linked to long wall HL1100M (2.349x2.479x0.427)	2	2476	4952
Horizontal top beam link to the roof(Central), HL1100M (2.4x1.108x0.600)	1	1536	1536
Horizontal top beam link to the roof(long), HL1100M (5.946x1.108x0.600)	2	3710	7420
Vertical pillar for L corner, ground to Level 1 (5.384x0.5x0.5)	2	657	1314
Vertical pillar for L corner, intermediate Levels (3.548x0.5x0.5)	4	258	1032
Vertical pillar for L corner, Level 3 to Level 4 (3.224x0.5x0.5)	2	423	846
Removable structure for warm membrane, IPE220 (1.54x0.22x0.11)	38	37	1406
12mm Warm membrane with welded ribs - central module ground to level 1 (4.5x1.6x0.658)	4	965	3860
12mm Warm membrane with welded ribs - central module intermediate level (4x1.6x0.162)	8	835	6680
12mm Warm membrane with welded ribs - central module top level (3.12x1.6x0.658)	4	652	2608
12mm Warm membrane with welded ribs - extremity module ground to level 1 (4.5x1.21x0.658)	2	767	1534
12mm Warm membrane with welded ribs - extremity module intermediate level (4x1.21x0.162)	4	665	2660
12mm Warm membrane with welded ribs - extremity module top level (3.12x1.21x0.658)	2	514	1028
12mm Warm membrane with welded ribs - larger module ground to level 1 (4.5x1.86x0.658)	2	1026	2052
12mm Warm membrane with welded ribs - larger module intermediate level (4x1.86x0.162)	4	943	3772
12mm Warm membrane with welded ribs - larger module top level (3.12x1.86x0.658)	2	739	1478
12mm Warm membrane with welded ribs - under removable,floor to top L beam (2.72x2.68x0.02)	1	1153	1153
12mm Warm membrane - removable, bottom (up to level 1) (1.82x2.68x0.02)	1	461	461
12mm Warm membrane - removable, intermediate level (4.19x2.68x0.02)	2	1015	2030
12mm Warm membrane - removable, top (0.64x2.68x0.02)	1	630	630
12mm Warm membrane -over removable,Small wall to roof (2.72x2.68x0.51)	1	214	214
12mm Warm membrane with welded ribs - Corner SW-LW ground to level 1 (3.9x1.21x0.334)	2	692	1384
12mm Warm membrane with welded ribs - Corner SW-LW intermediate level (4x1.21x0.334)	4	703	2812
12mm Warm membrane with welded ribs - Corner SW-LW top level (2.52x1.21x0.334)	2	450	900
12mm Warm membrane with welded ribs - Corner SW-LW-Floor/Roof (1.06x0.7x0.6)	4	64	256
Short wall with opening	1		156567
Vertical beam , HL1100M (13.124x1.158x0.492)	39	7500	292500
Horizontal spacer beam with access hole (moment connection), HL1100M (1.518x1.108x0.402)	8	645	5160
Horizontal spacer beam without access hole (moment connection), HL1100M (1.518x1.108x0.402)	4	732	2928
Horizontal spacer beam with access hole (pinned connection), HL1100M (1.518x1.108x0.402)	68	452	30736
Horizontal spacer beam without access hole (pinned connection), HL1100M (1.518x1.108x0.402)	72	539	38808
12mm Warm membrane with welded ribs - central module ground to level 1 (4.5x1.6x0.658)	38	965	36670
12mm Warm membrane with welded ribs - central module intermediate level (4x1.6x0.162)	76	835	63460
12mm Warm membrane with welded ribs - central module top level (3.12x1.6x0.658)	38	652	24776
12mm Warm membrane with welded ribs - extremity module ground to level 1 (4.5x0.66x0.658)	2	444	888
12mm Warm membrane with welded ribs - extremity module intermediate level (4x0.66x0.162)	4	387	1548
12mm Warm membrane with welded ribs - extremity module top level (3.12x0.66x0.658)	2	295	590
Long wall	2		996128
Metallic structure			2896760

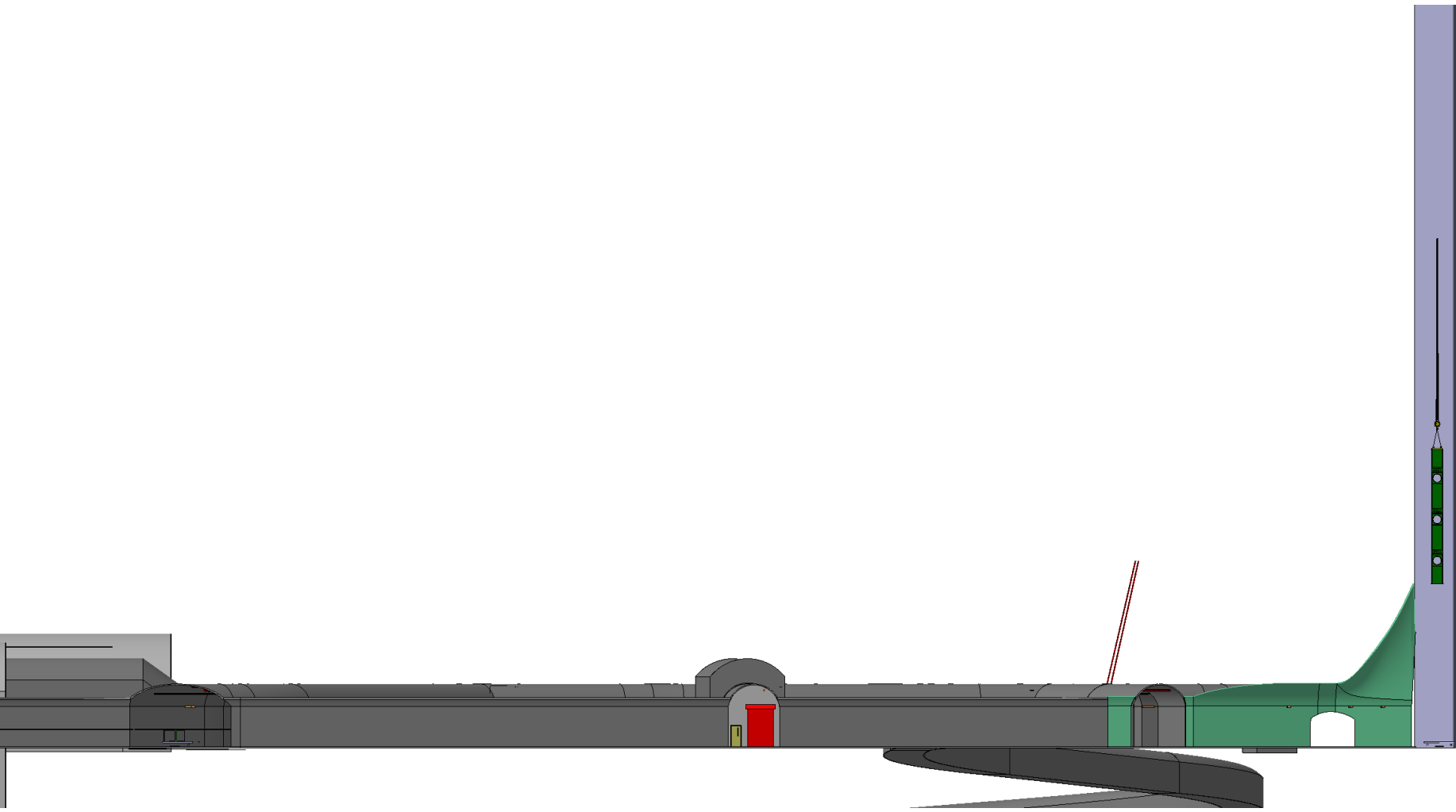
Vertical beam lowering



Weight: 7.5t
Length: 13.6m



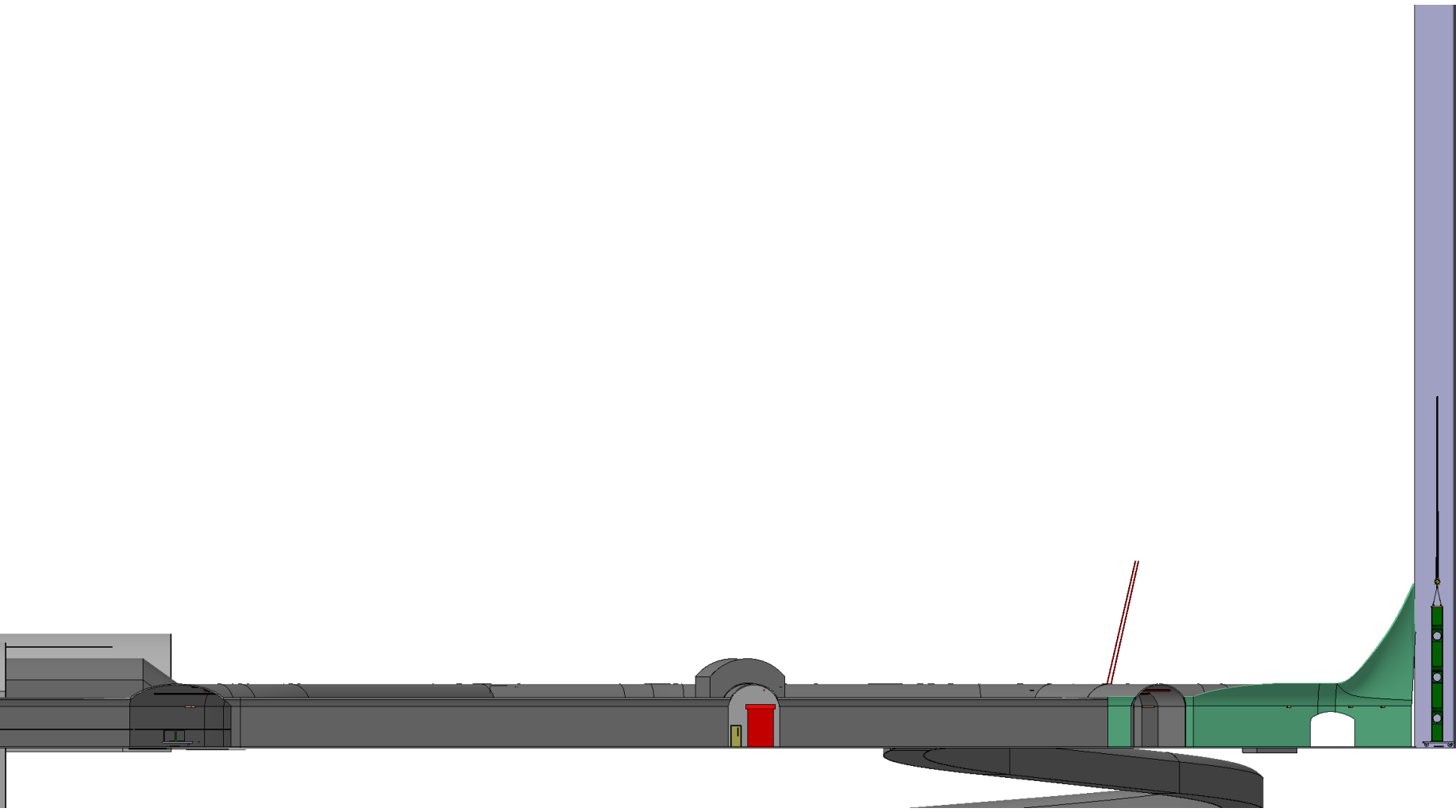
Vertical beam lowering



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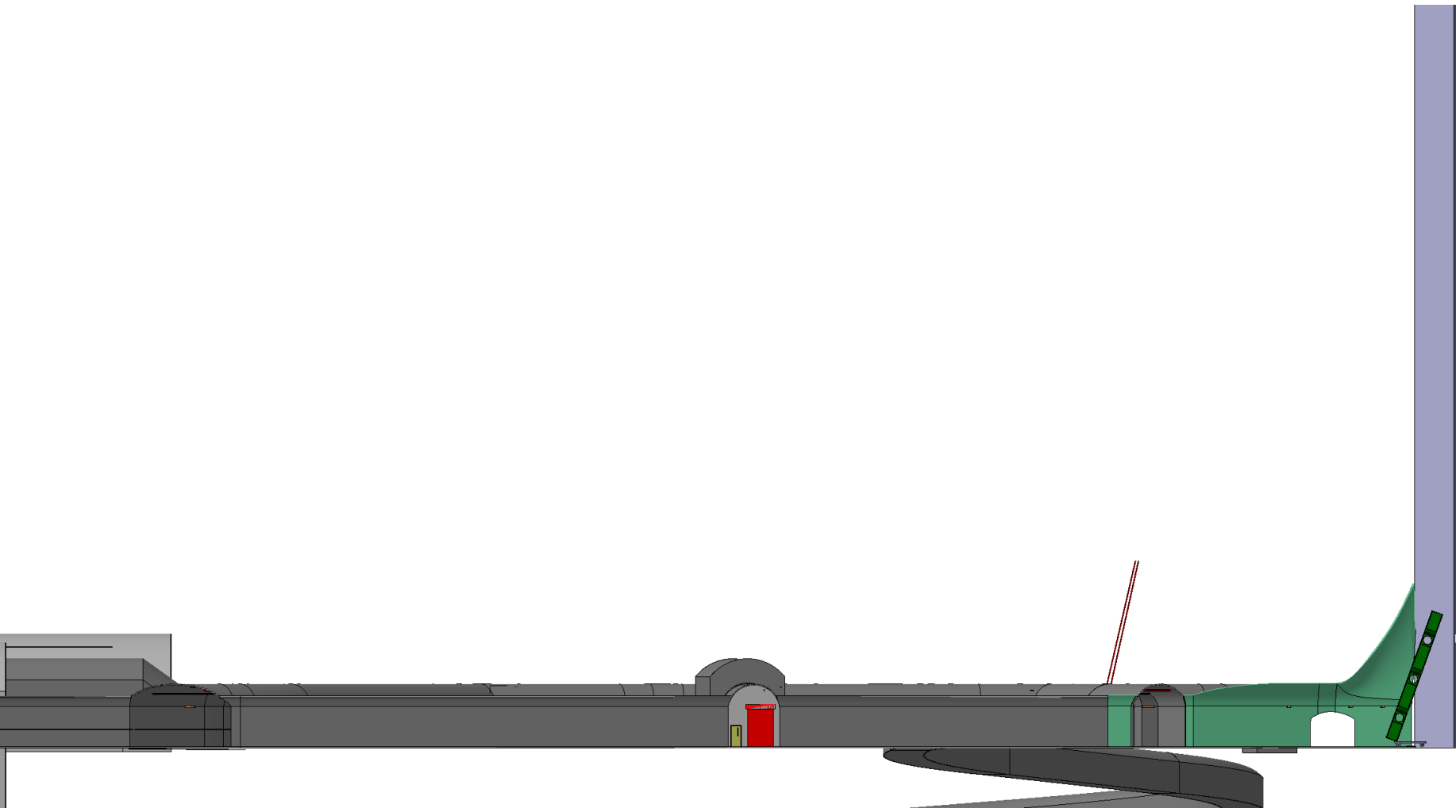
Vertical beam lowering



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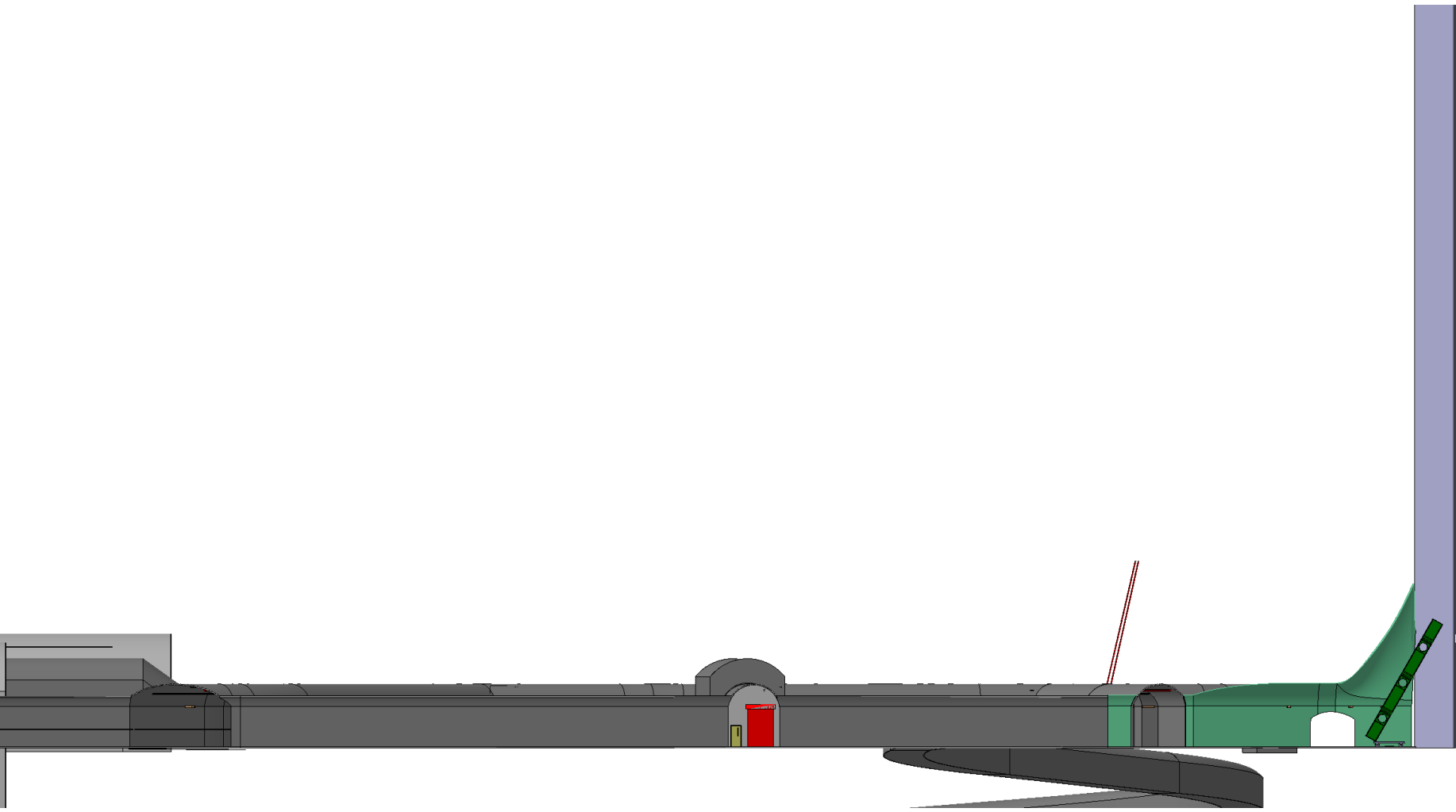
Vertical beam lowering



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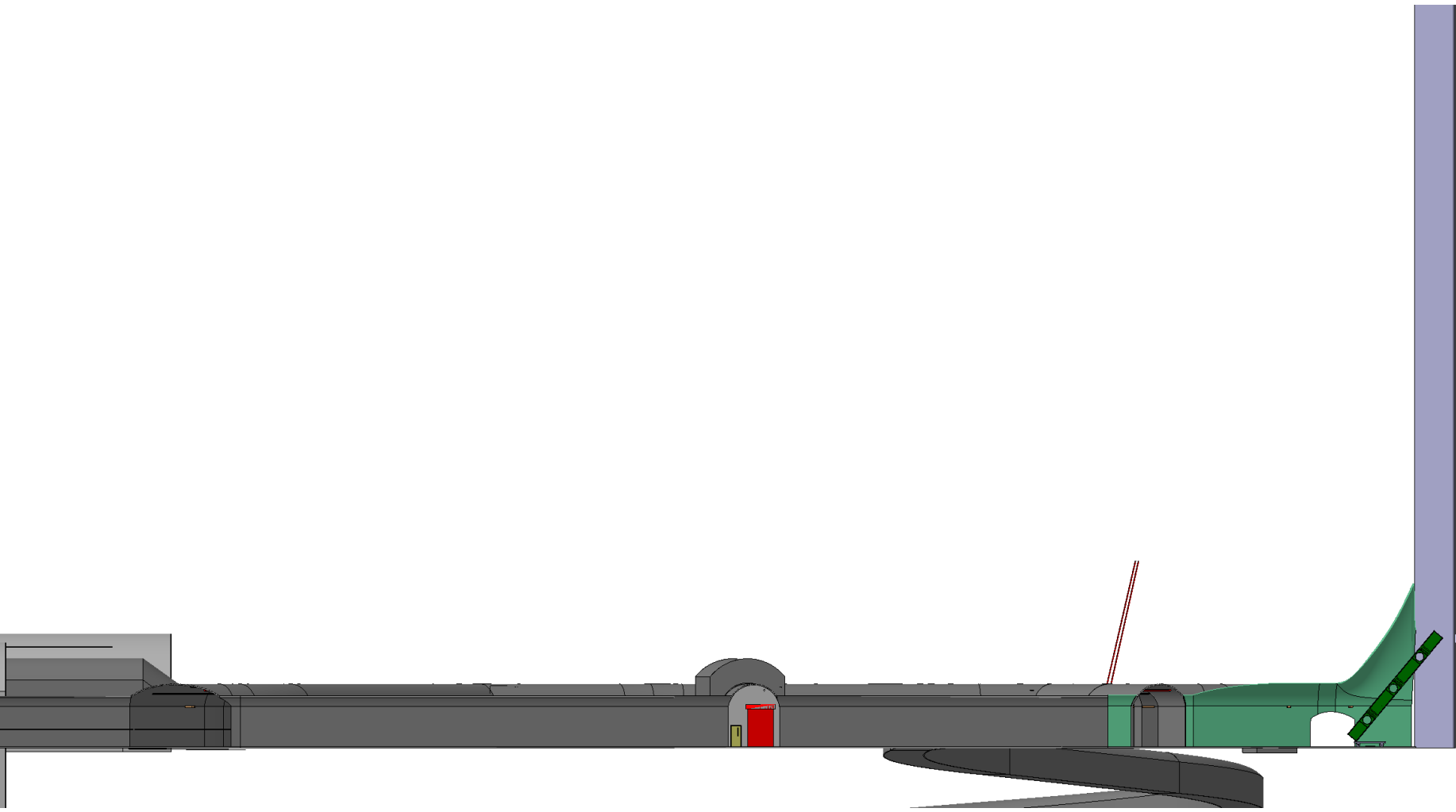
Vertical beam lowering



LBNF

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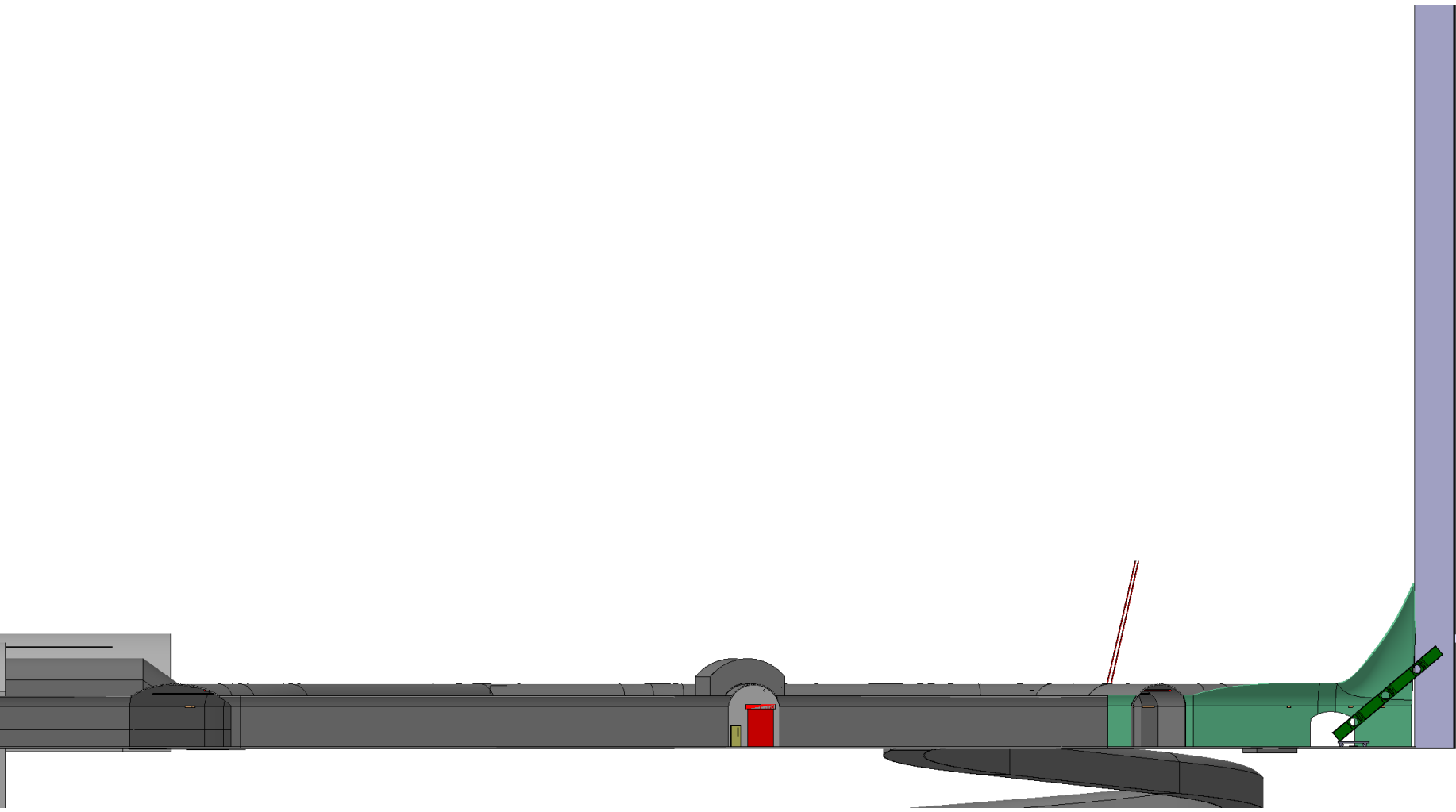
Vertical beam lowering



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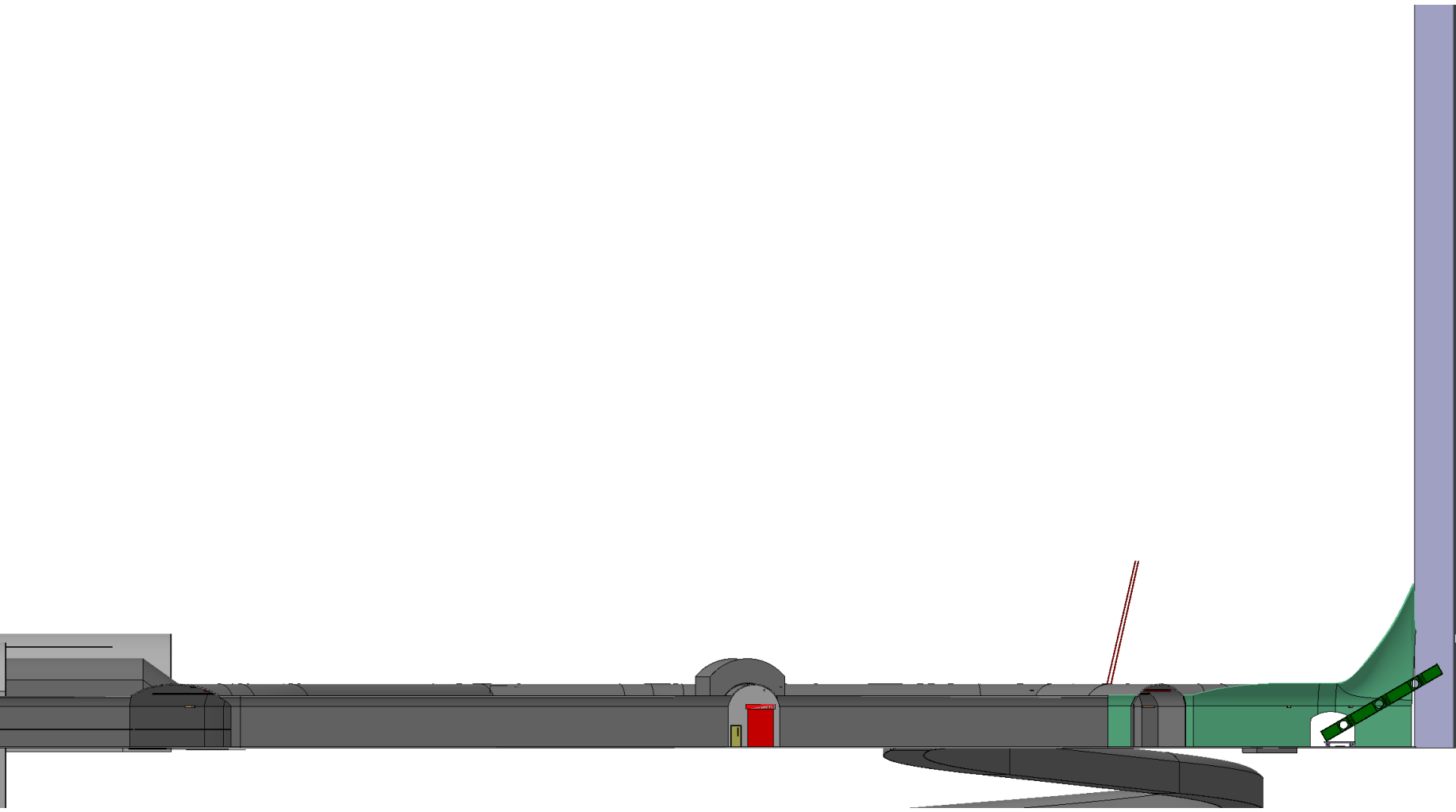
Vertical beam lowering



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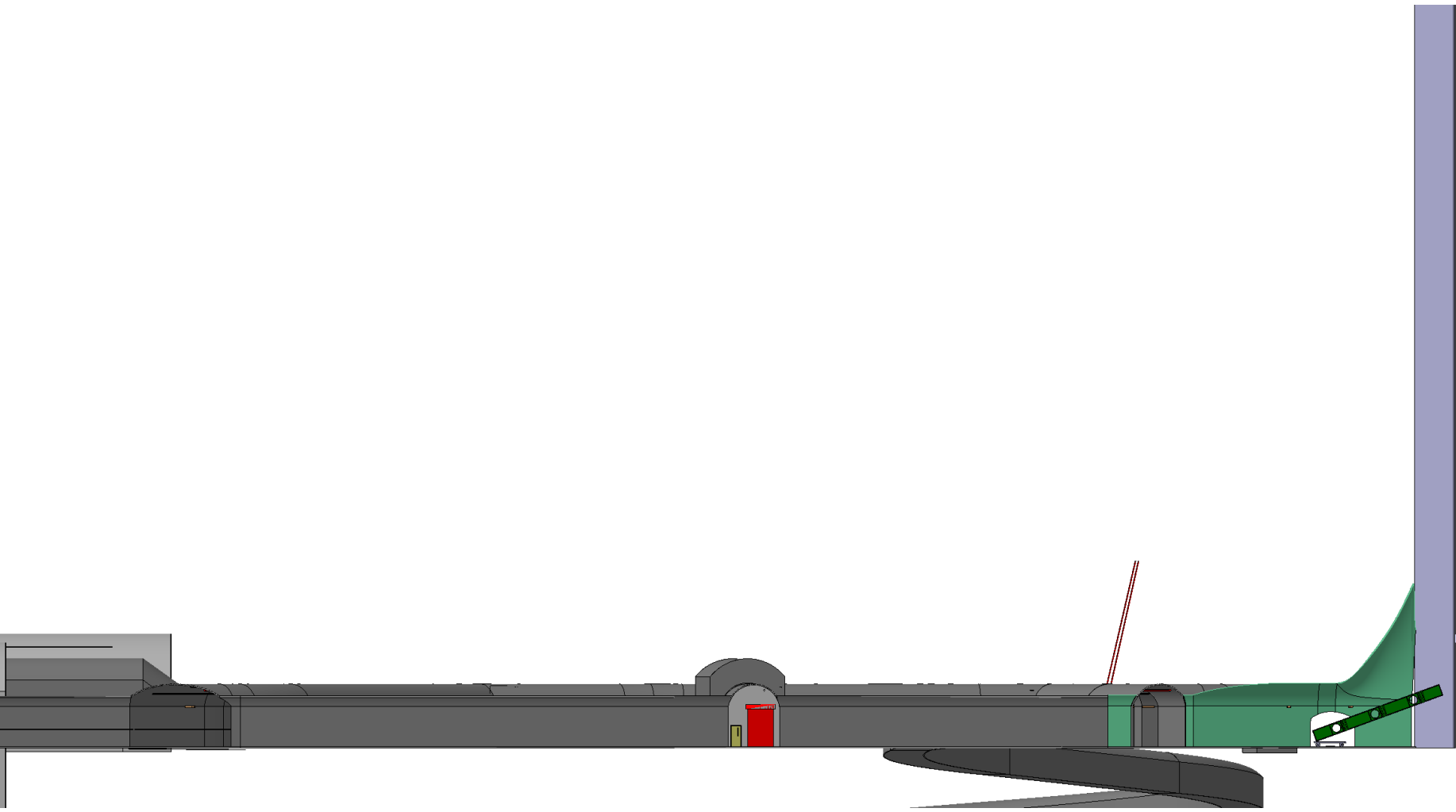
Vertical beam lowering



LBNF

CERN NP

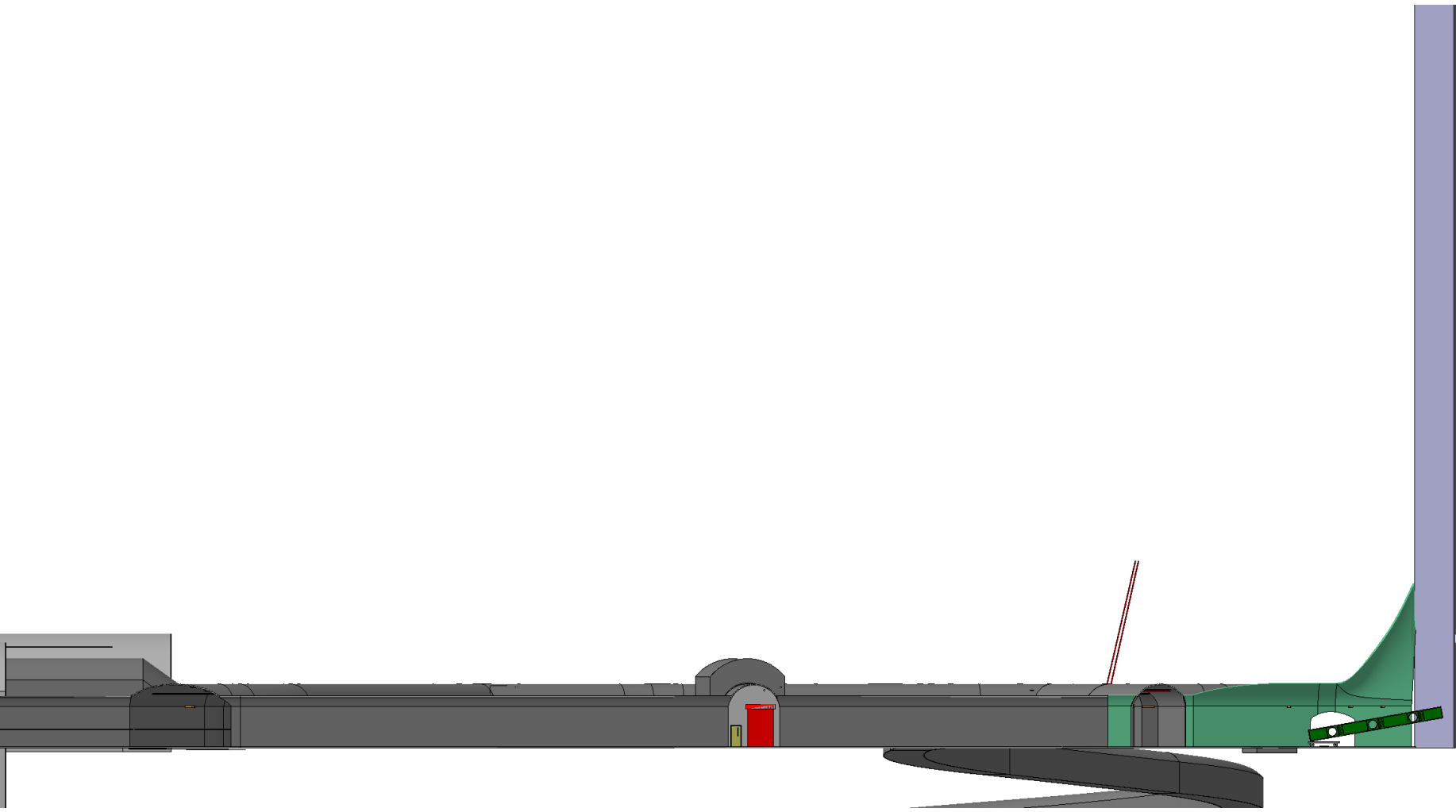
Vertical beam lowering



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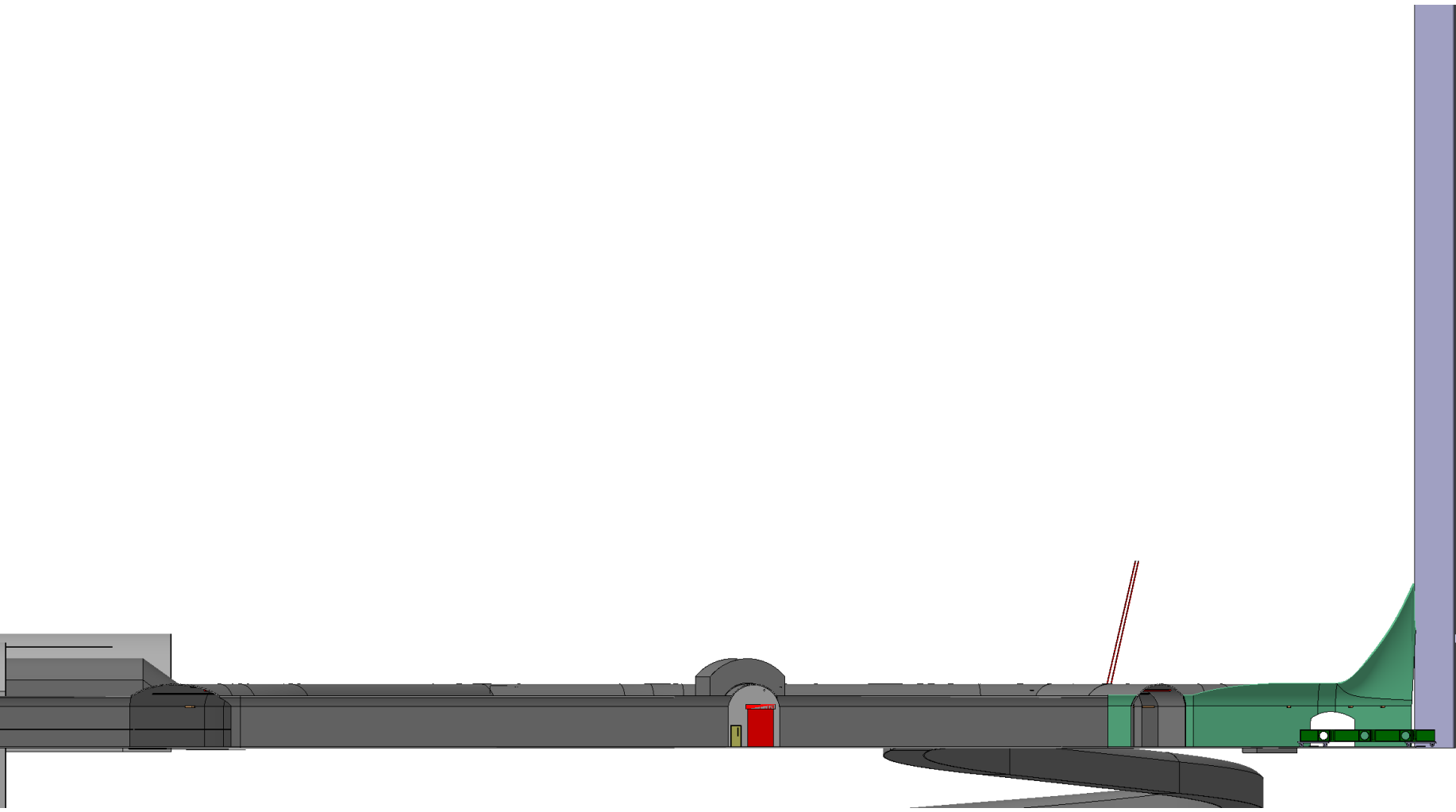
Vertical beam lowering



LBNF

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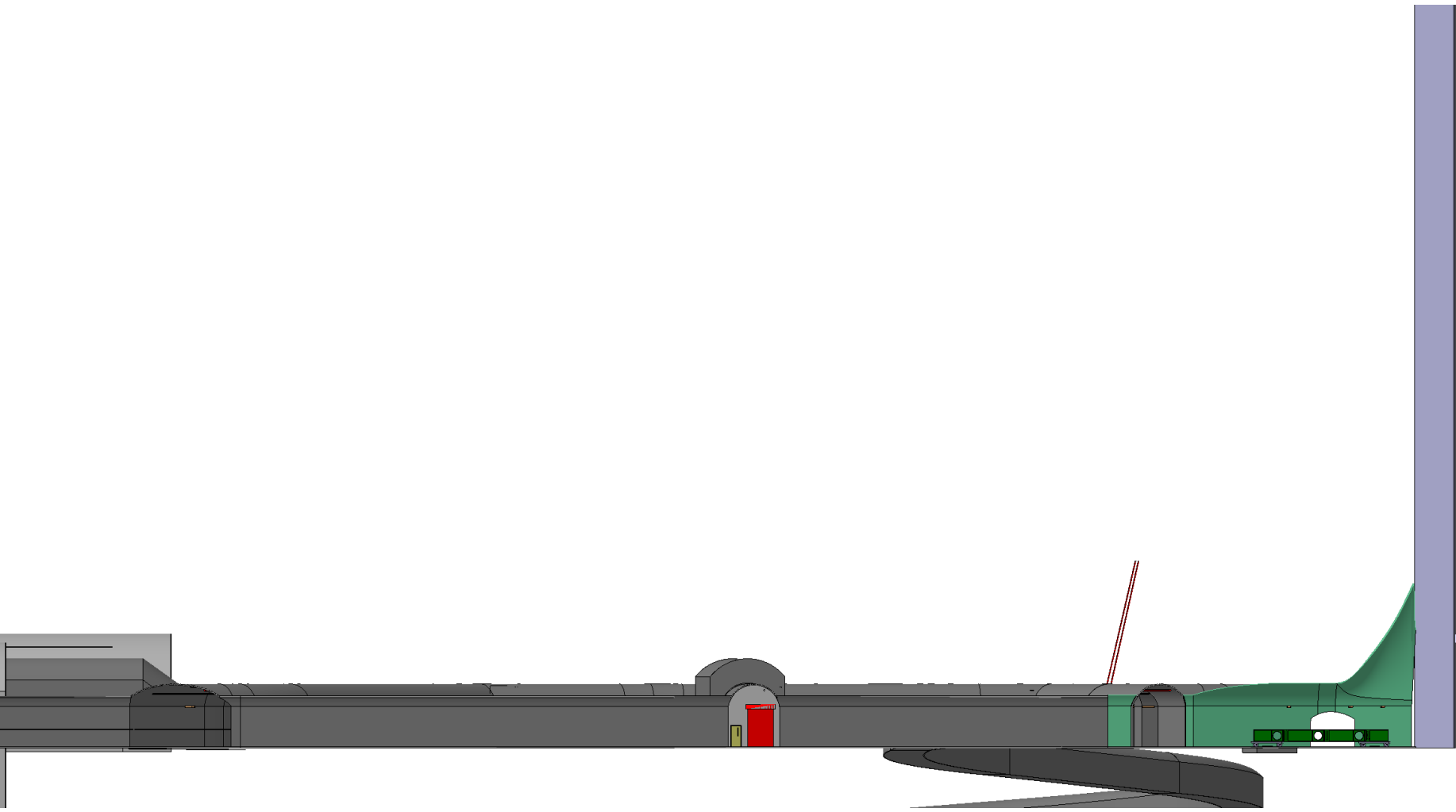
Vertical beam lowering



LBNF

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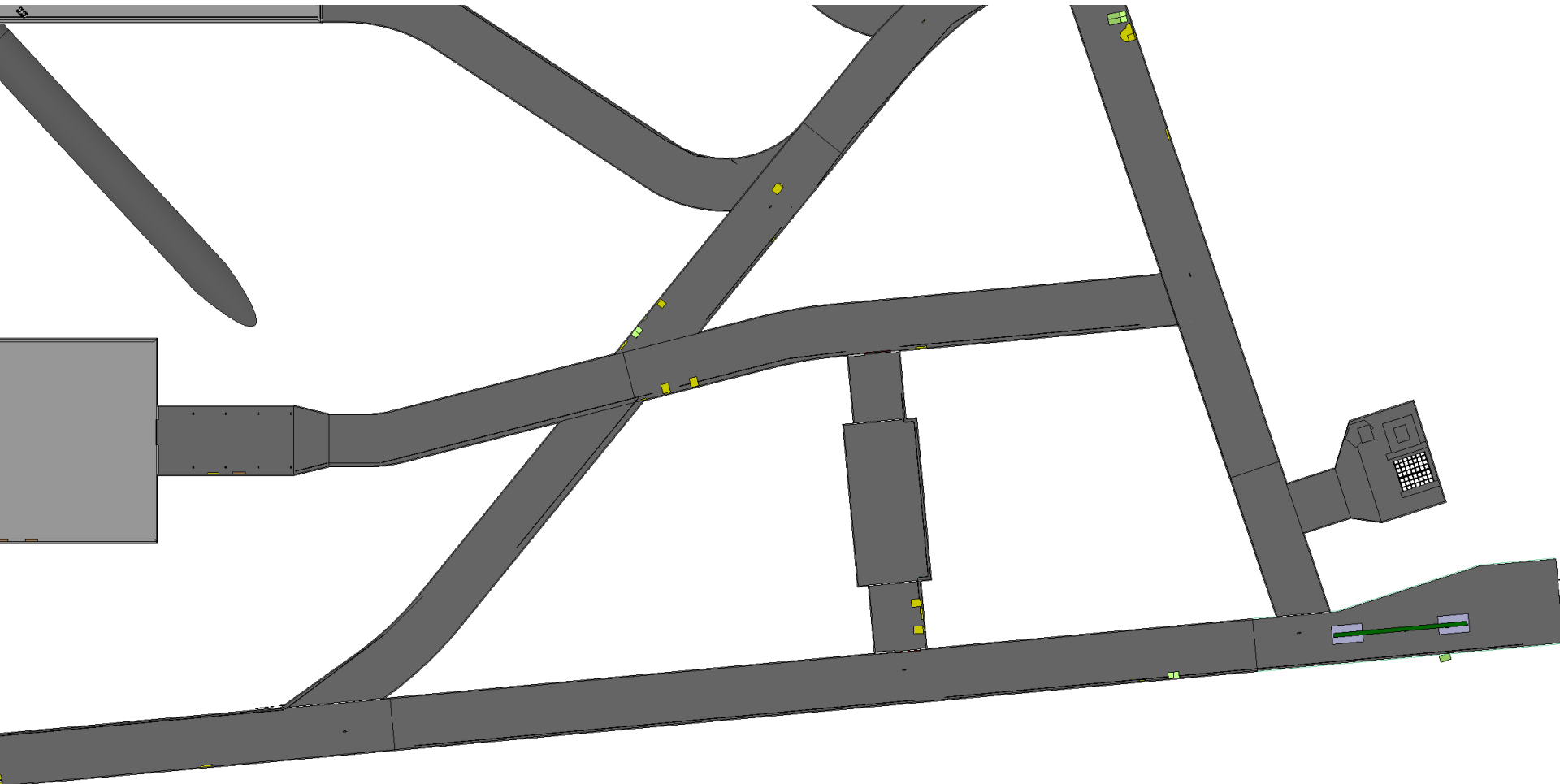
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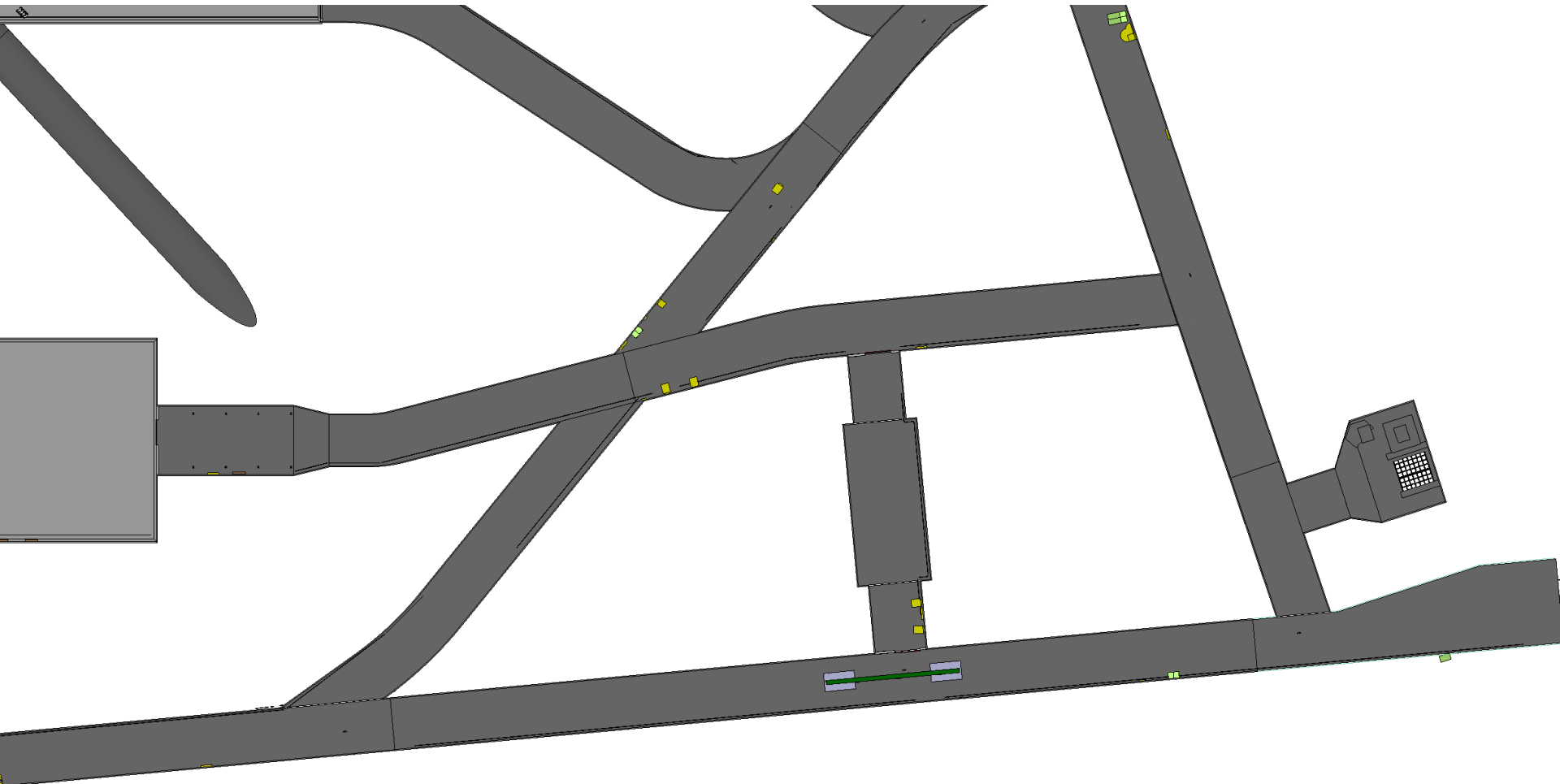
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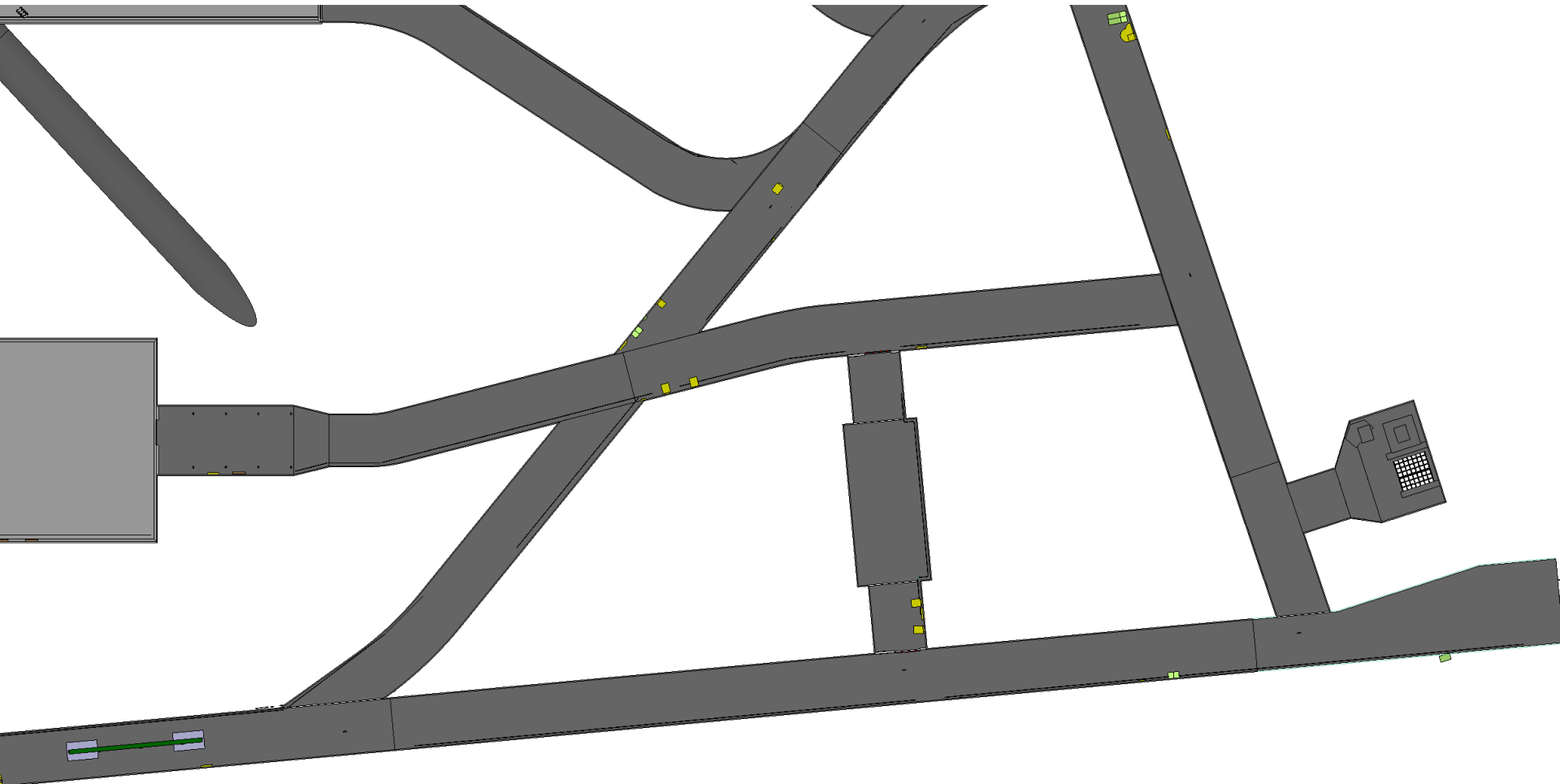
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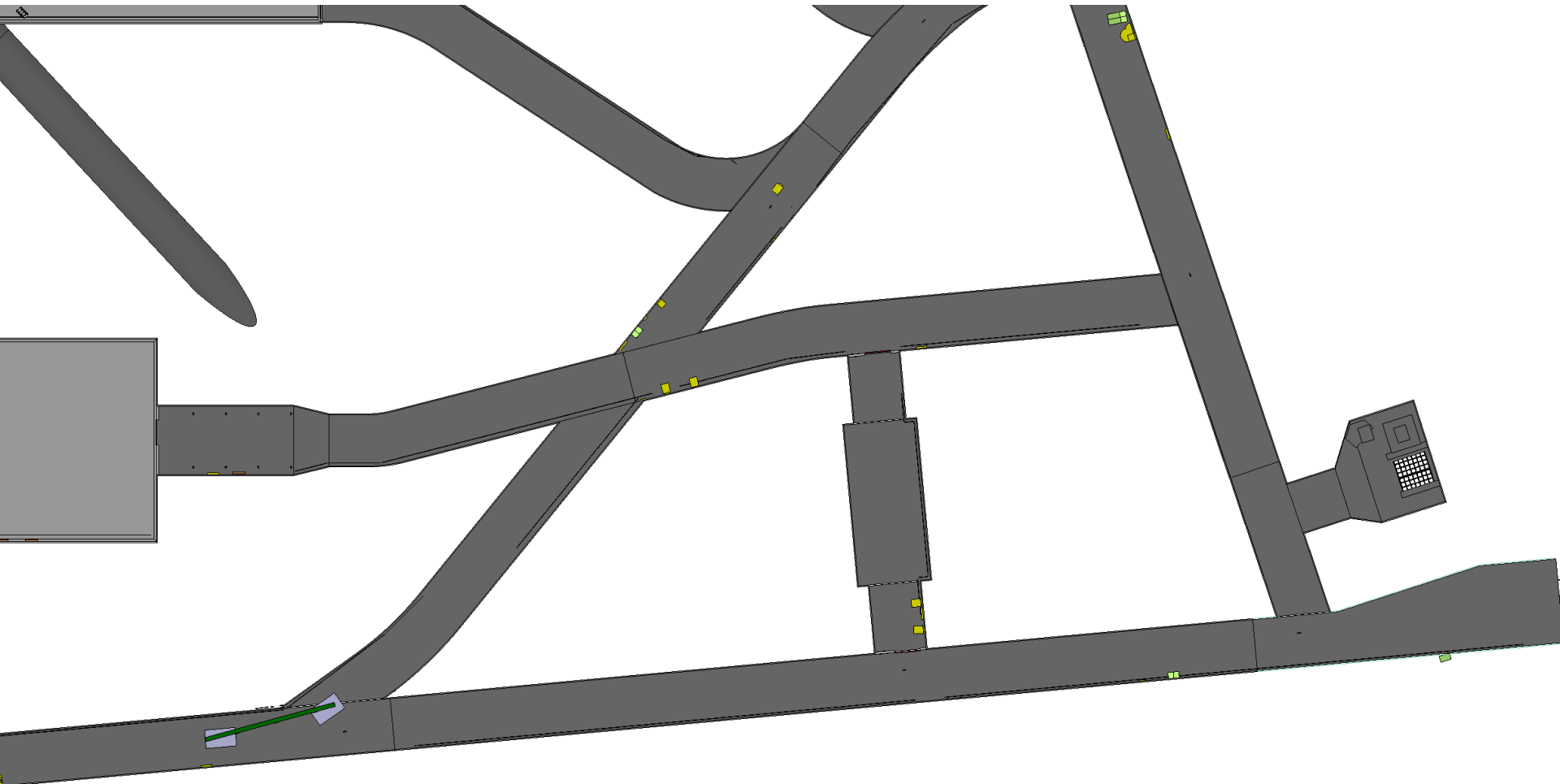
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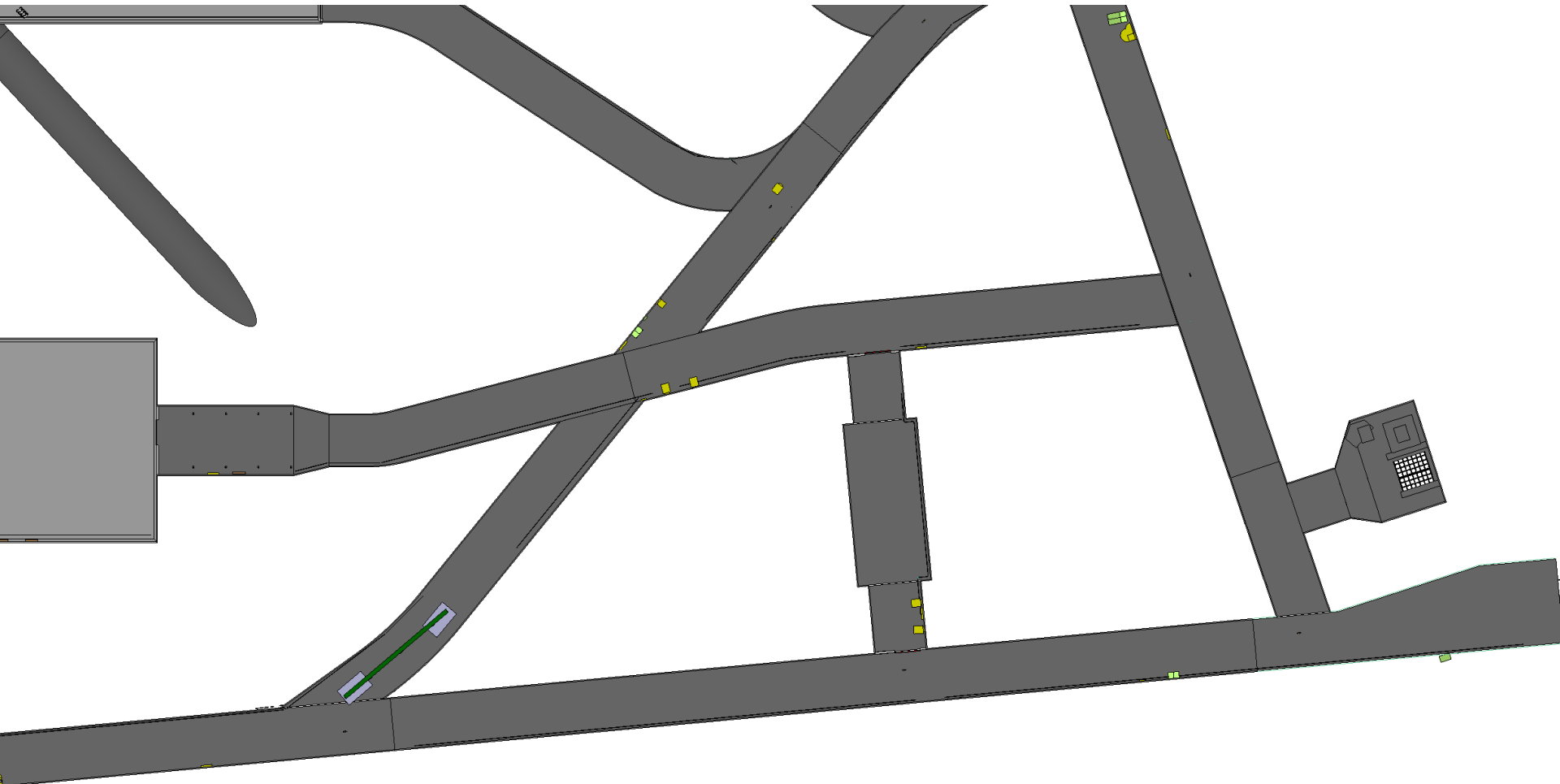
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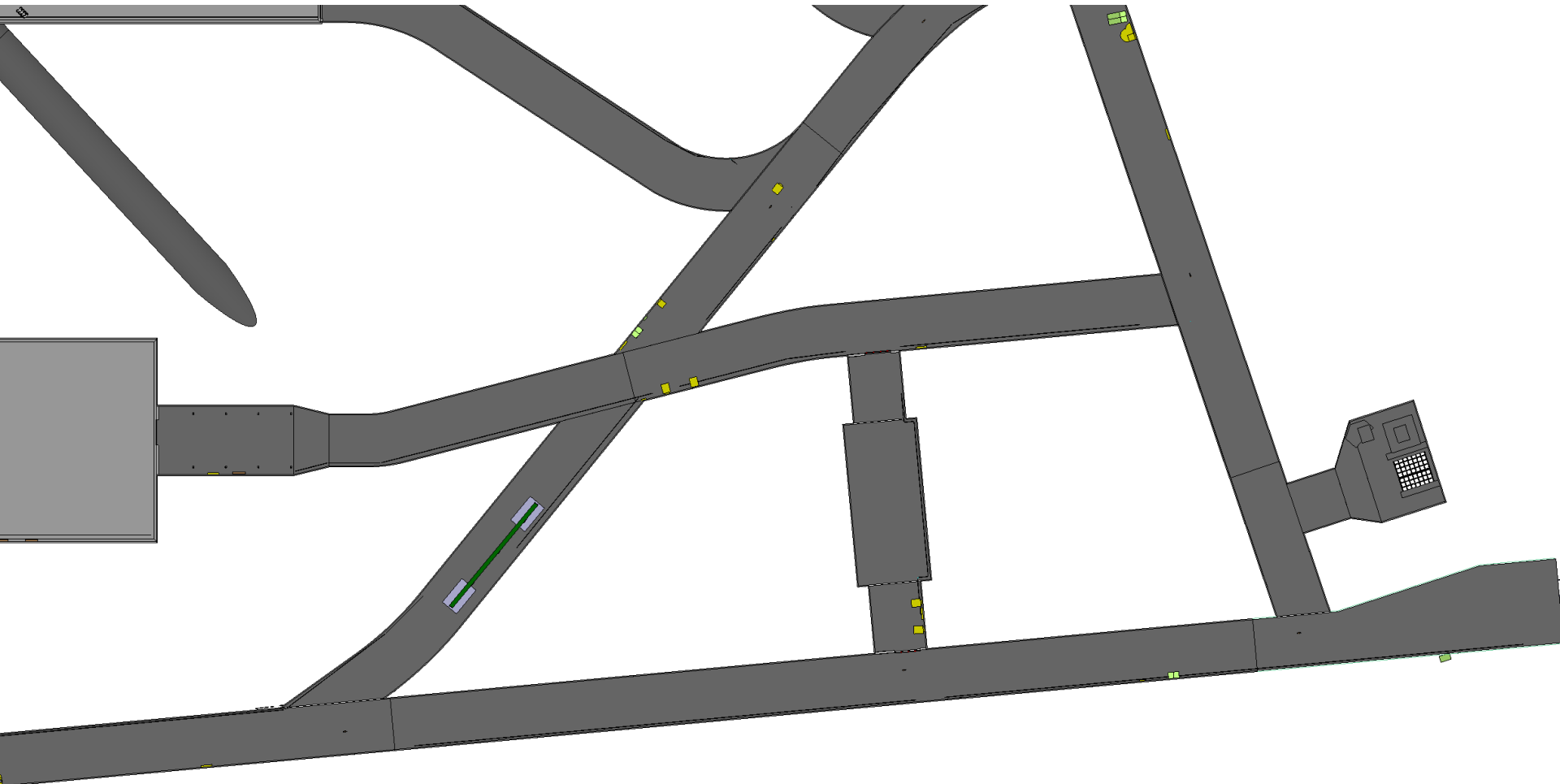
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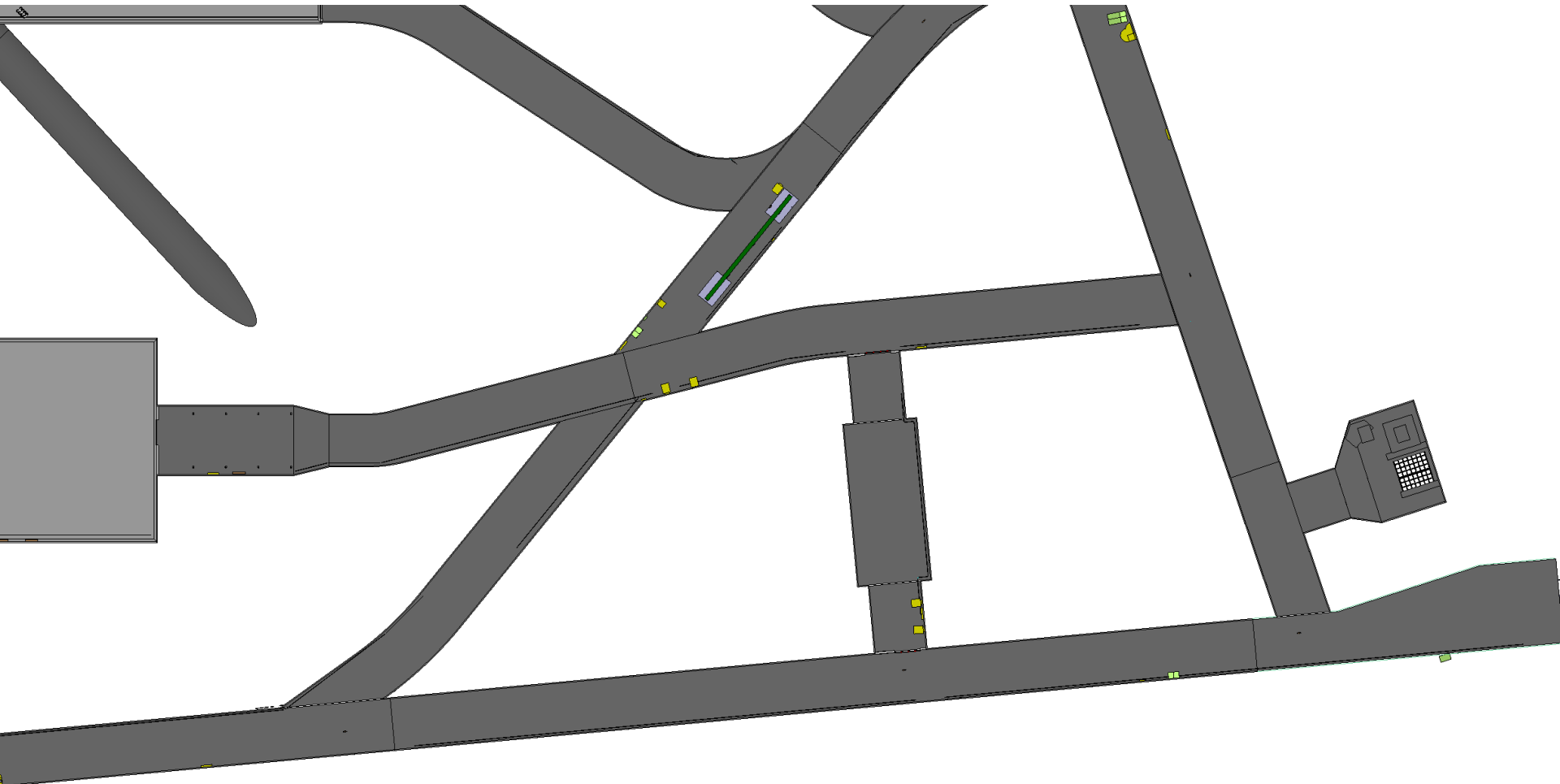
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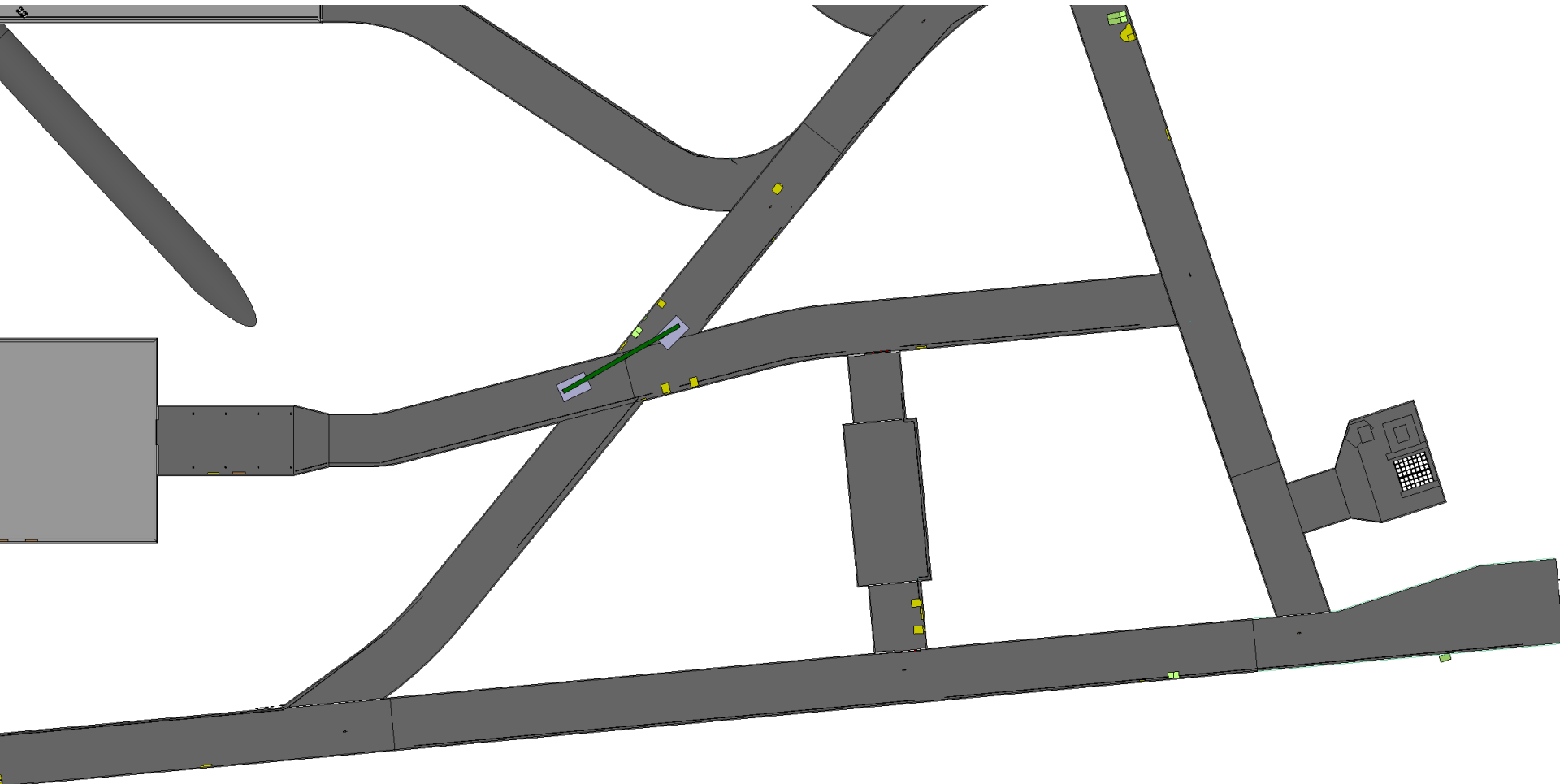
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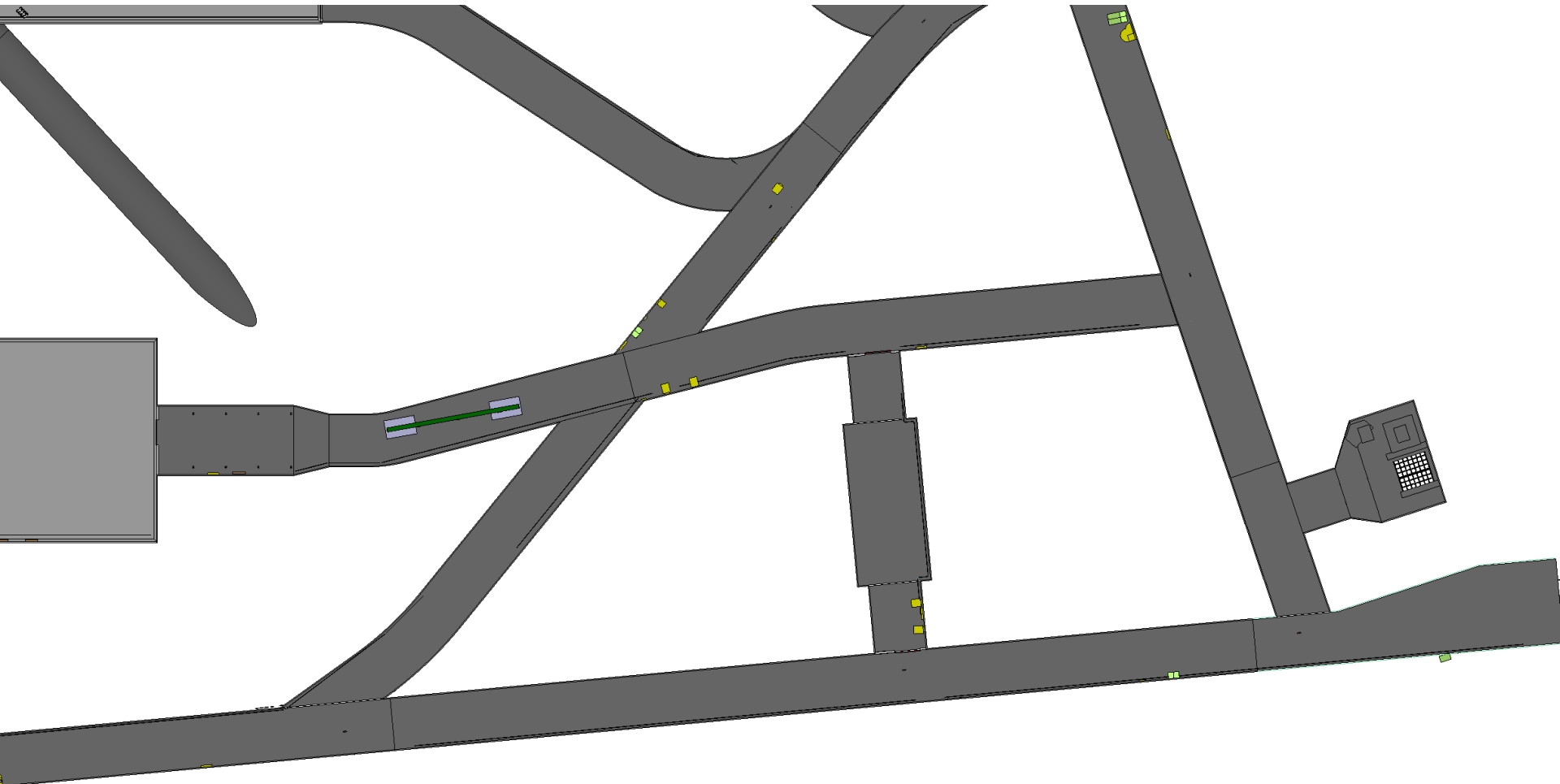
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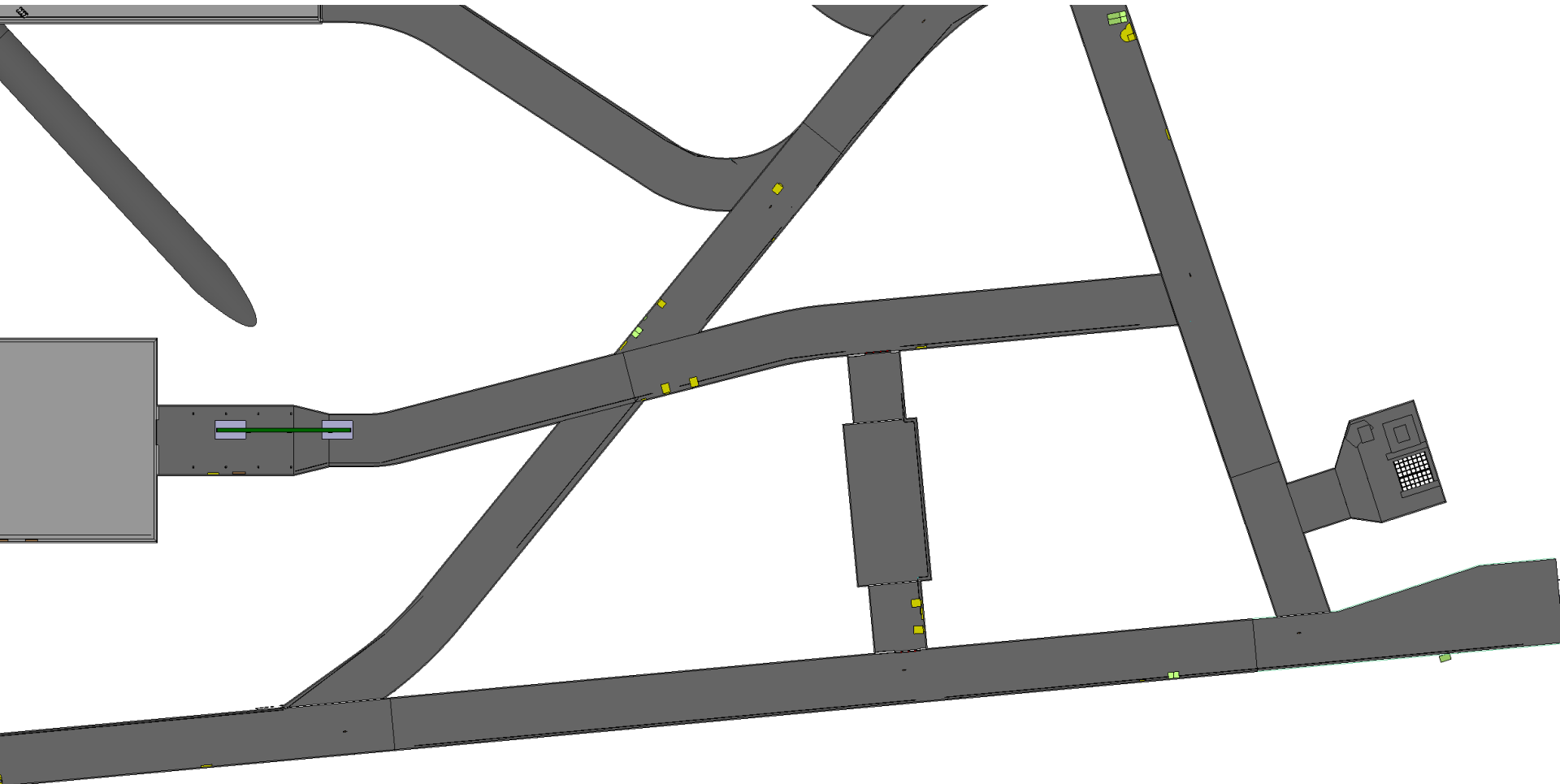
Vertical beam lowering



Vertical beam lowering



Vertical beam lowering



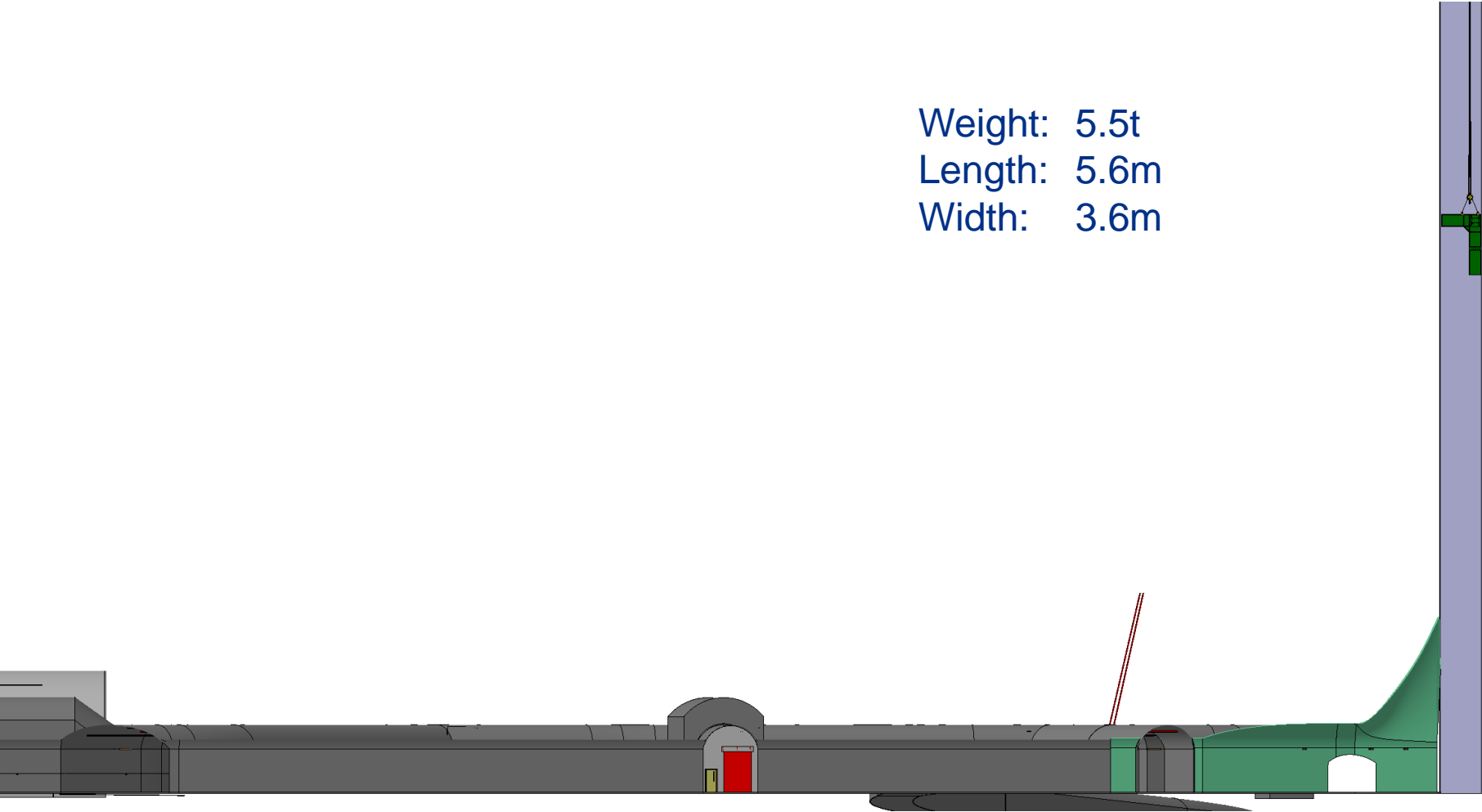
Corner beam lowering

5.5t and 5.6m x 3.6m

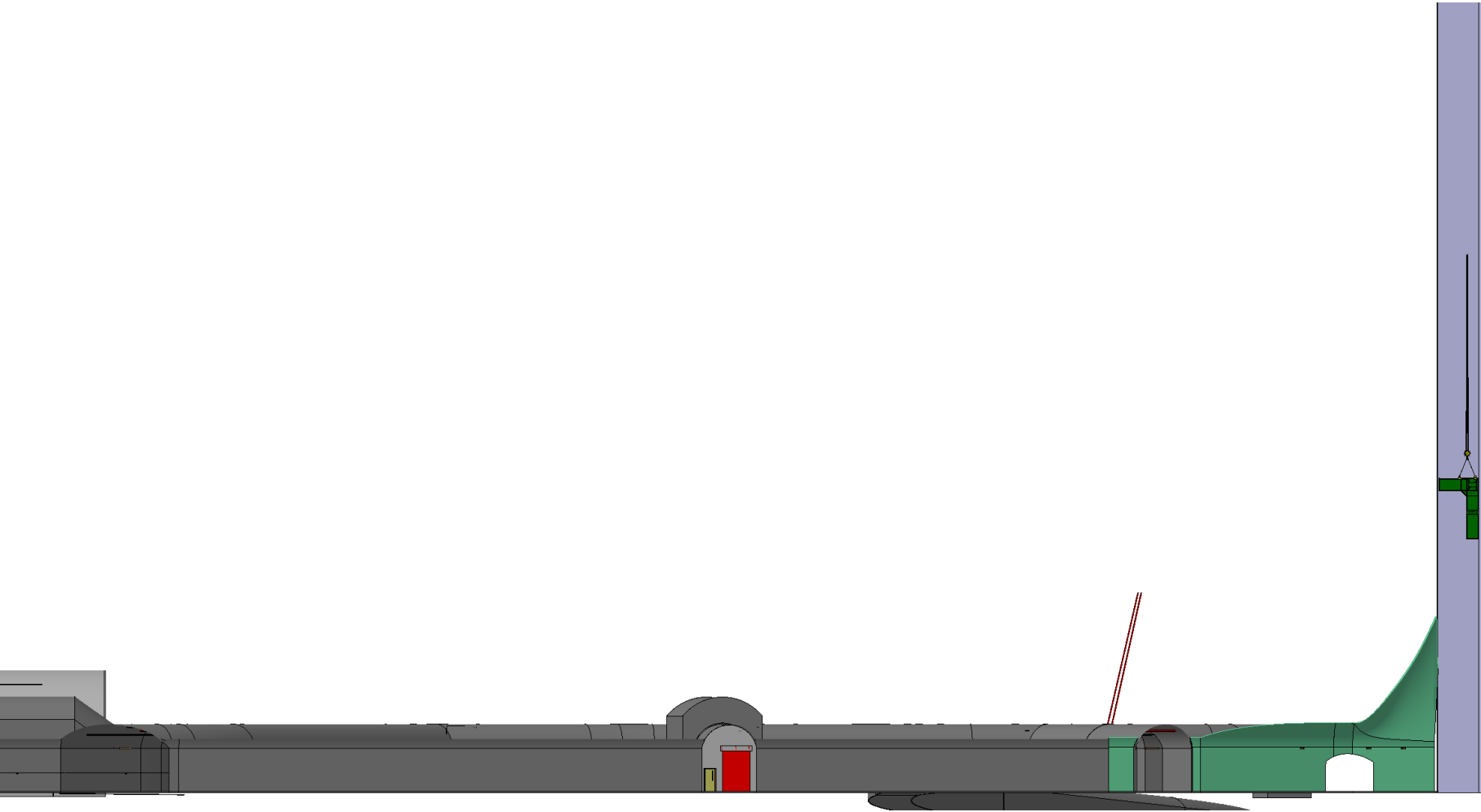
Weight: 5.5t

Length: 5.6m

Width: 3.6m



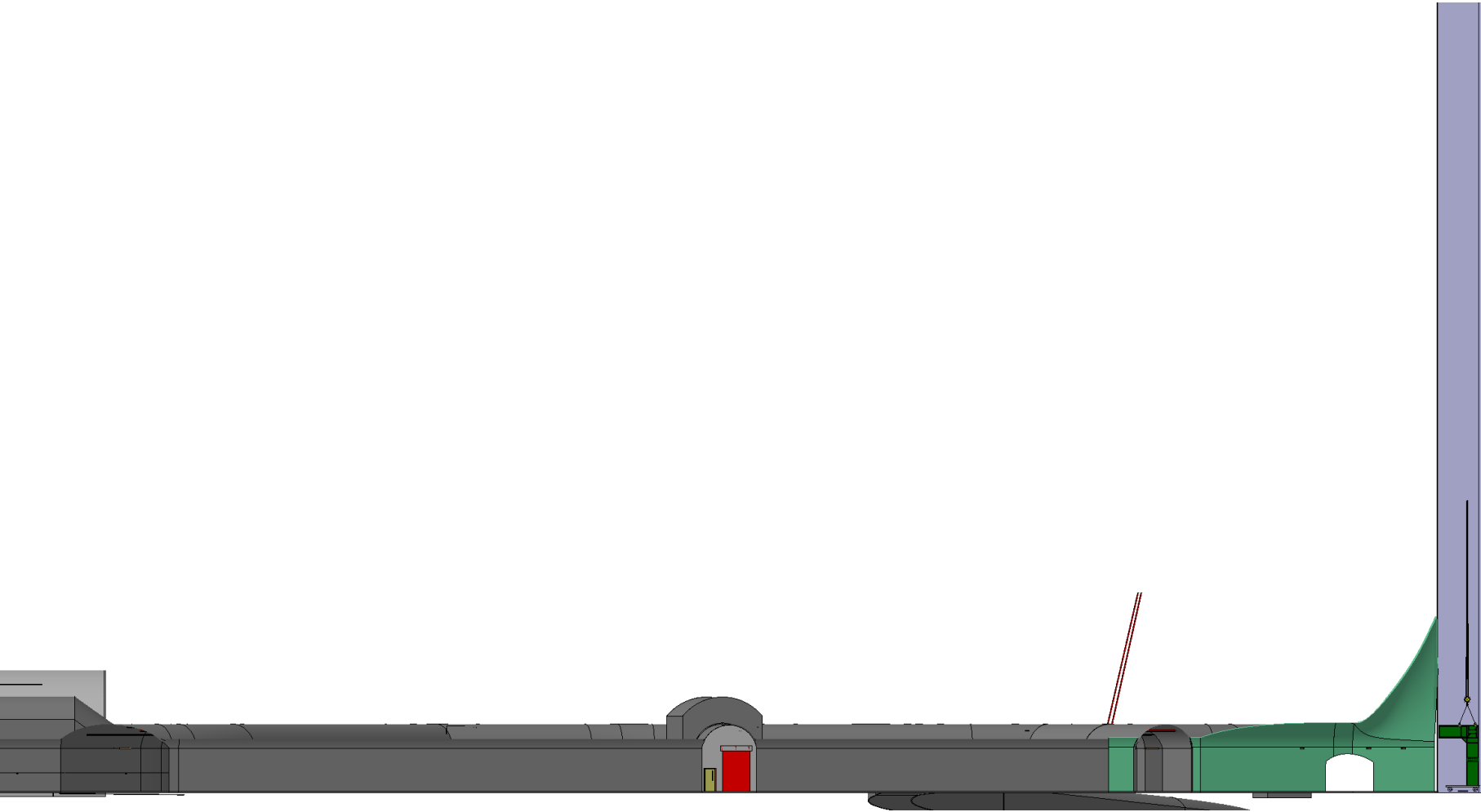
Corner beam lowering



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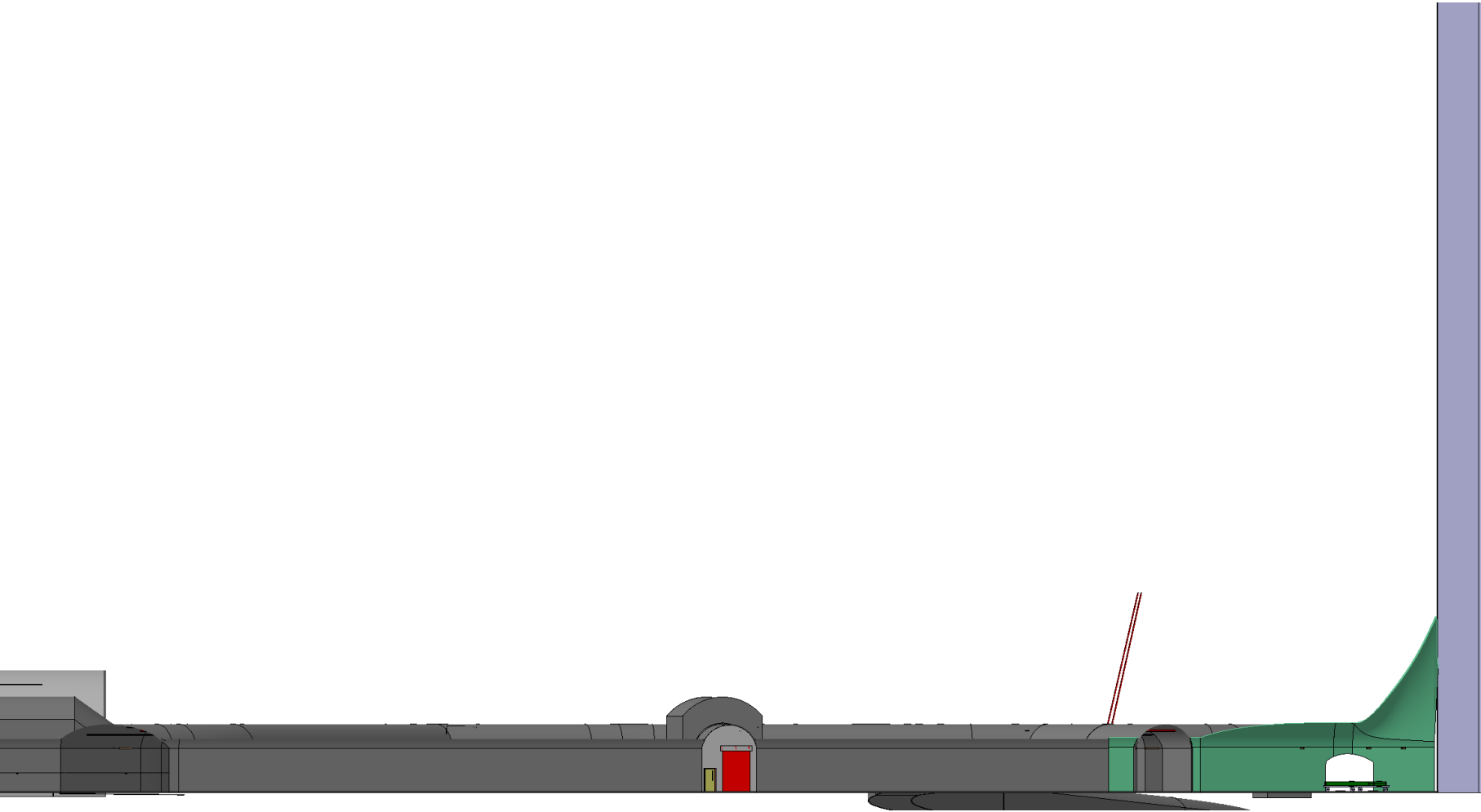
Corner beam lowering



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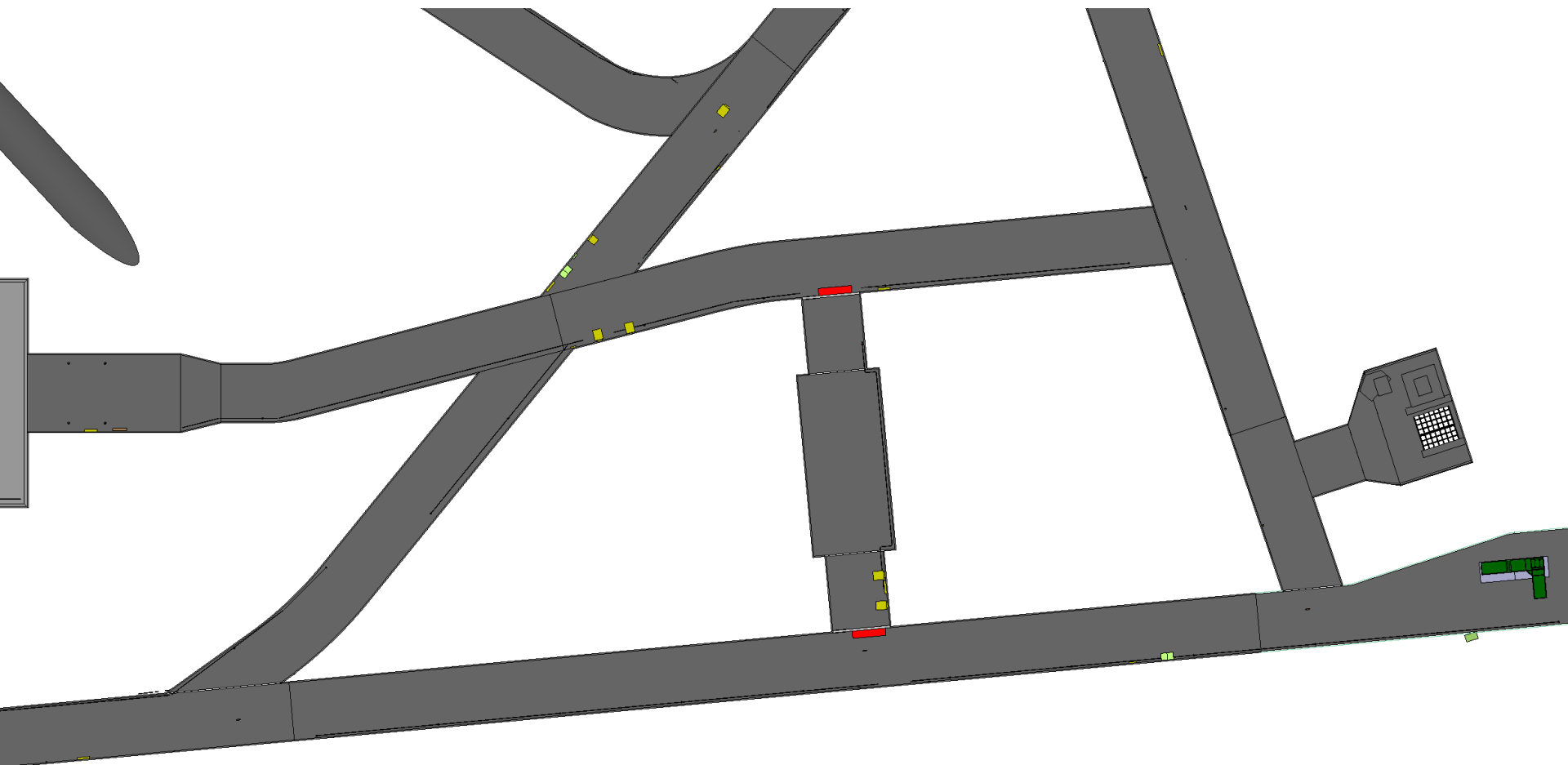
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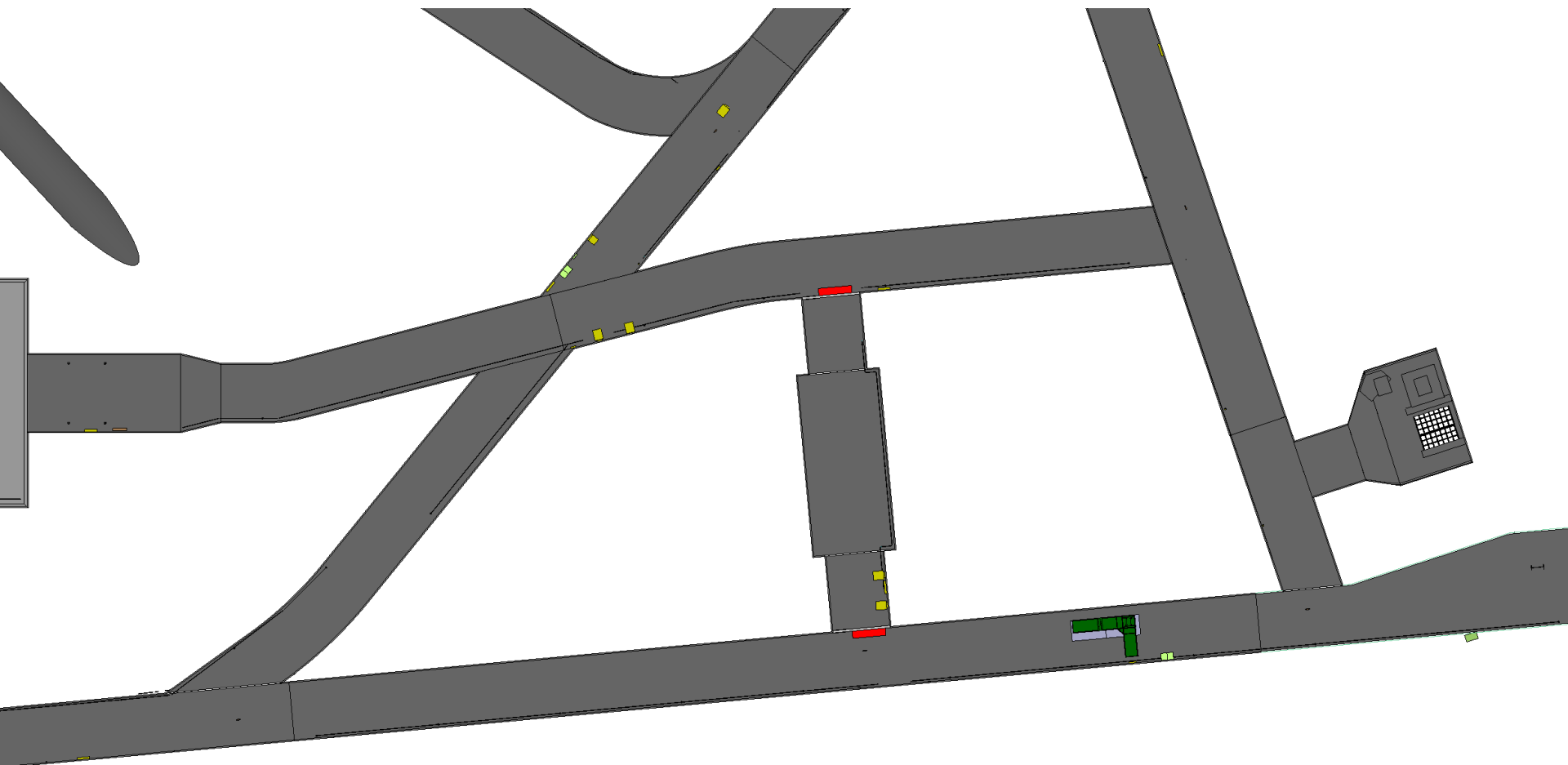
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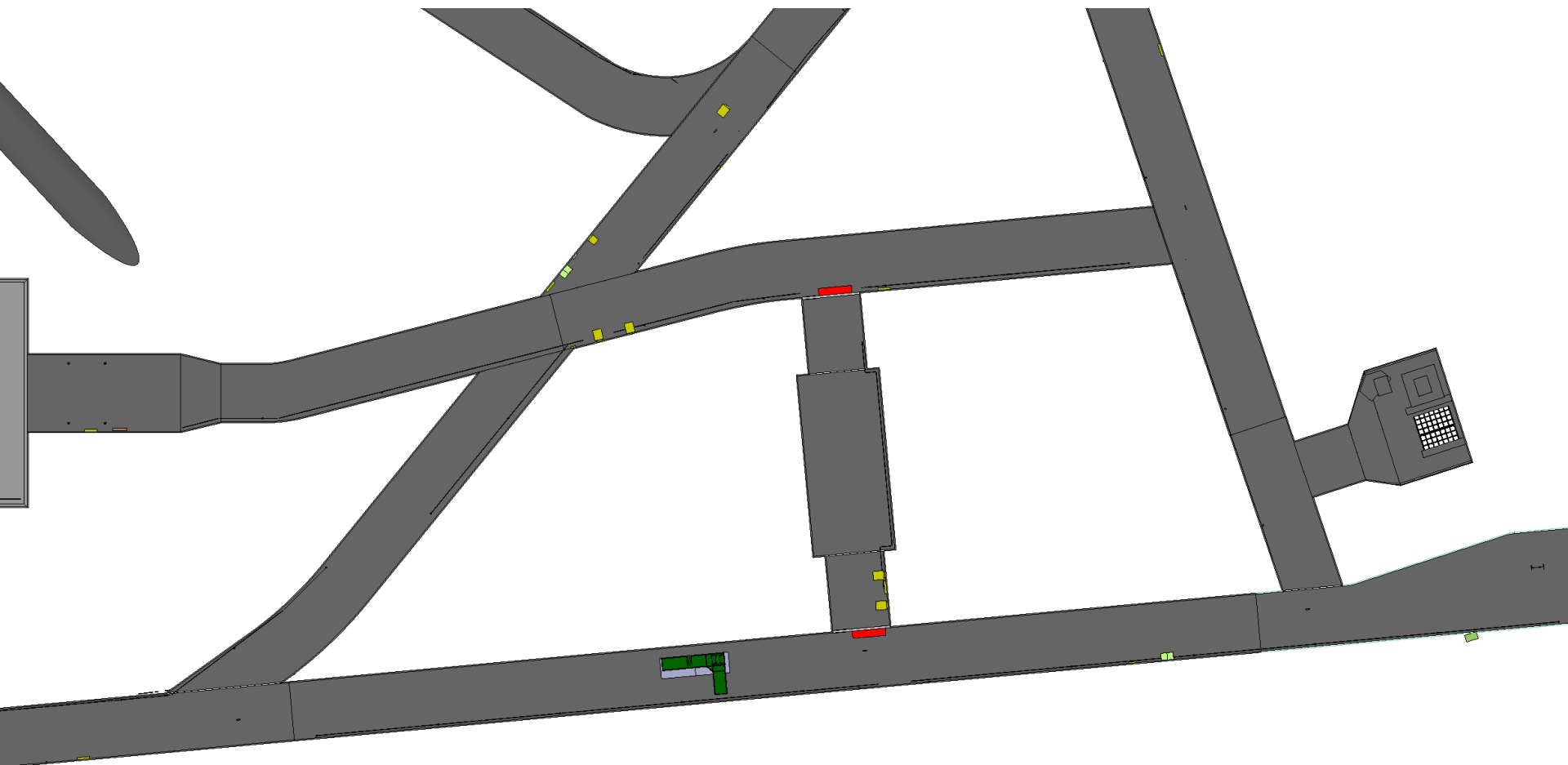
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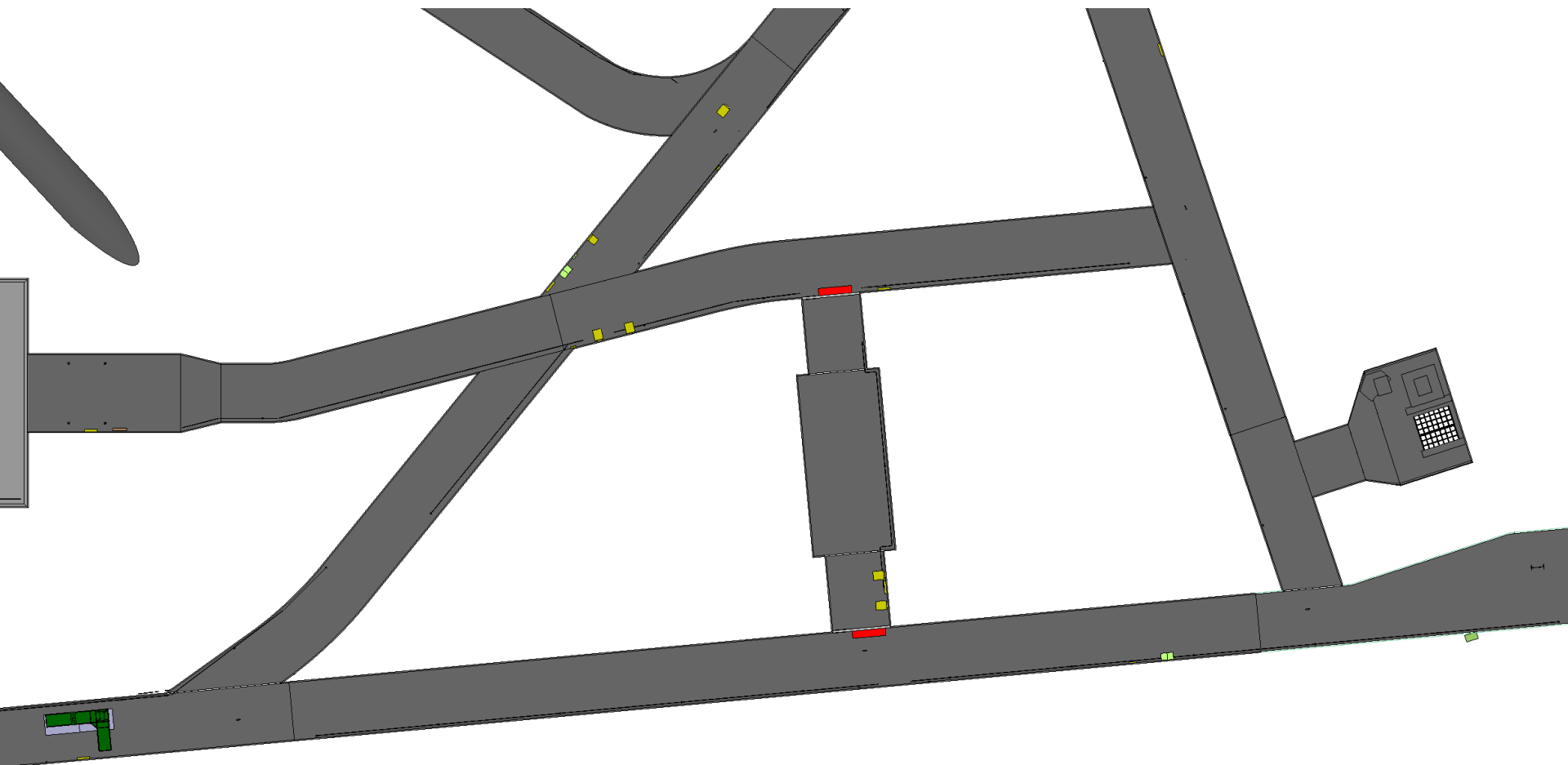
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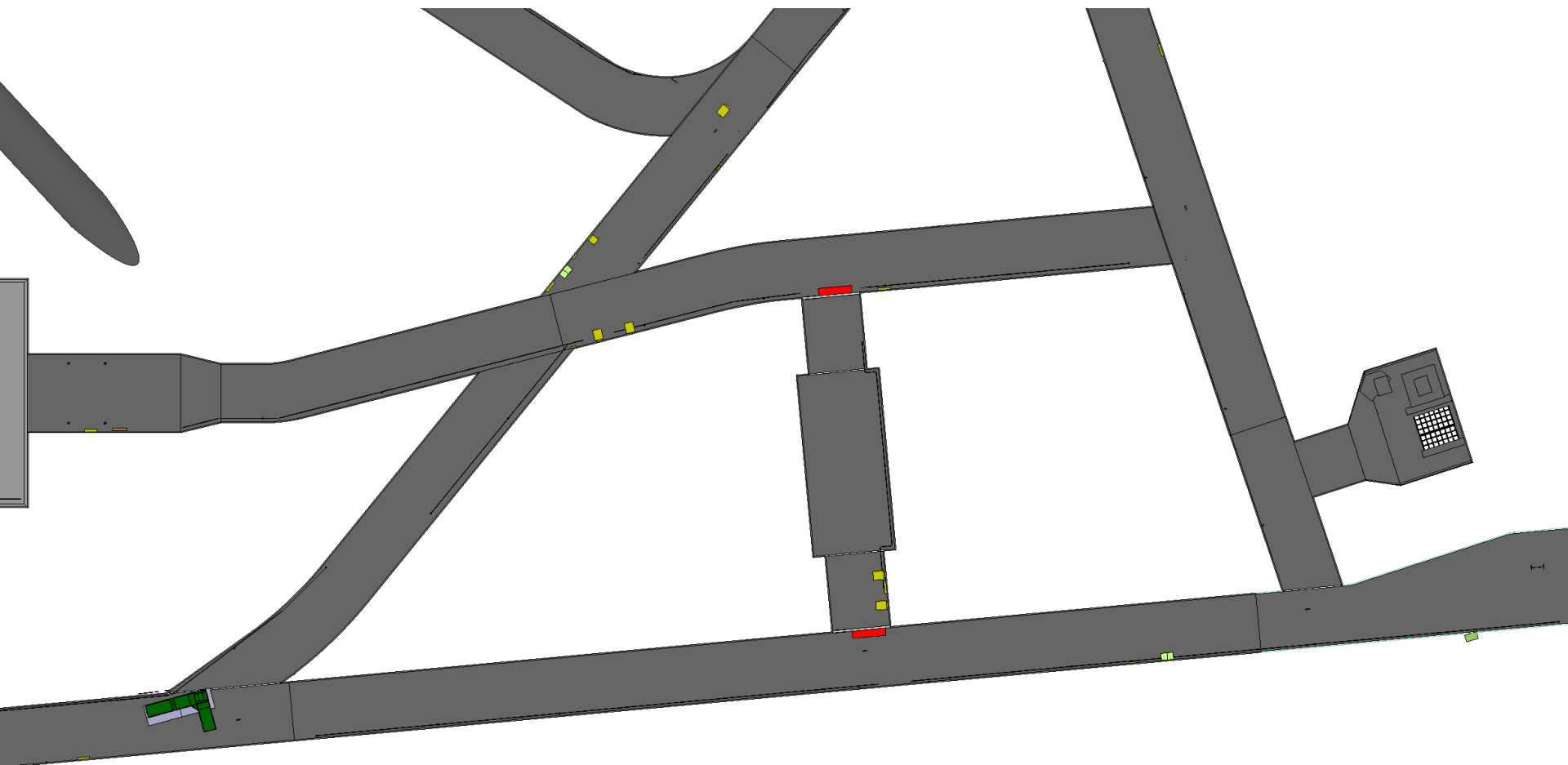
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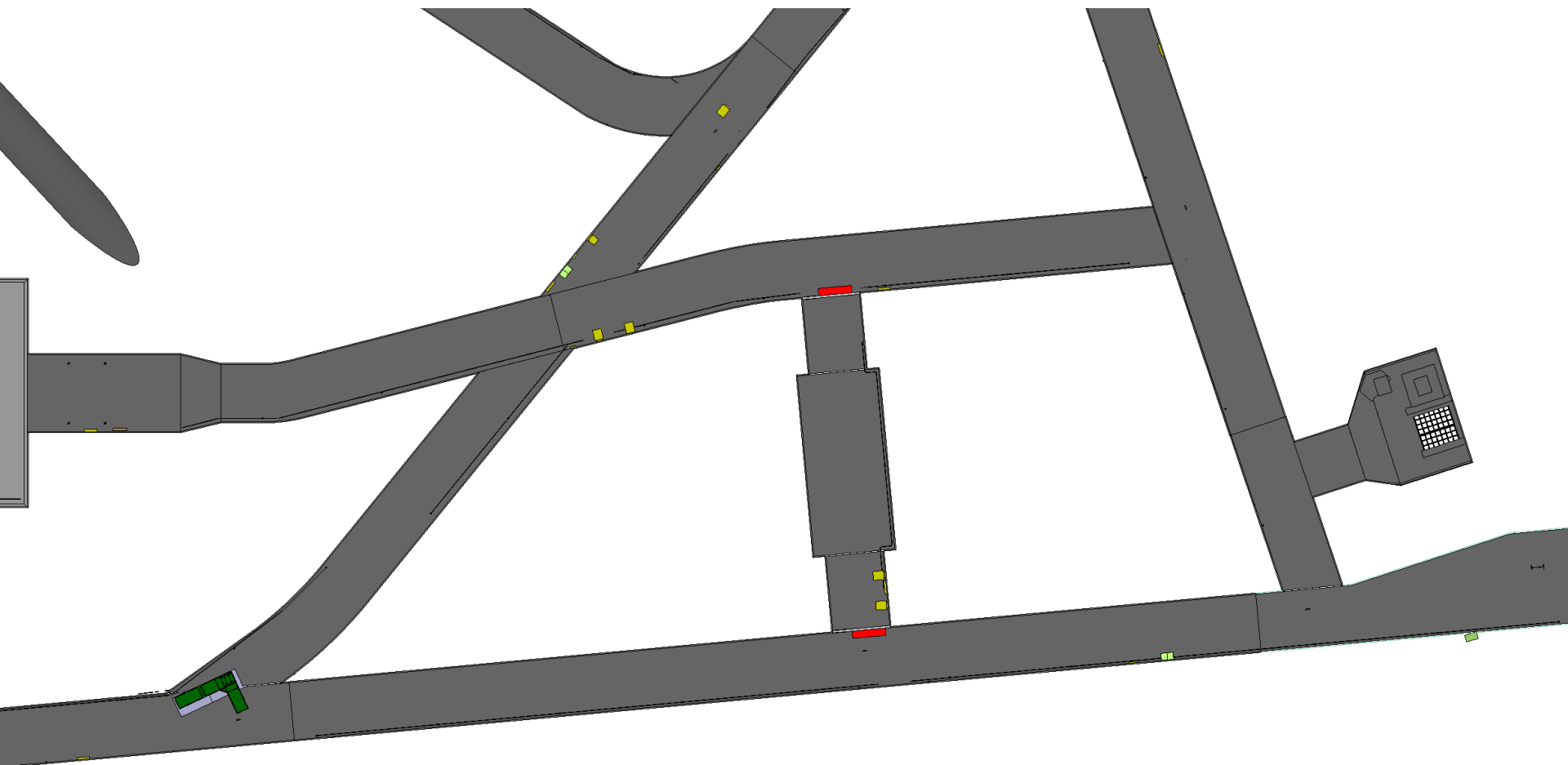
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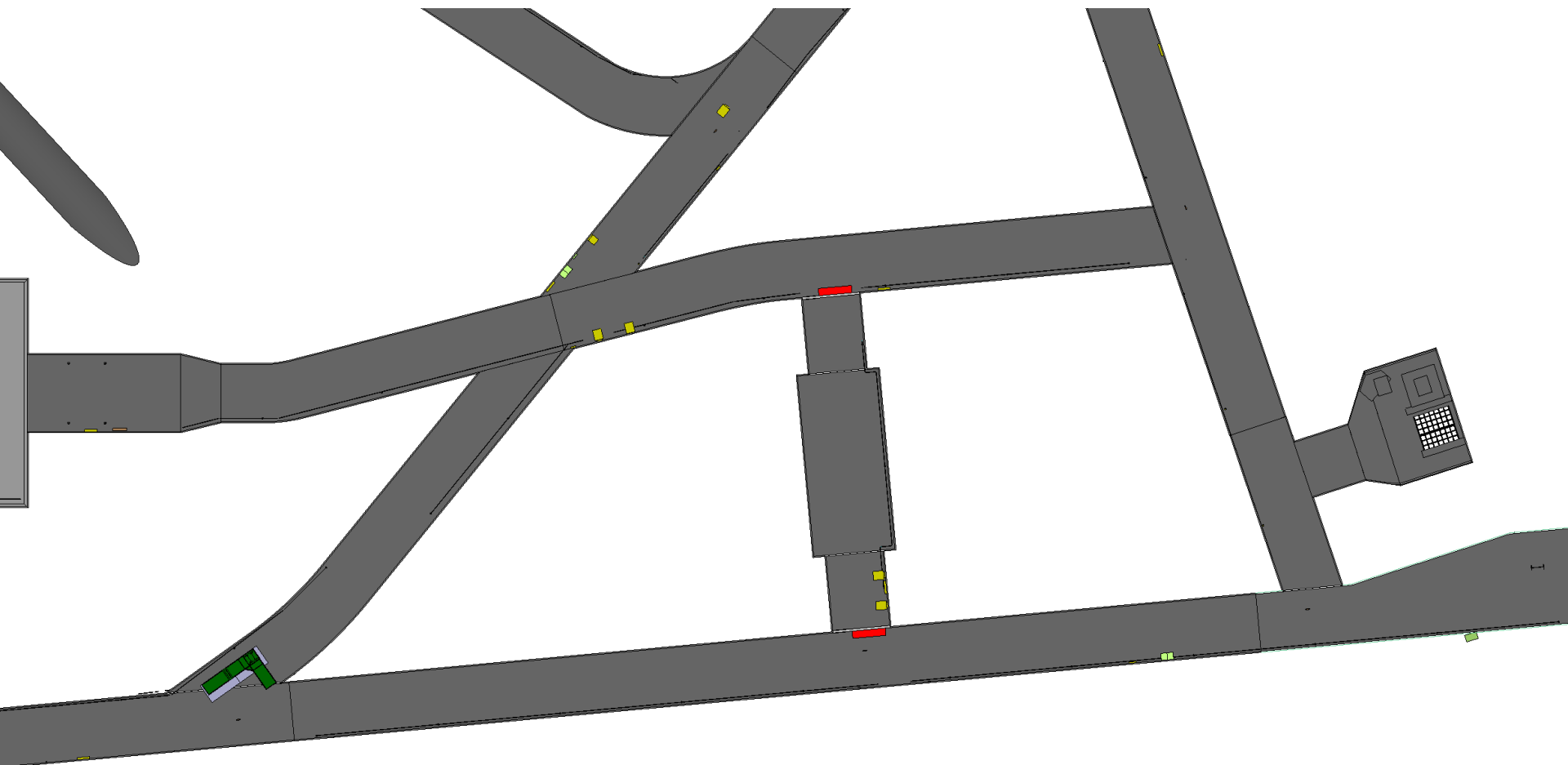
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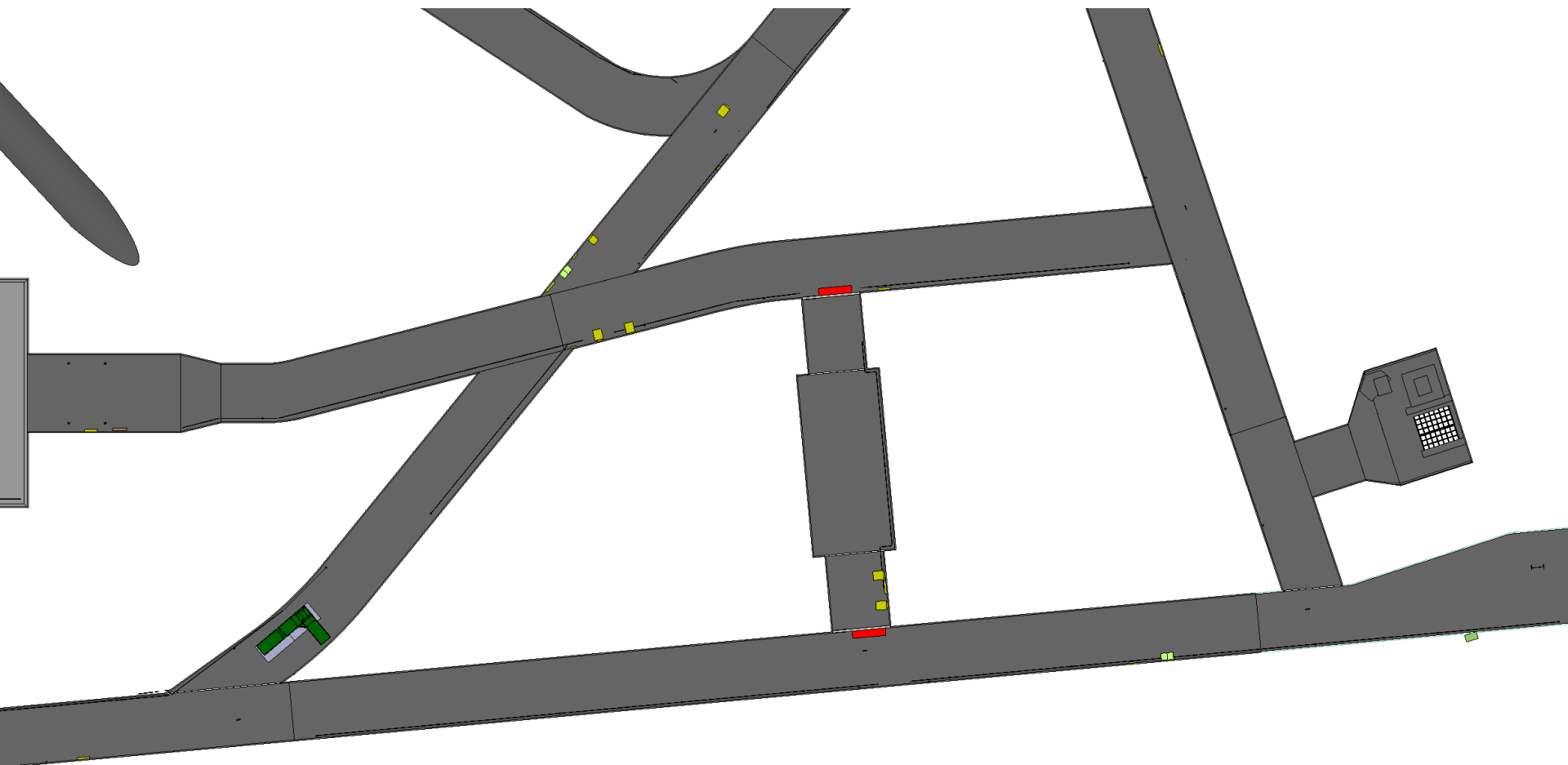
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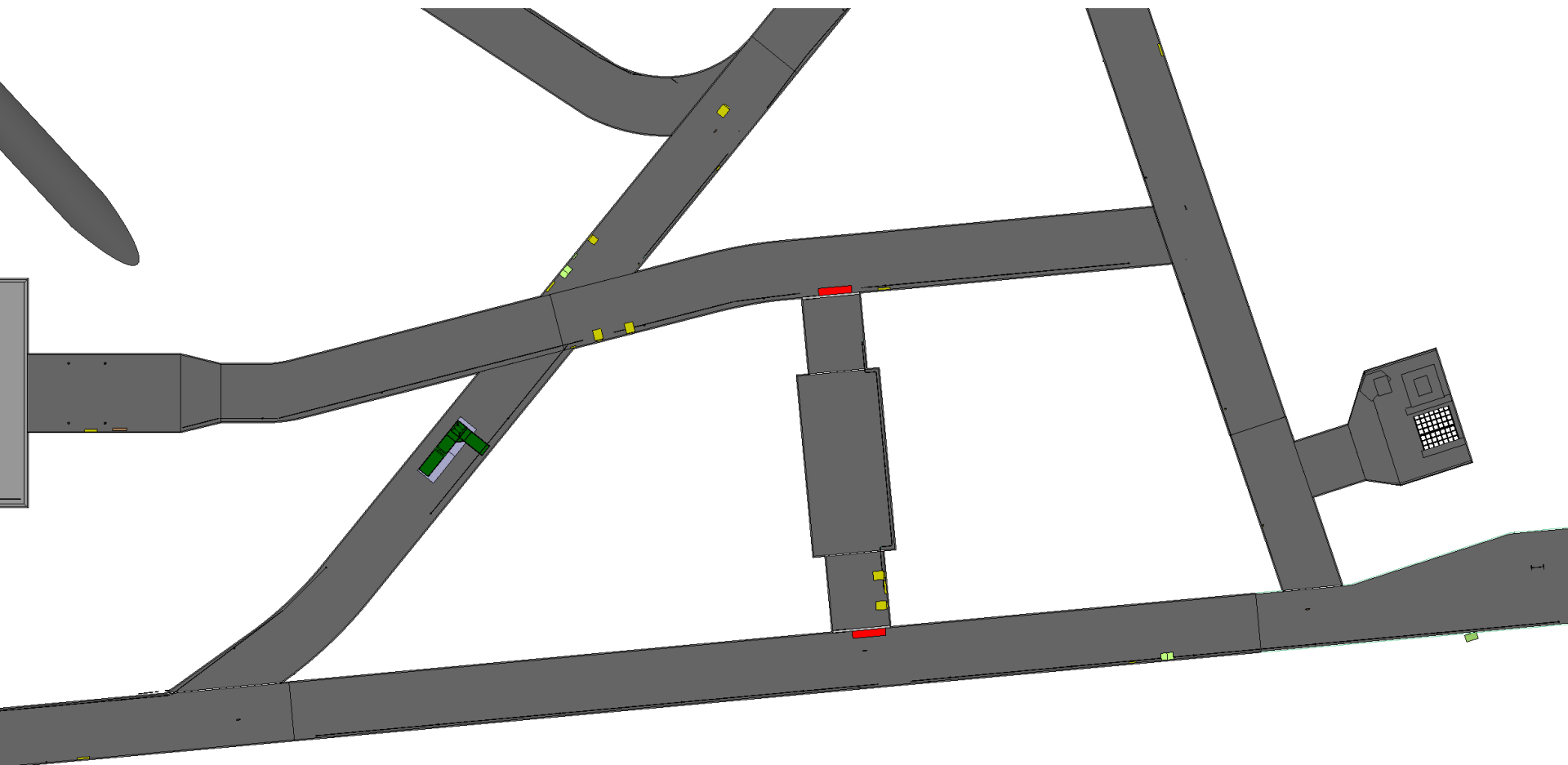
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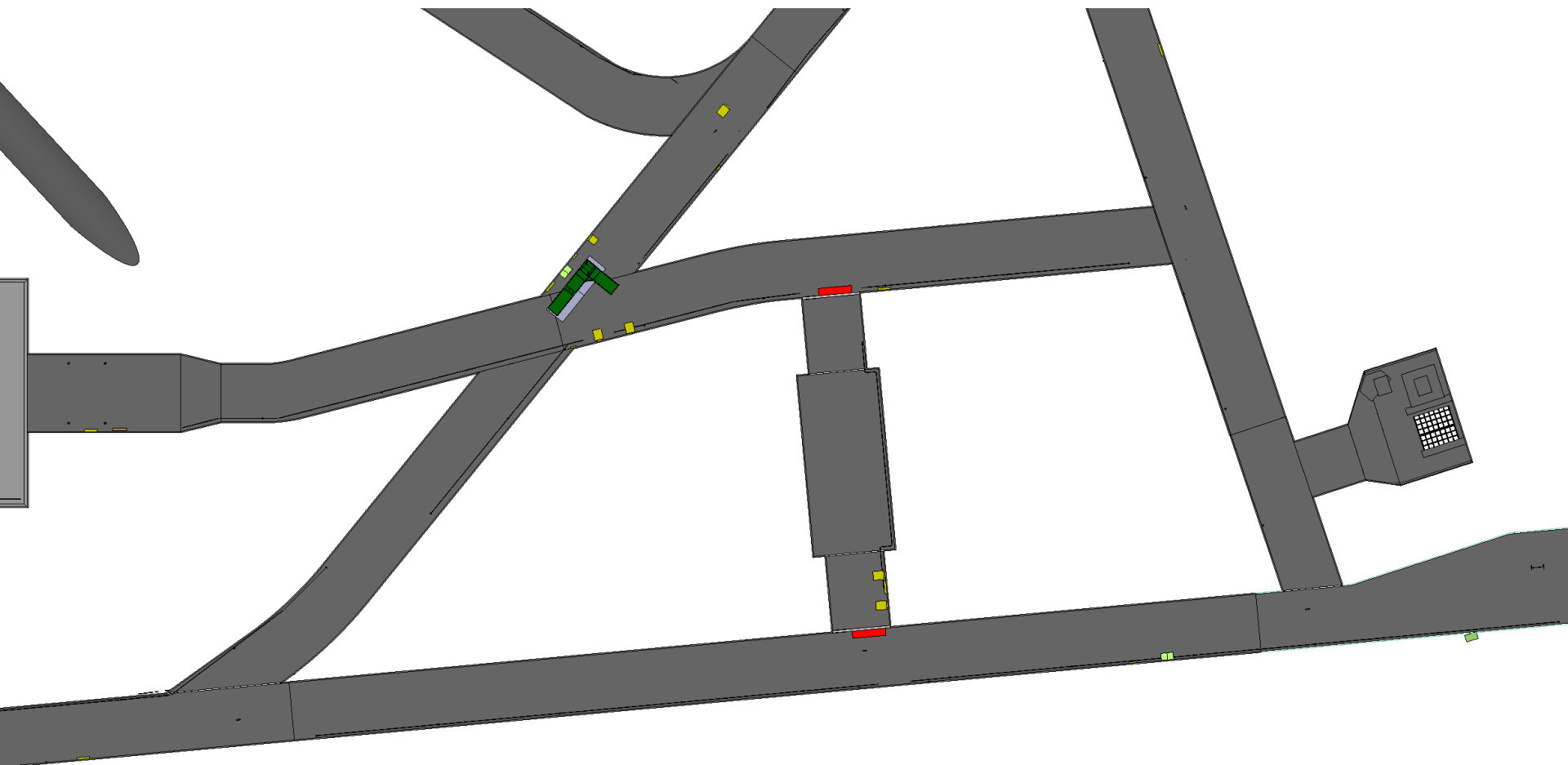
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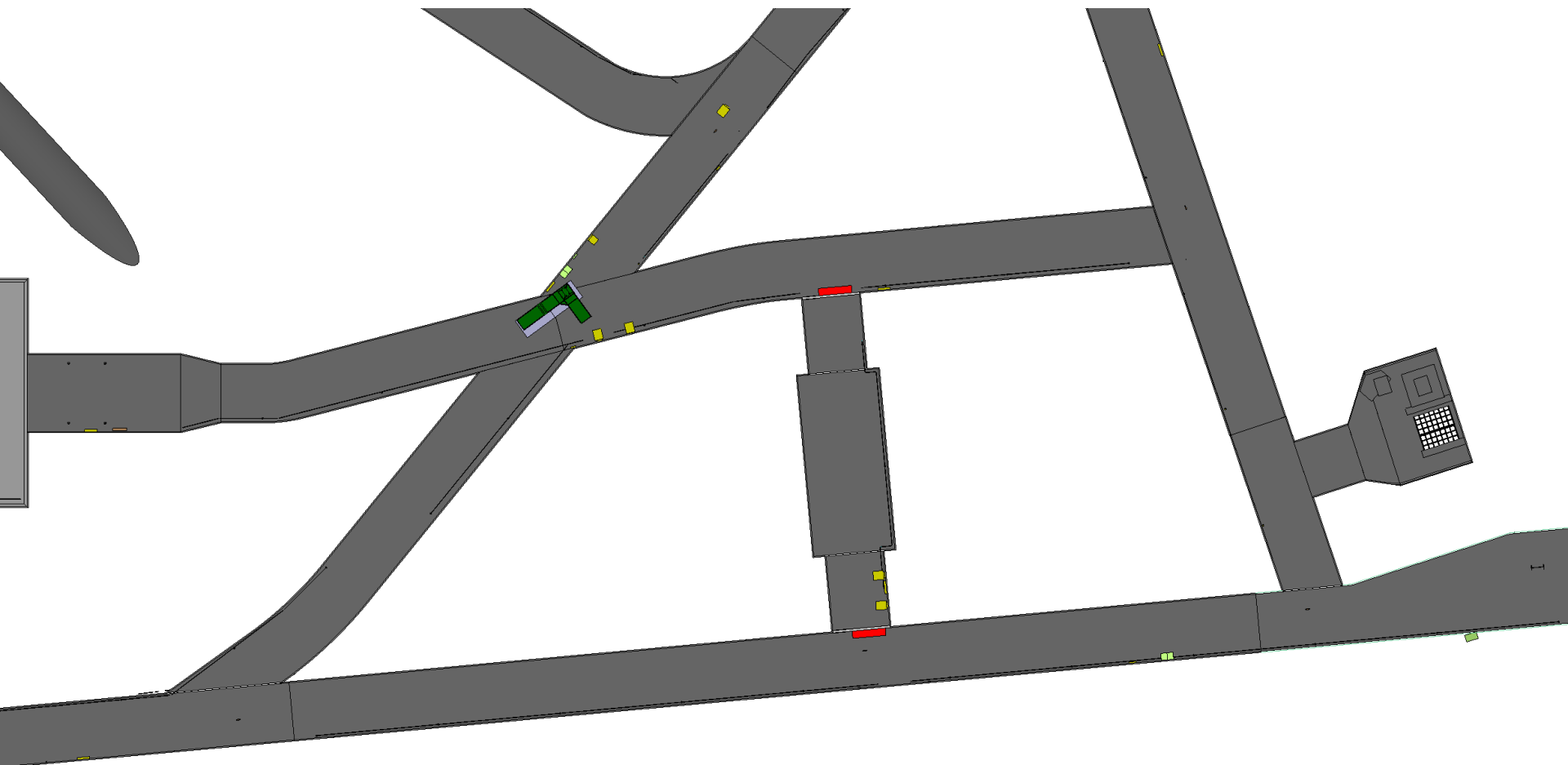
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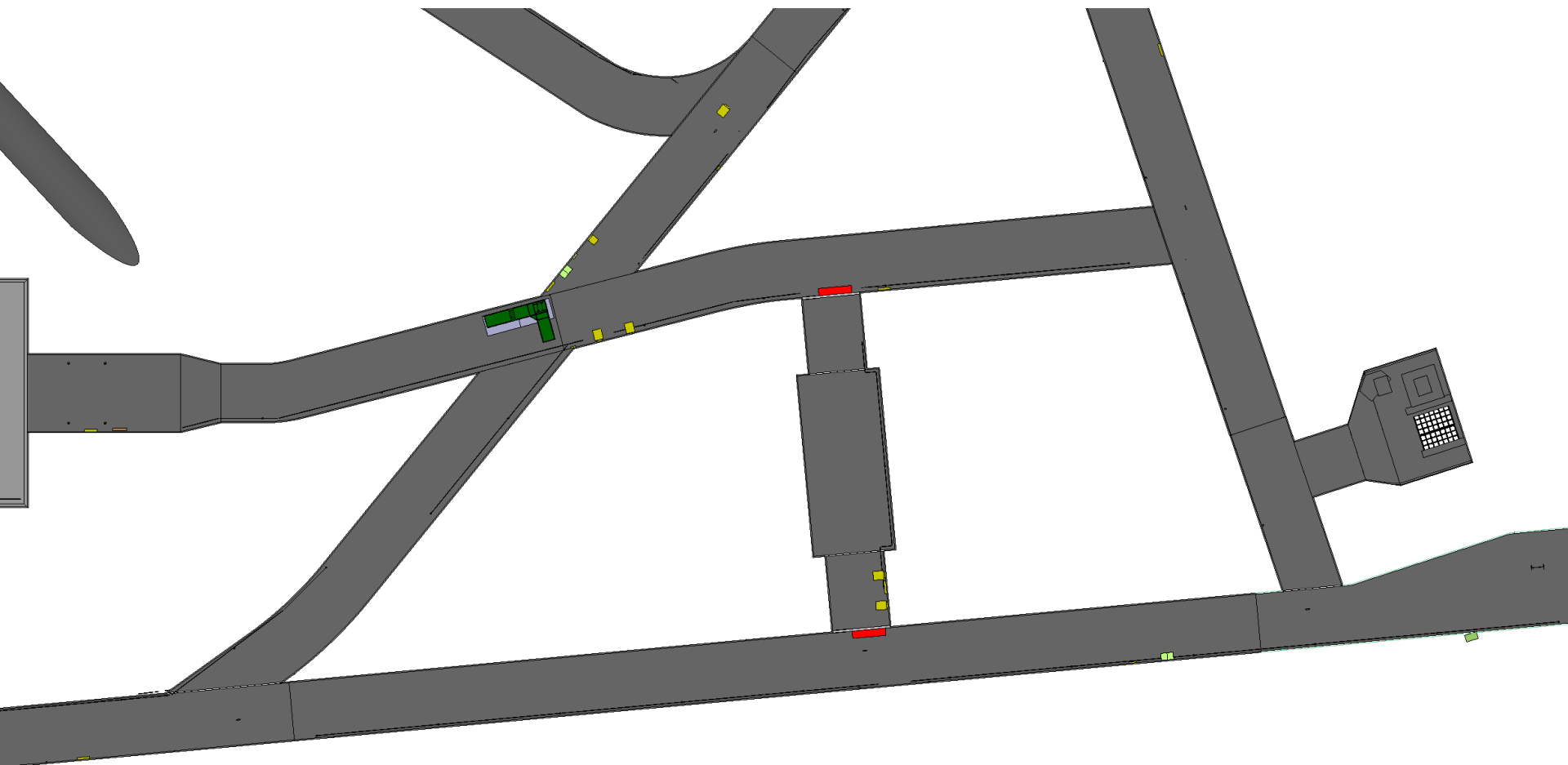
Corner beam lowering



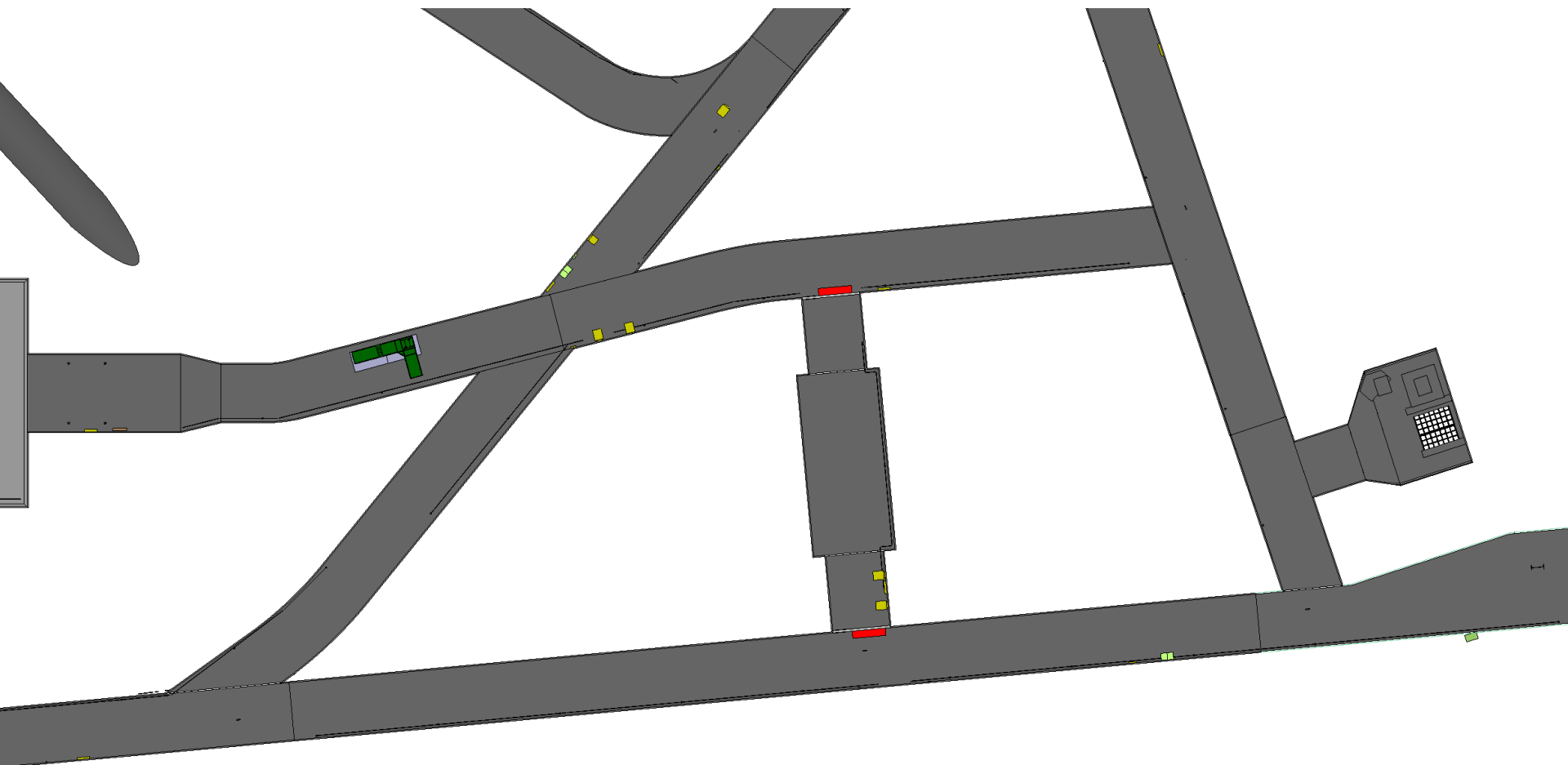
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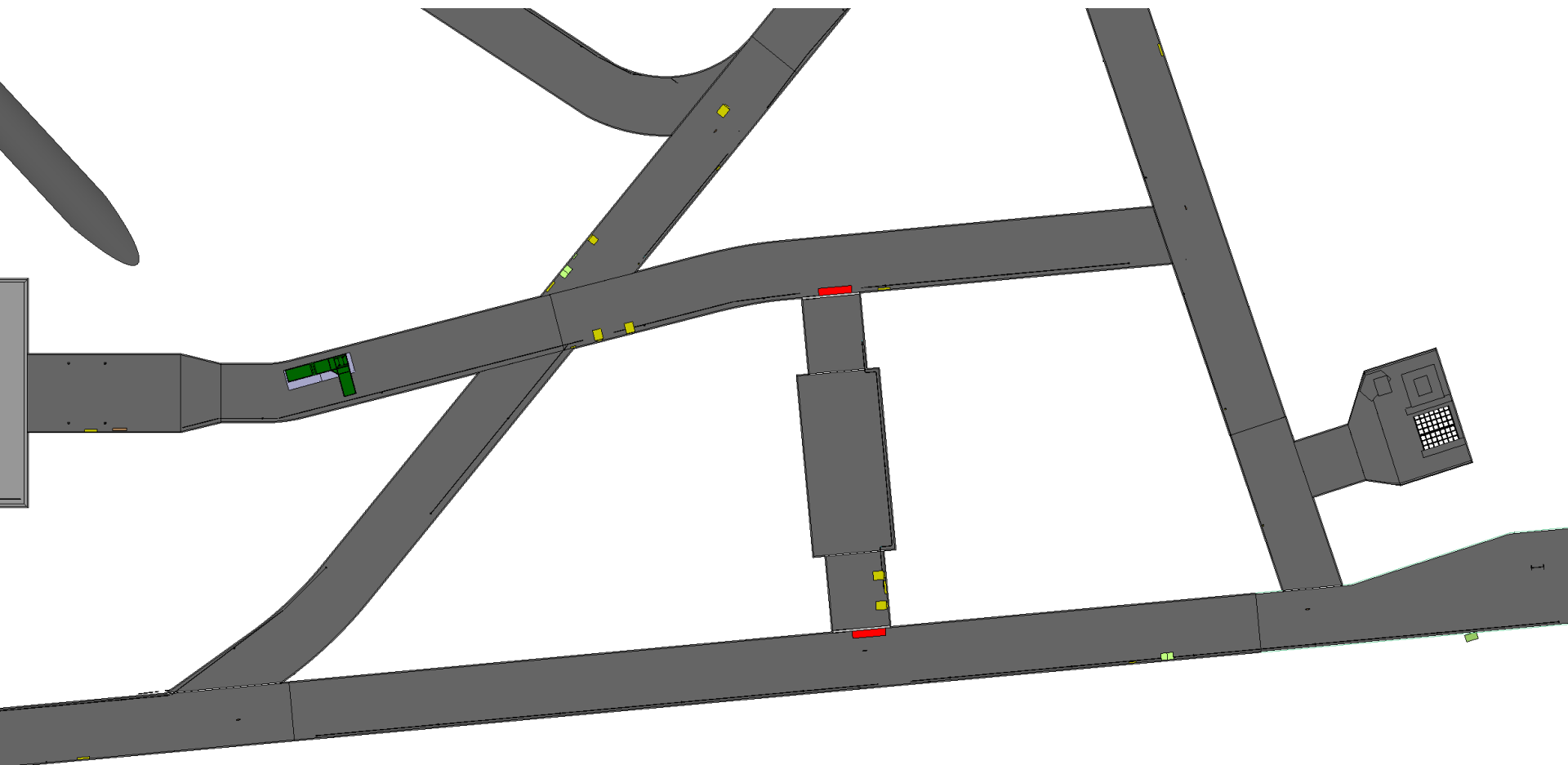
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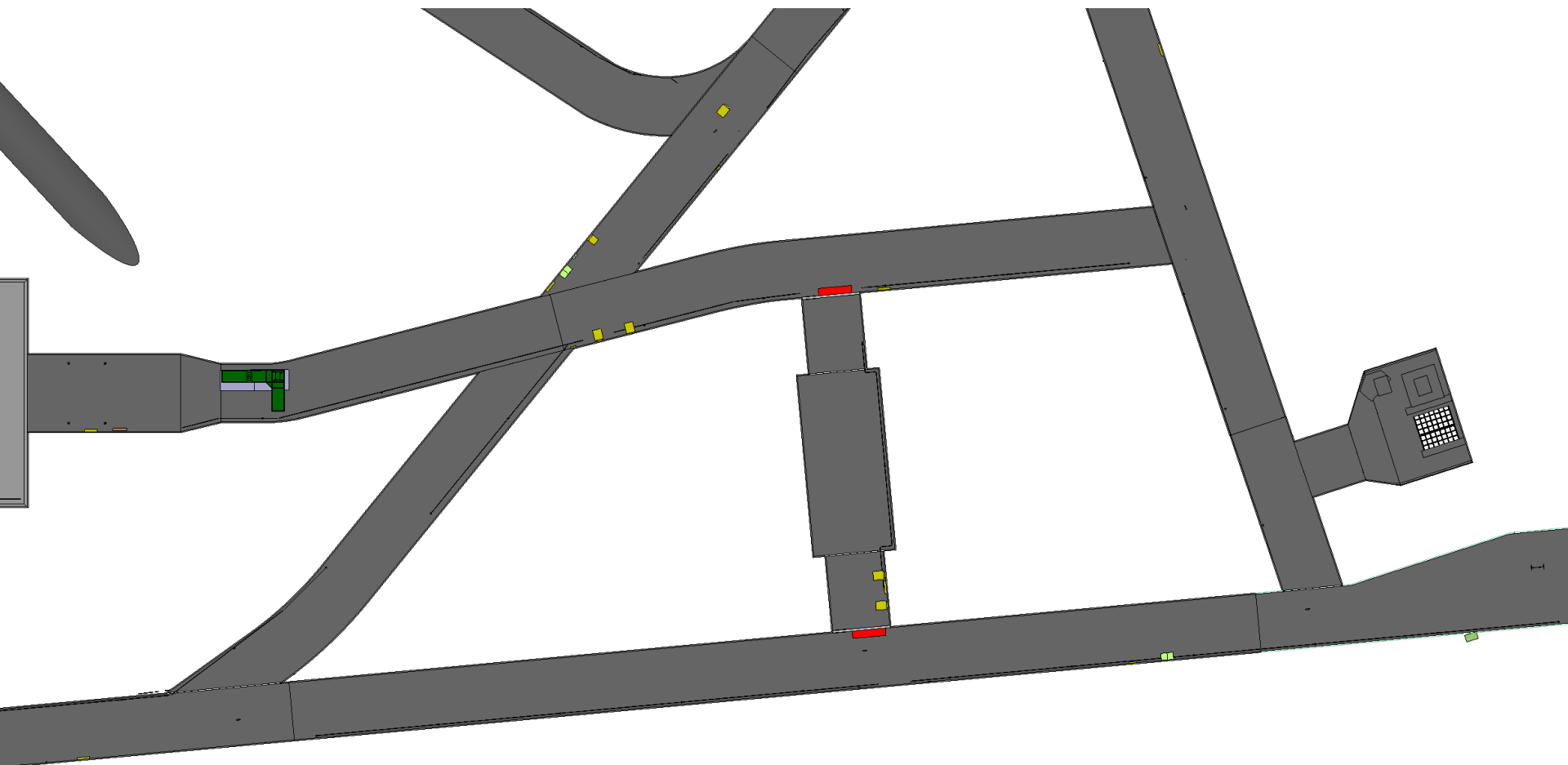
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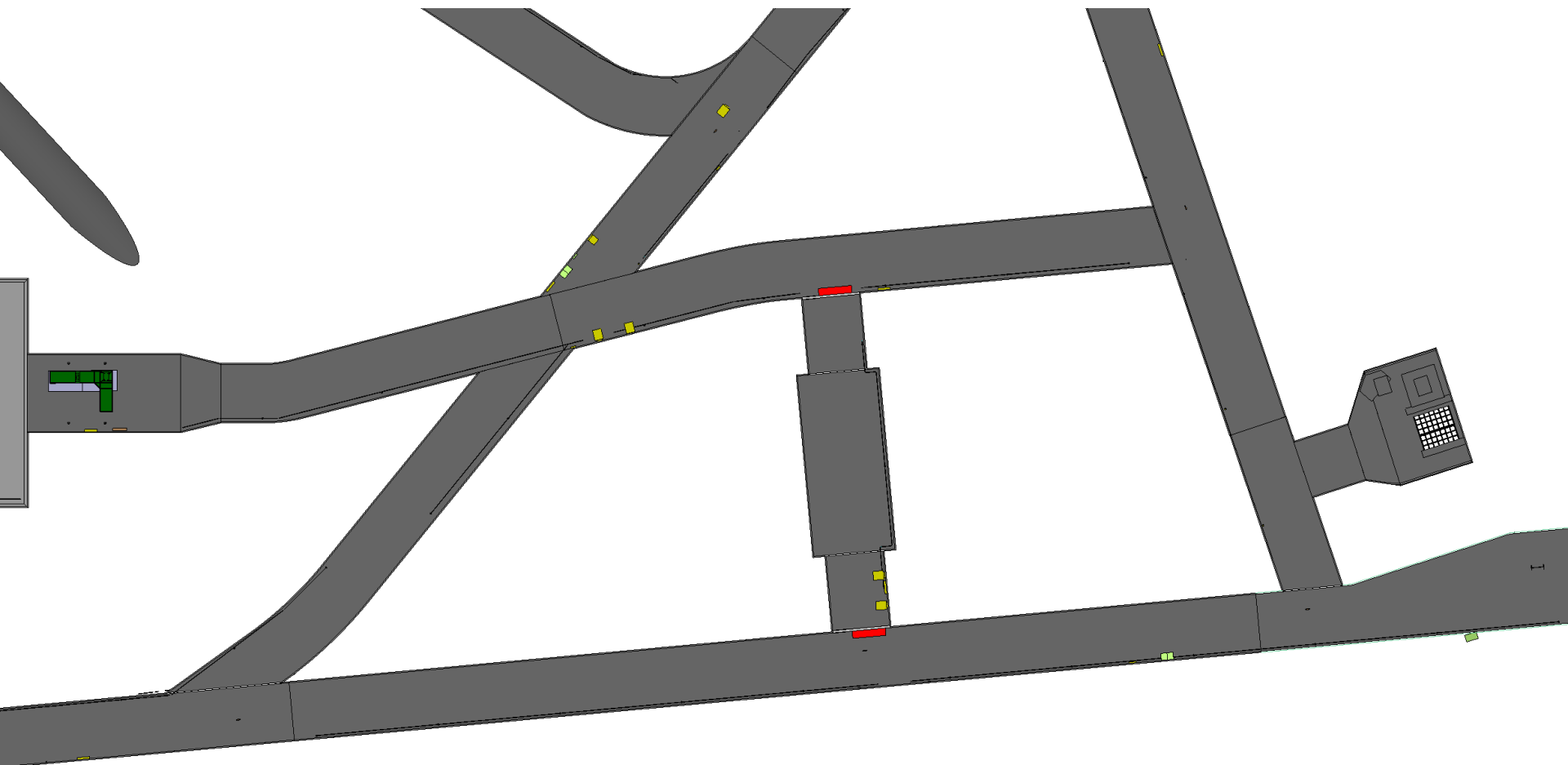
Corner beam lowering



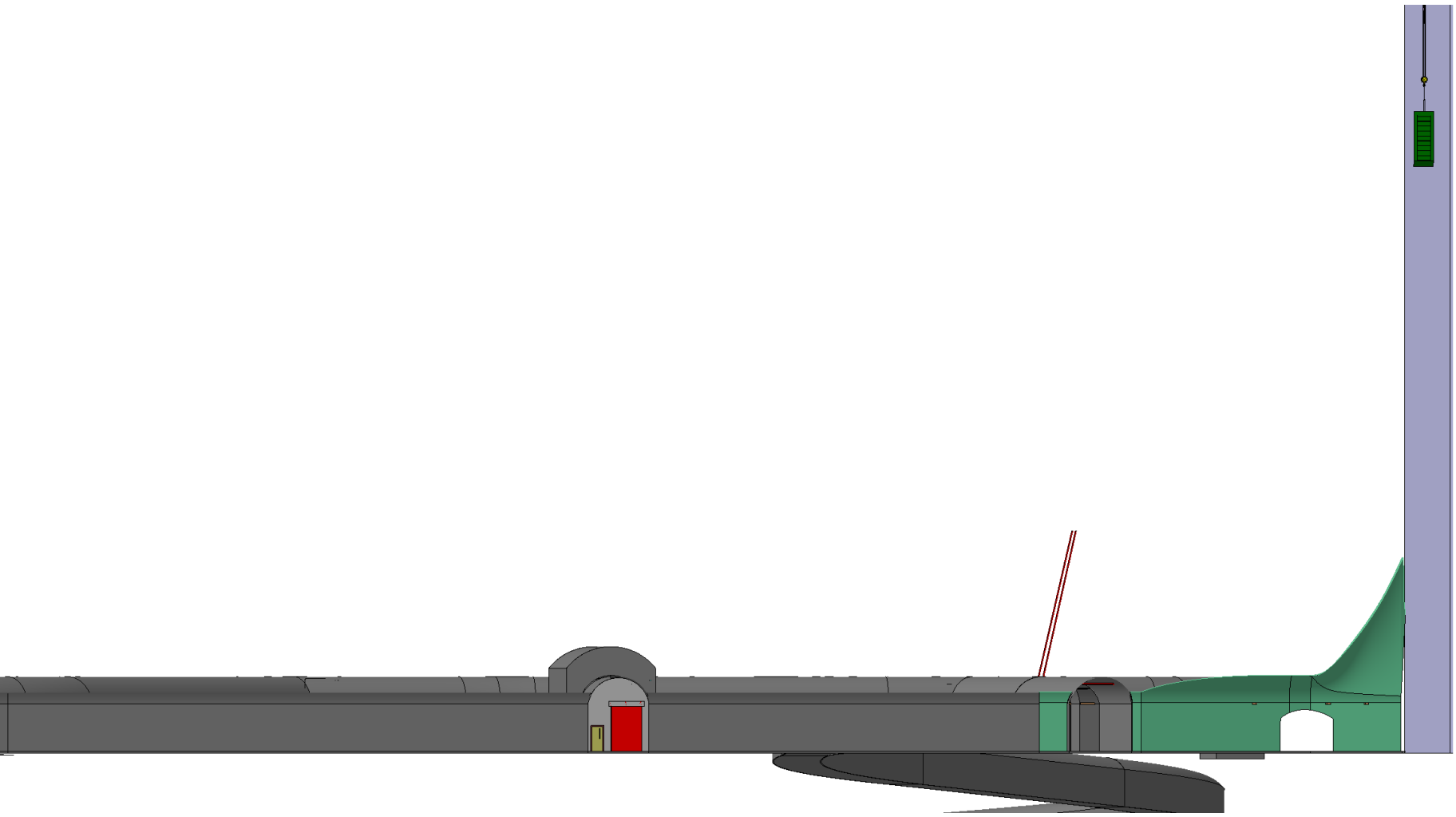
Corner beam lowering



Corner beam lowering



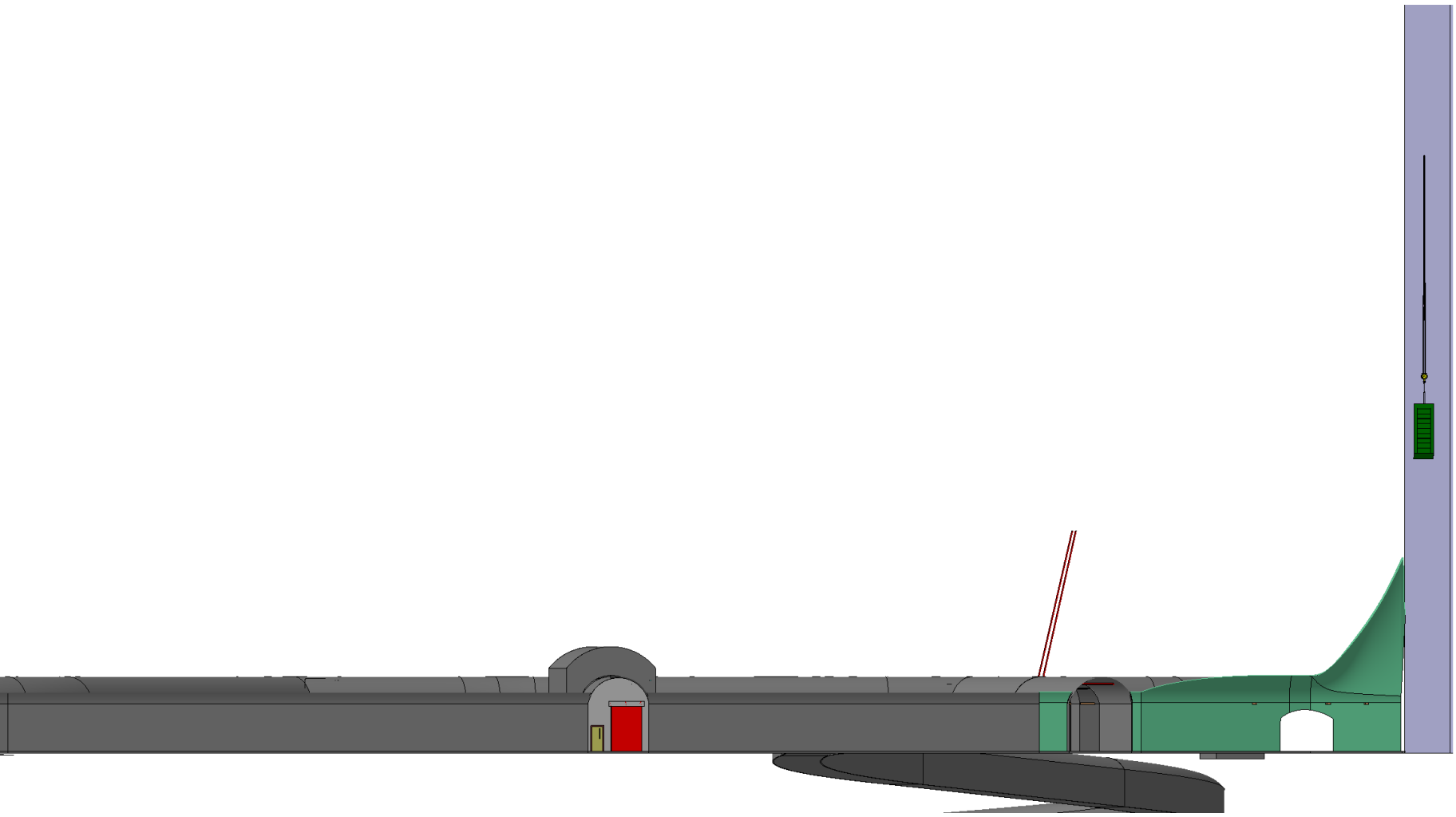
Warm skin lowering



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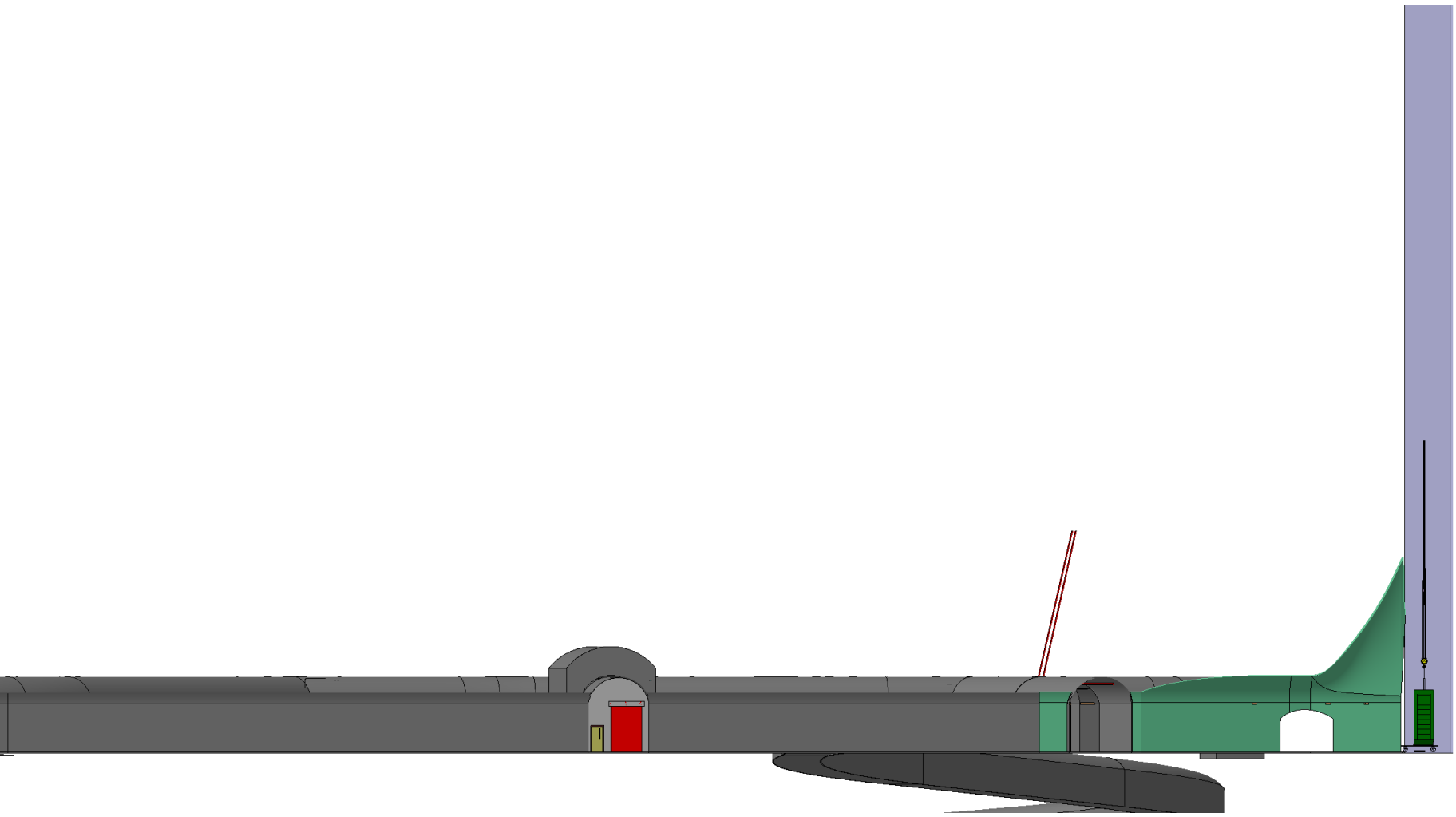
Warm skin lowering



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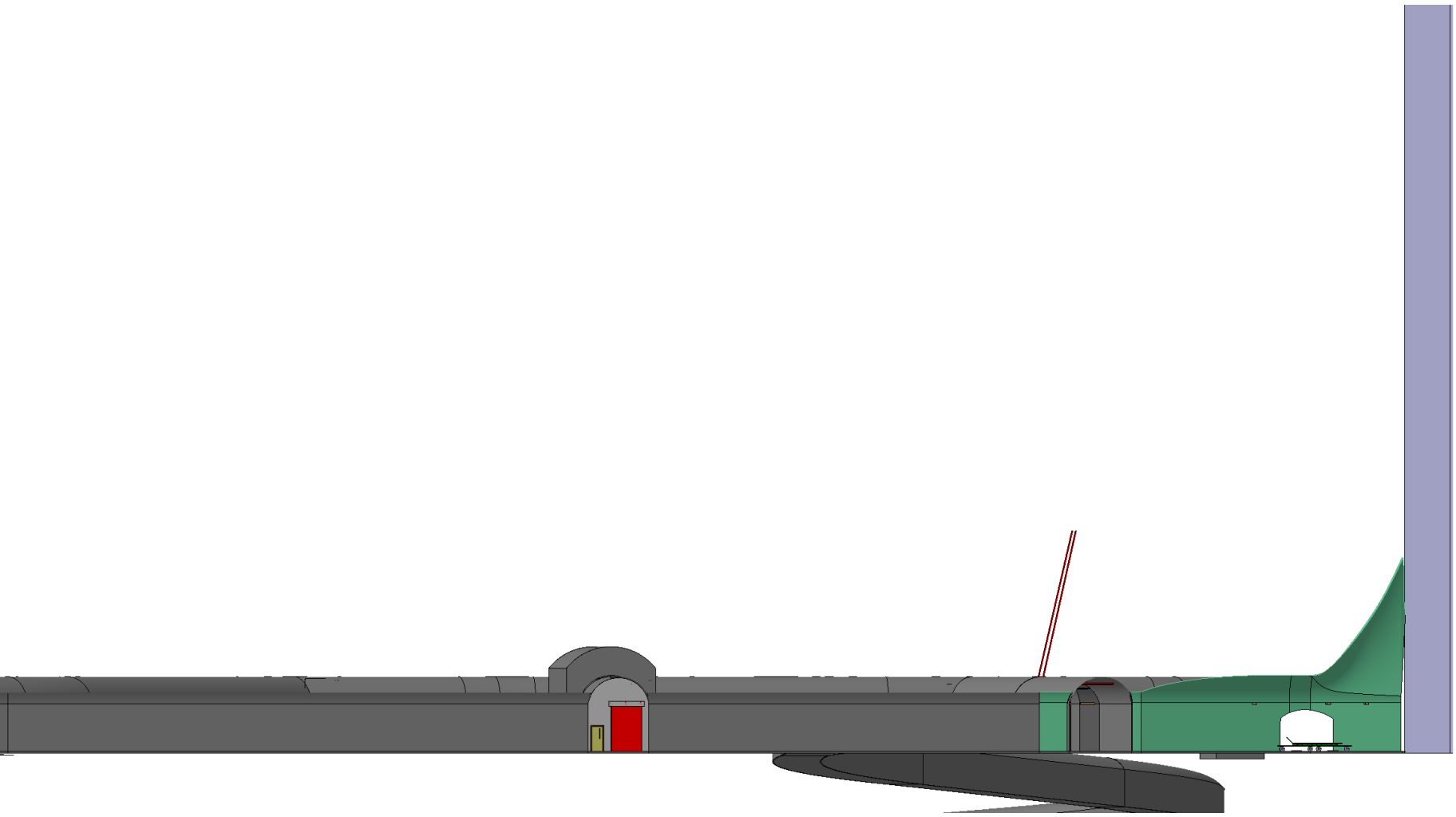
Warm skin lowering



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CERN NP

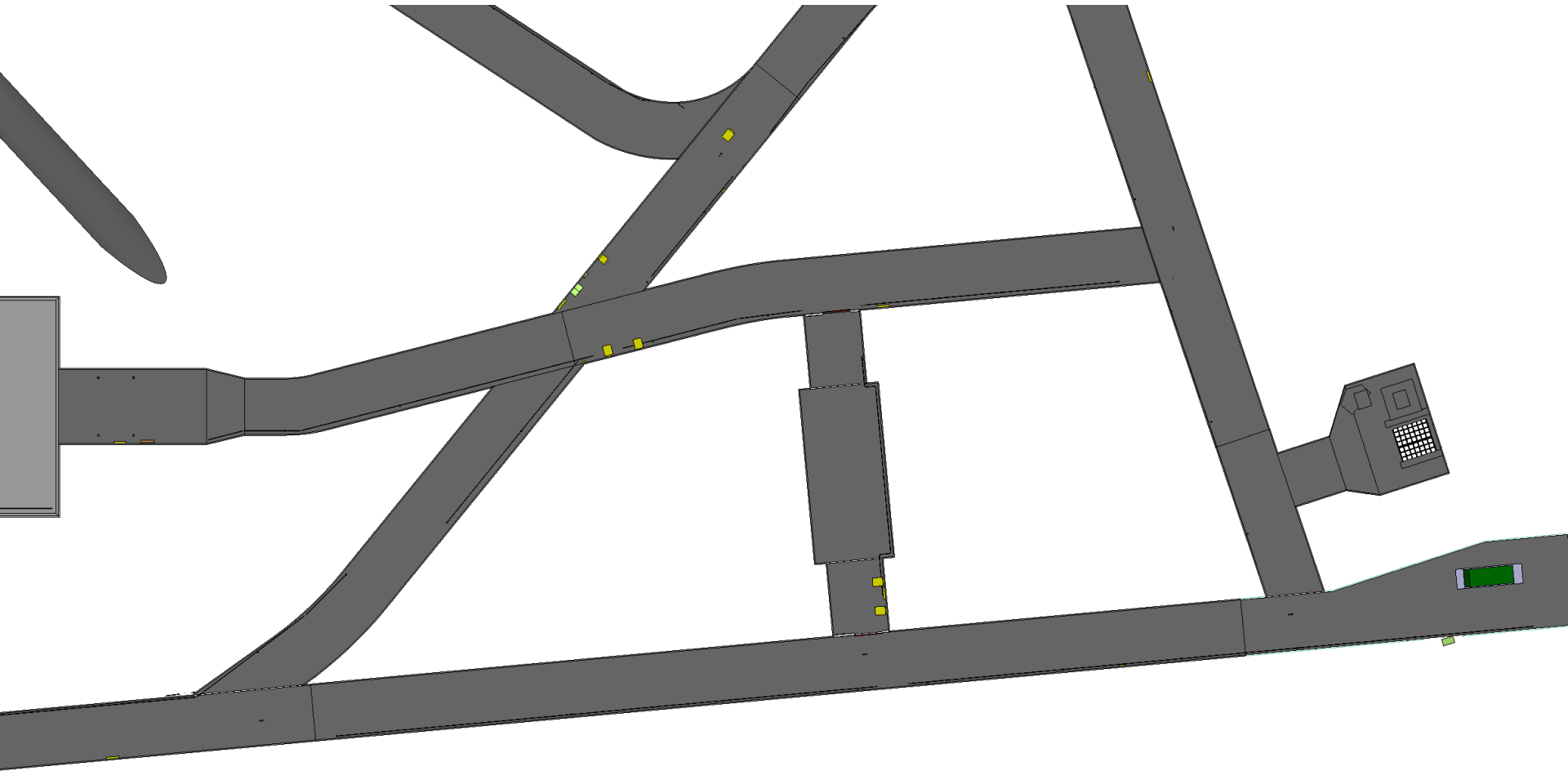
Warm skin lowering



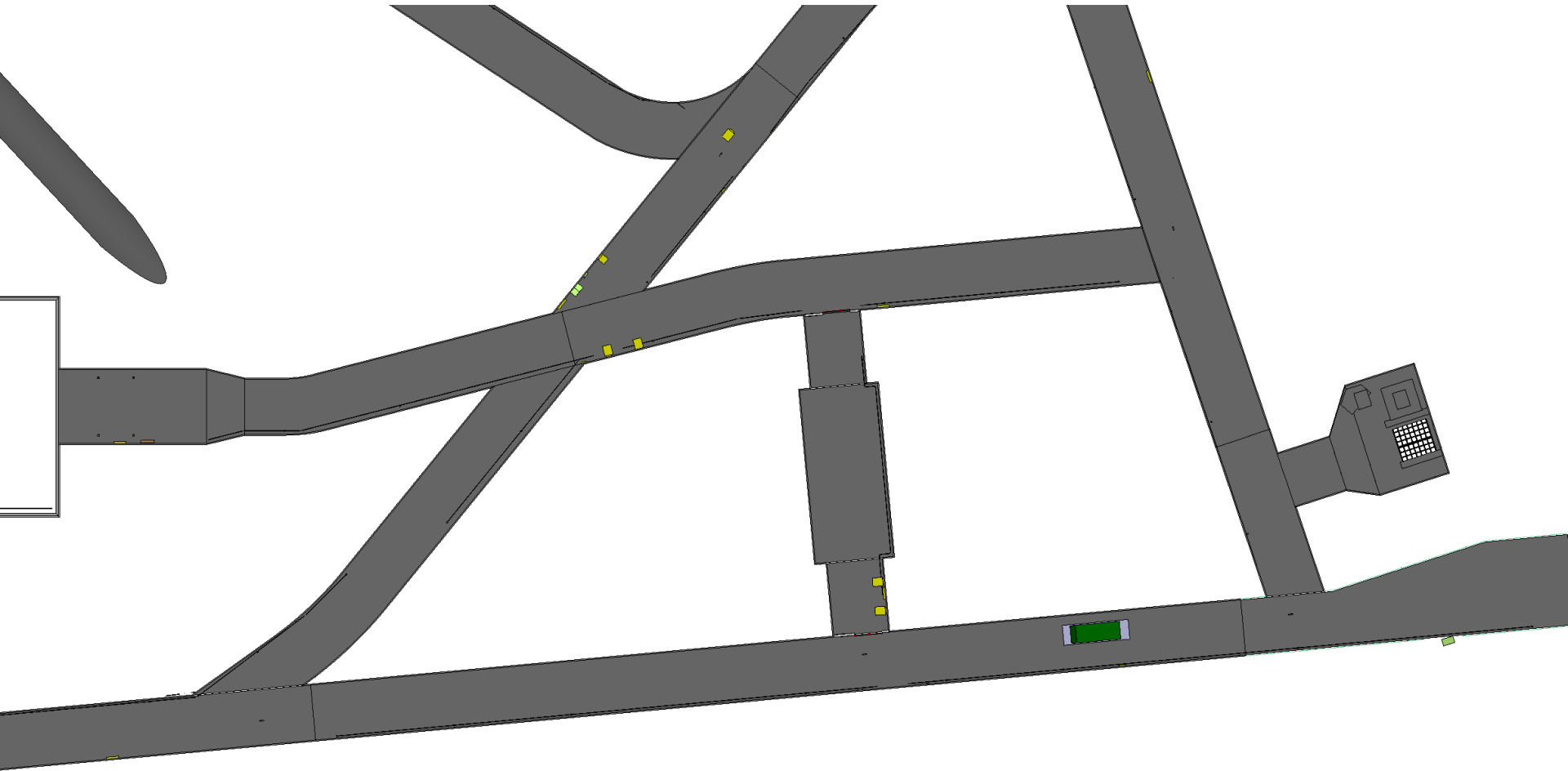
LBNF

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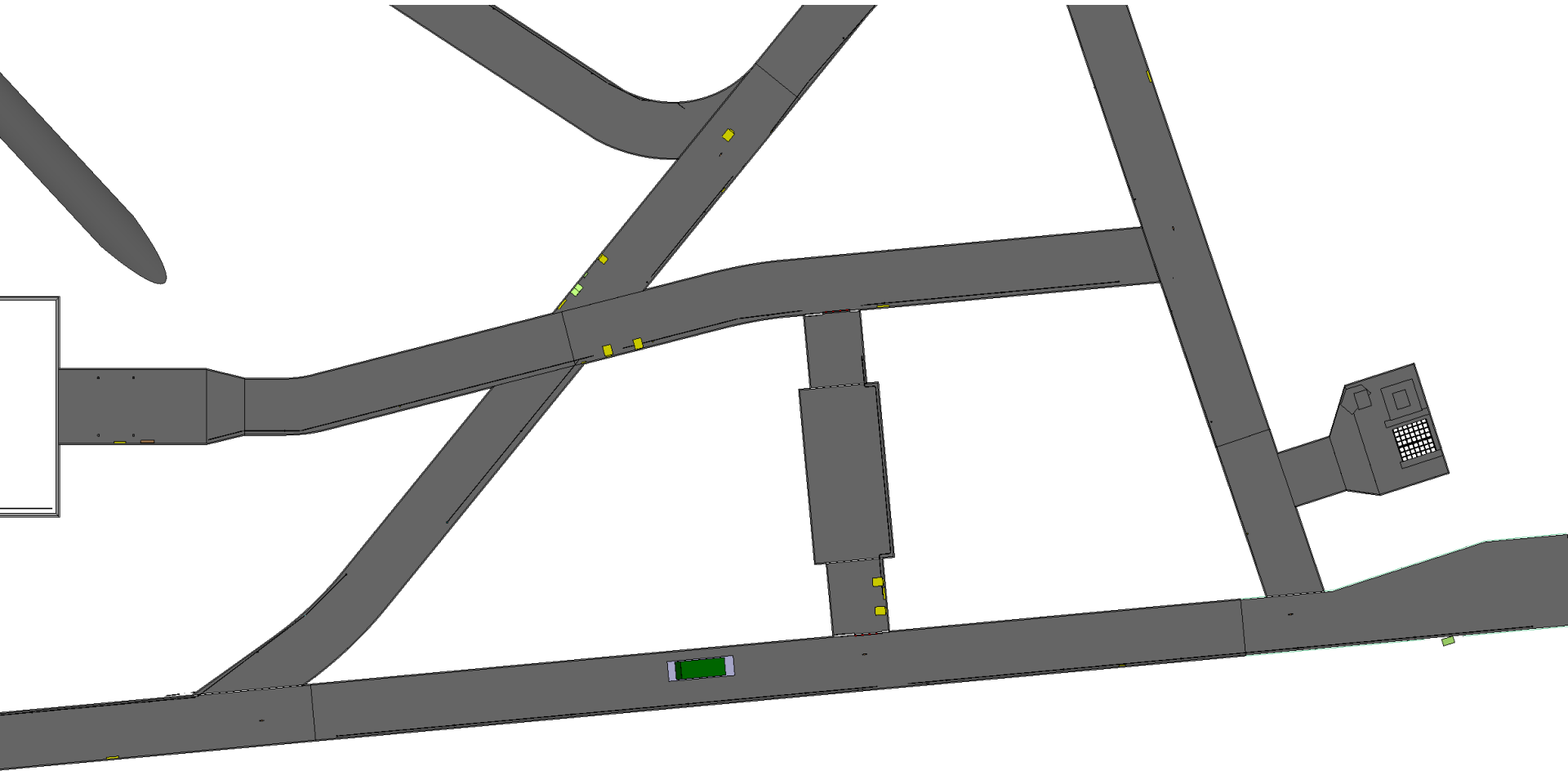
Warm skin lowering



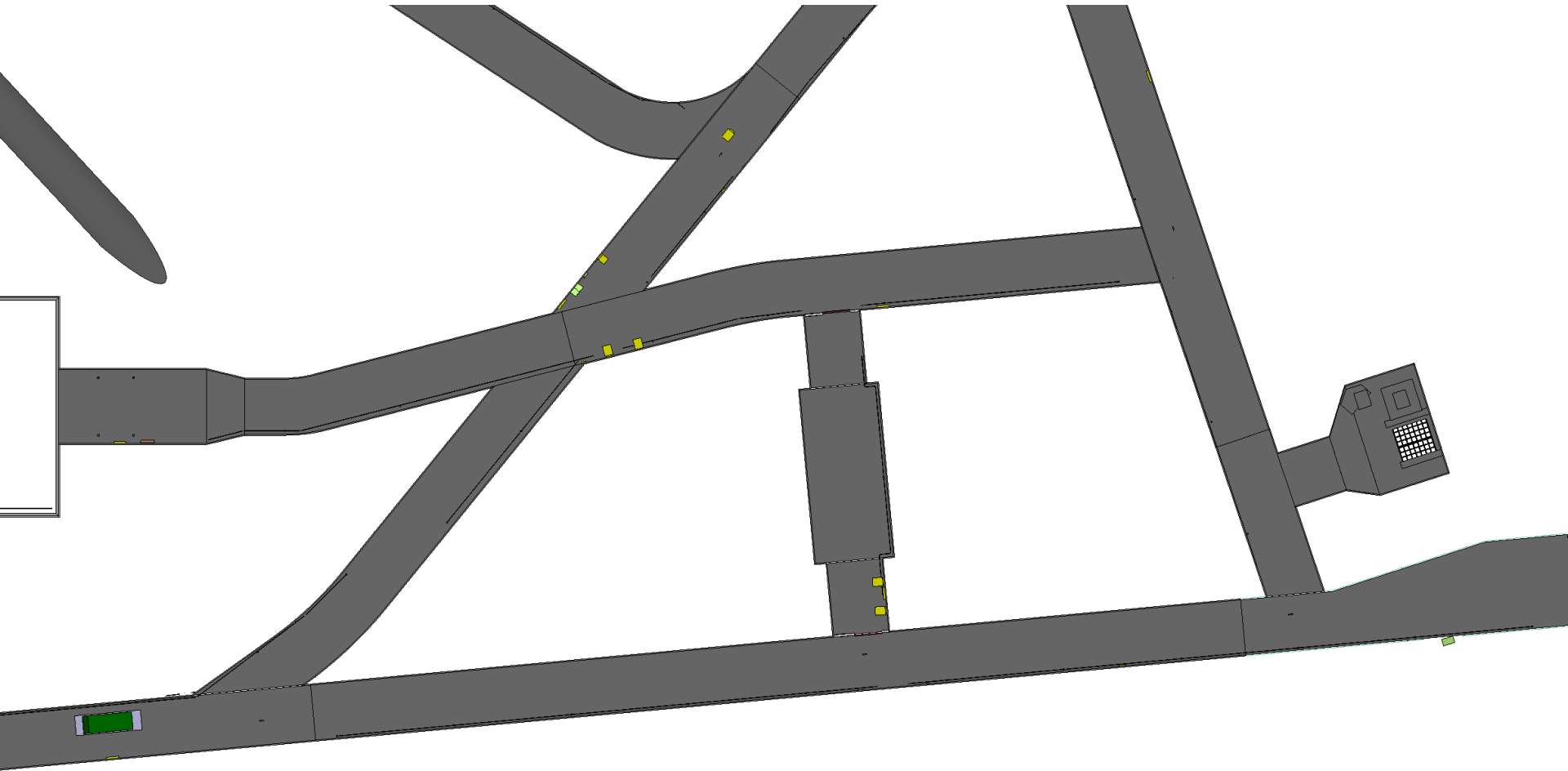
Warm skin lowering



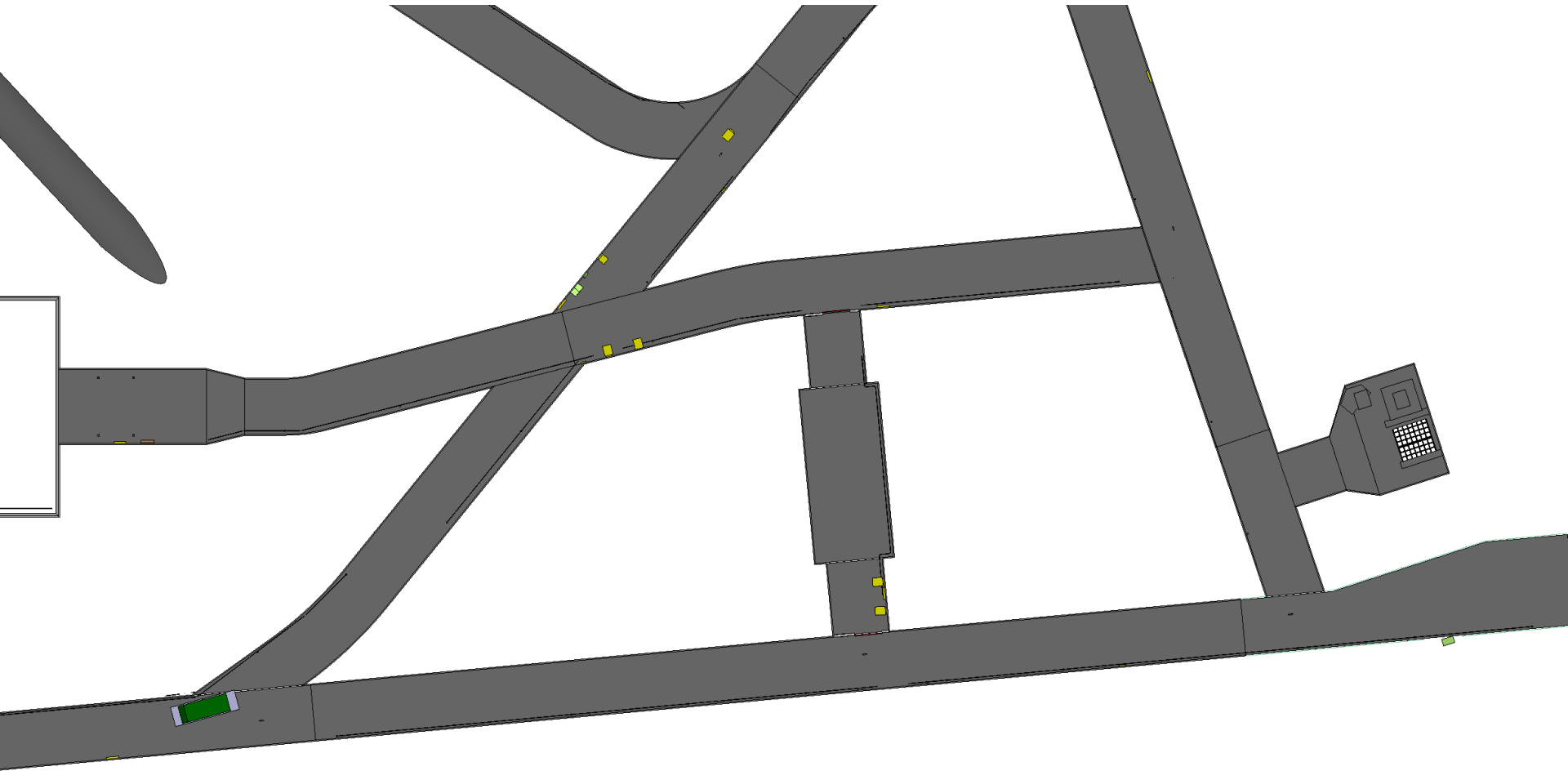
Warm skin lowering



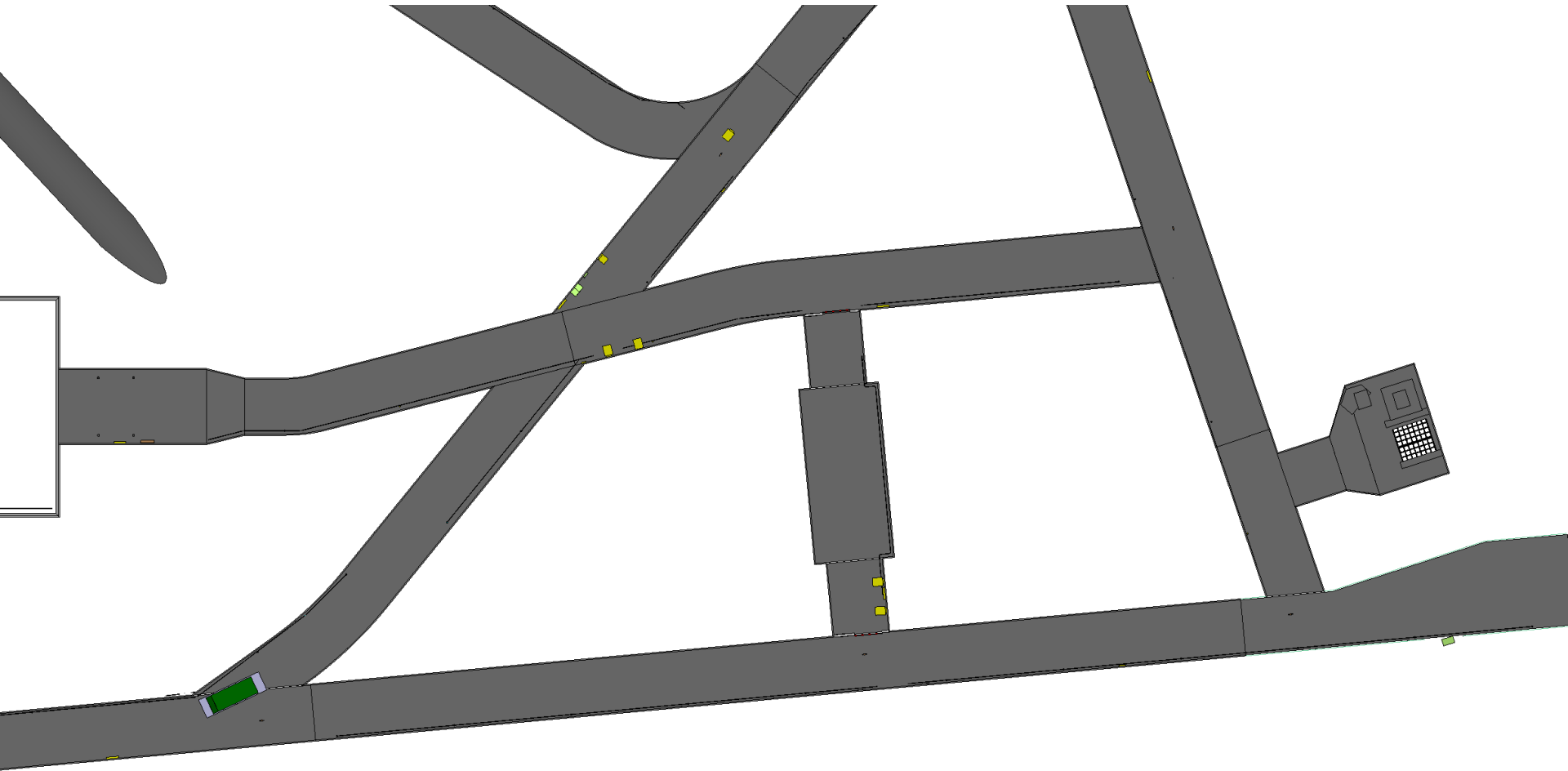
Warm skin lowering



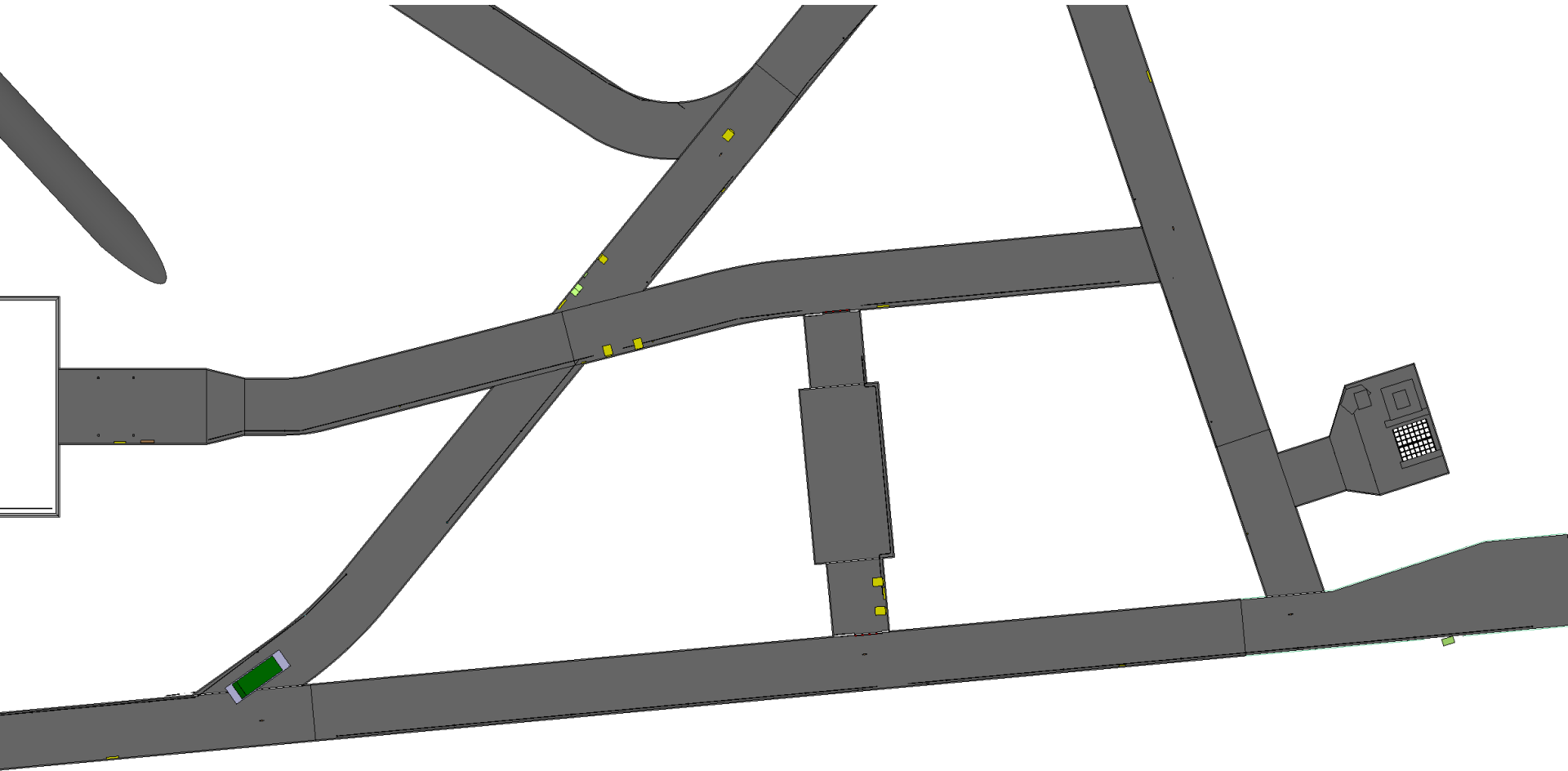
Warm skin lowering



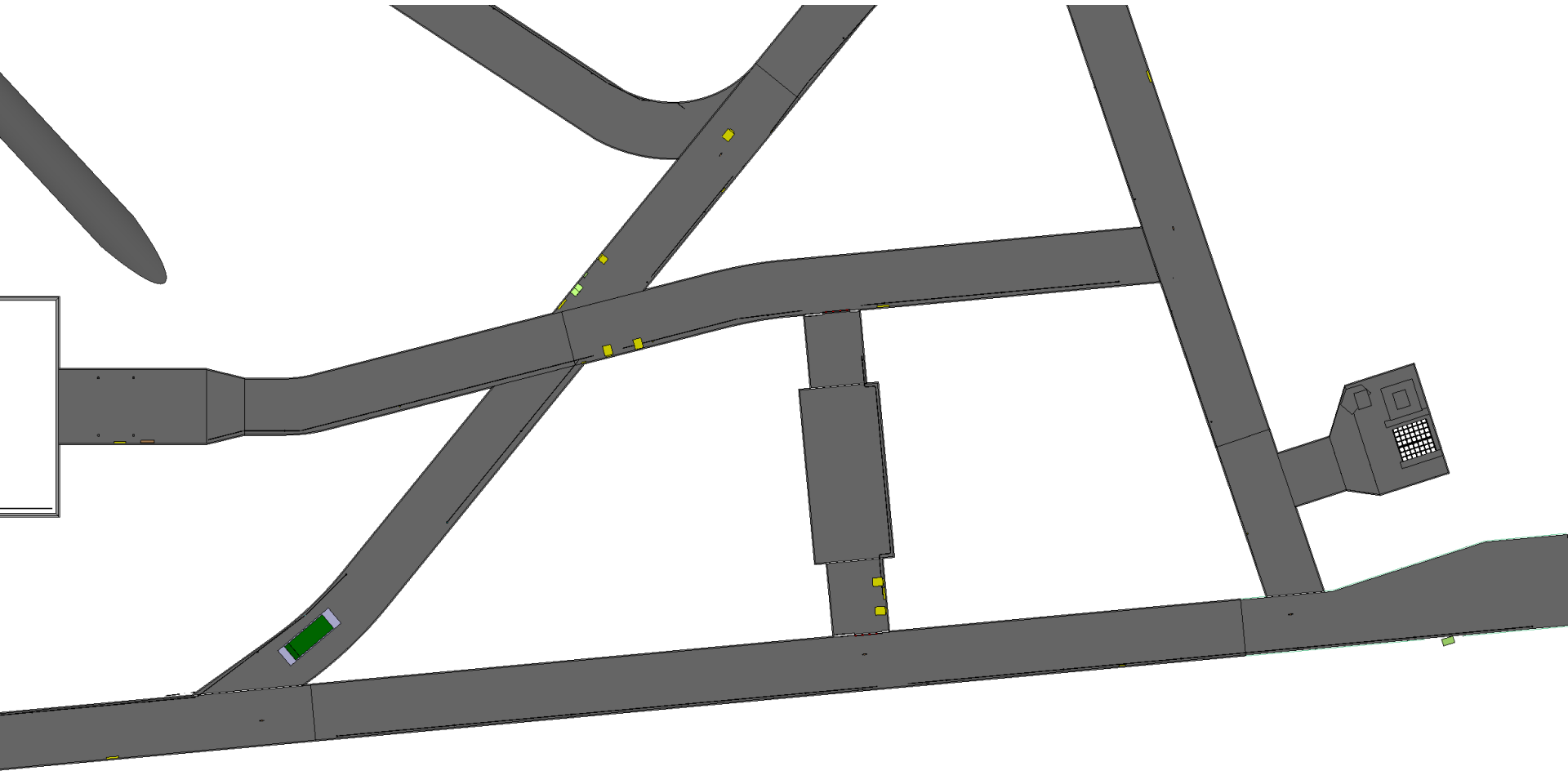
Warm skin lowering



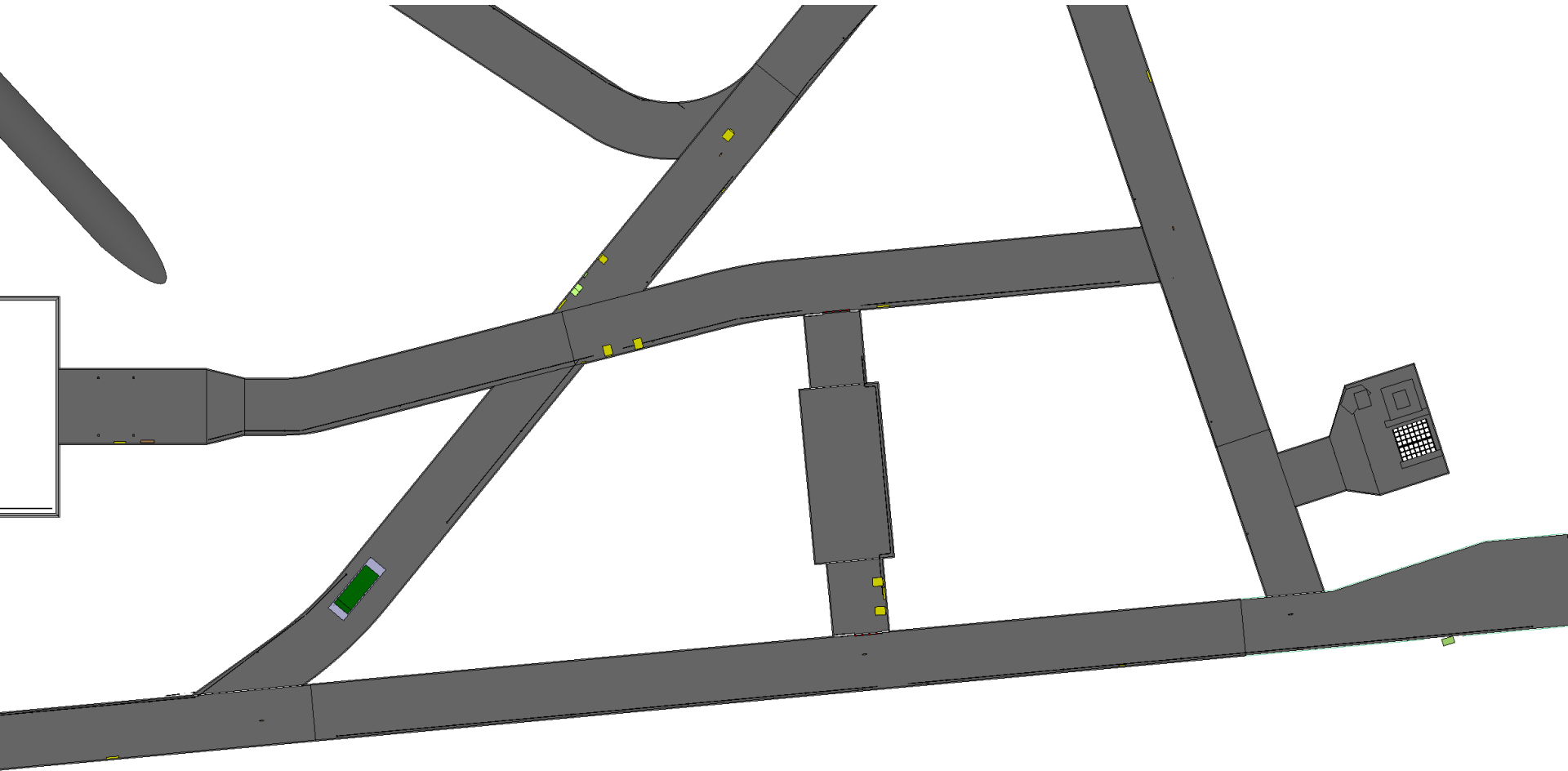
Warm skin lowering



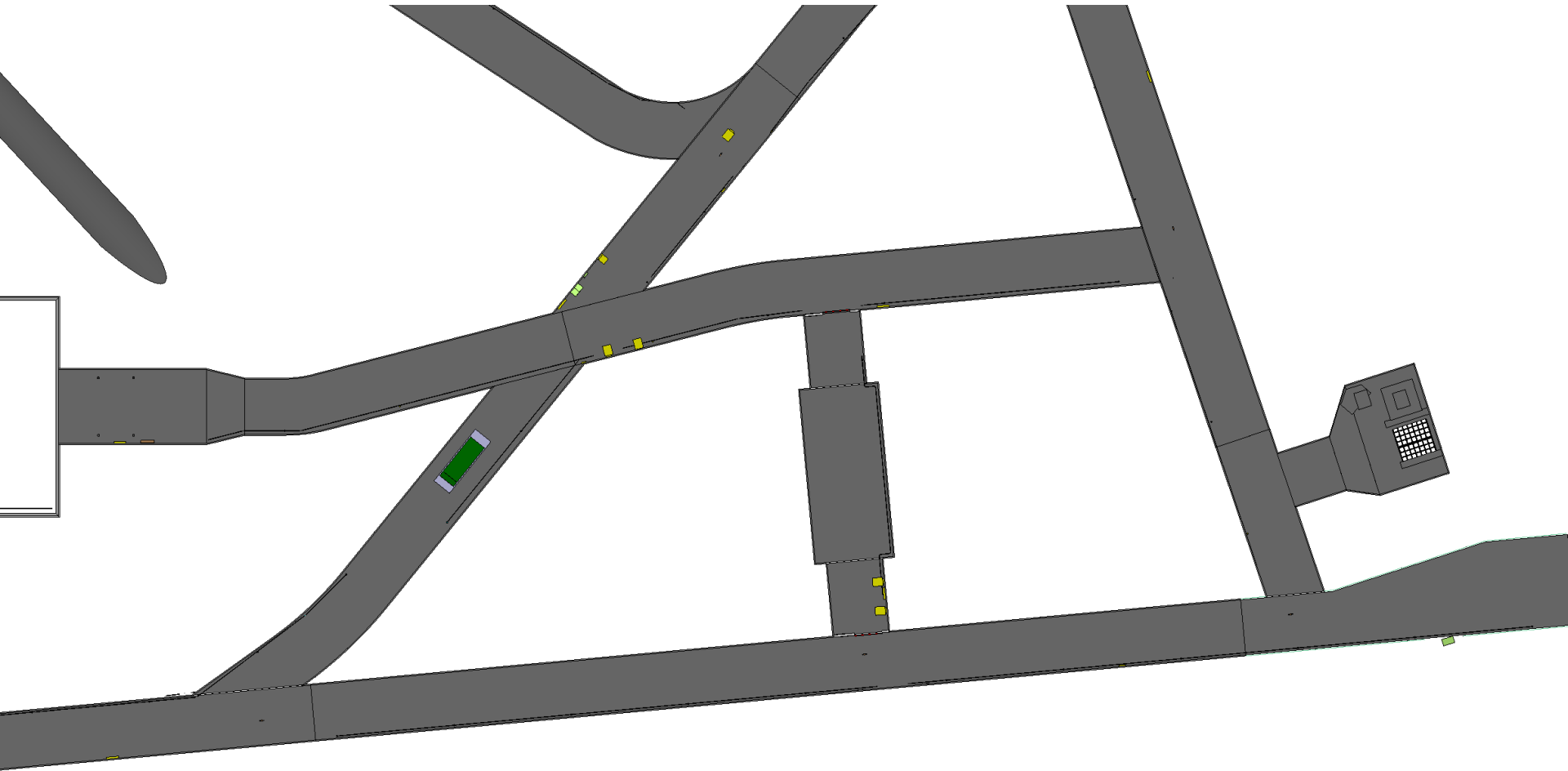
Warm skin lowering



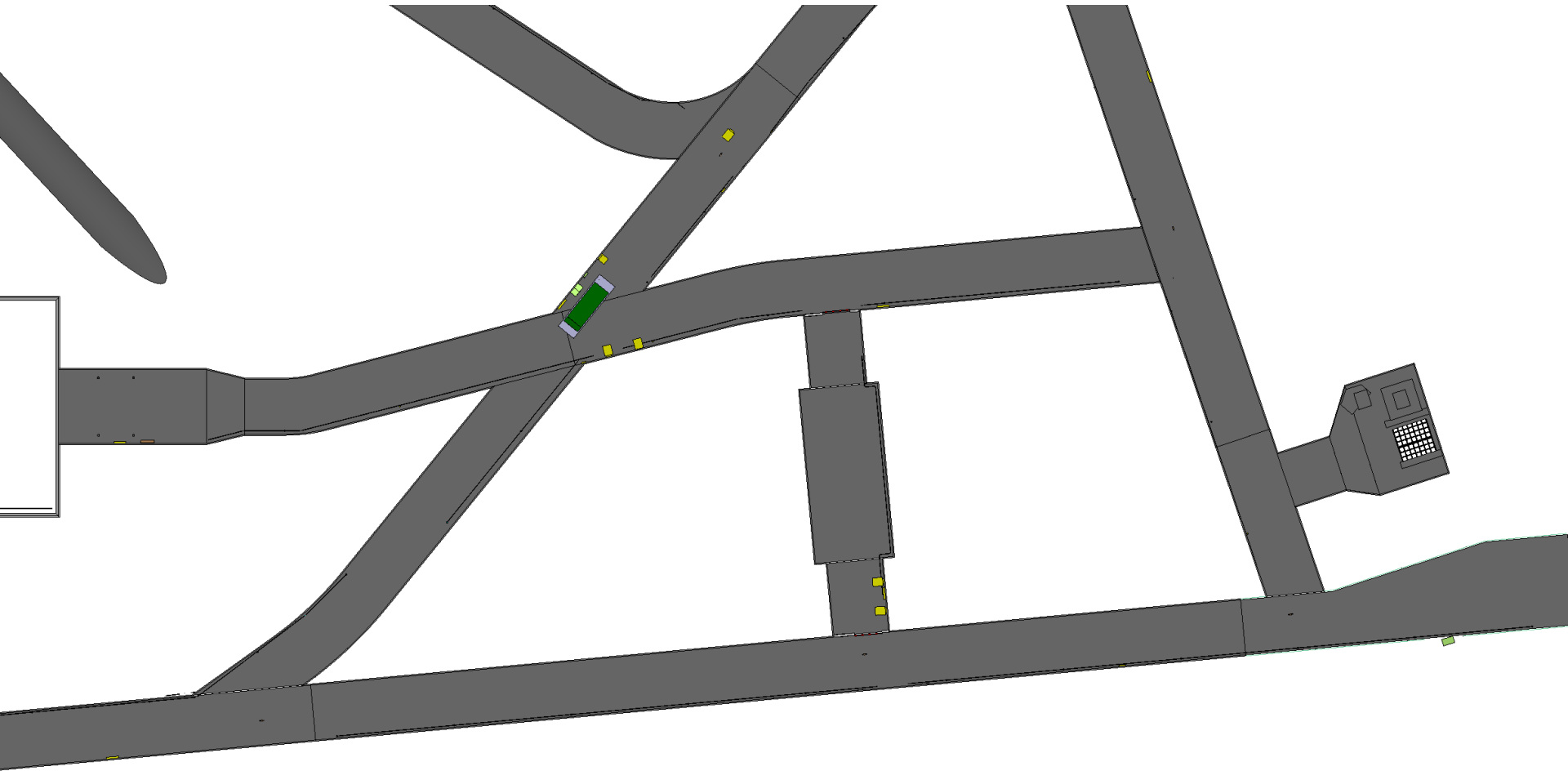
Warm skin lowering



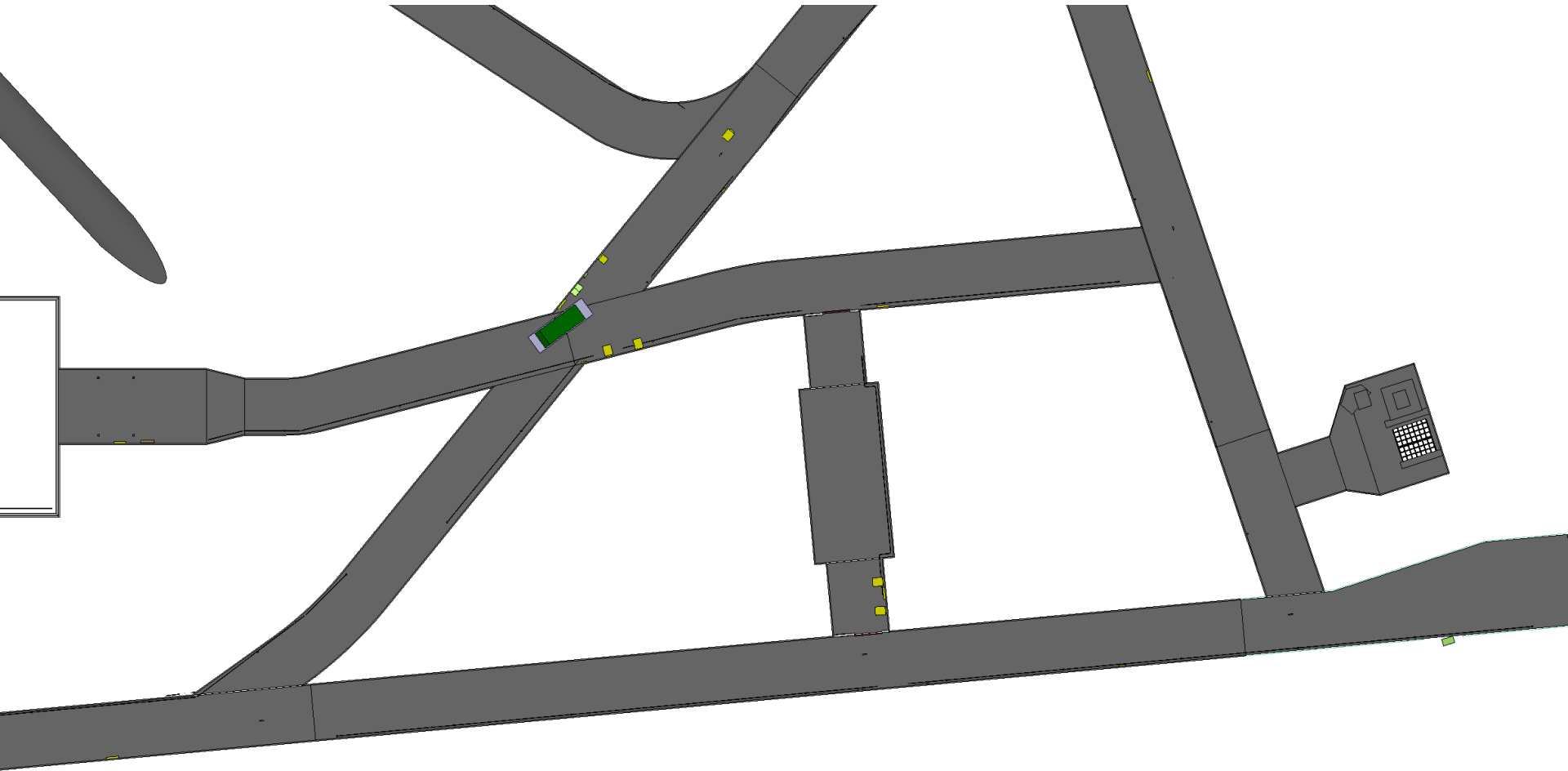
Warm skin lowering



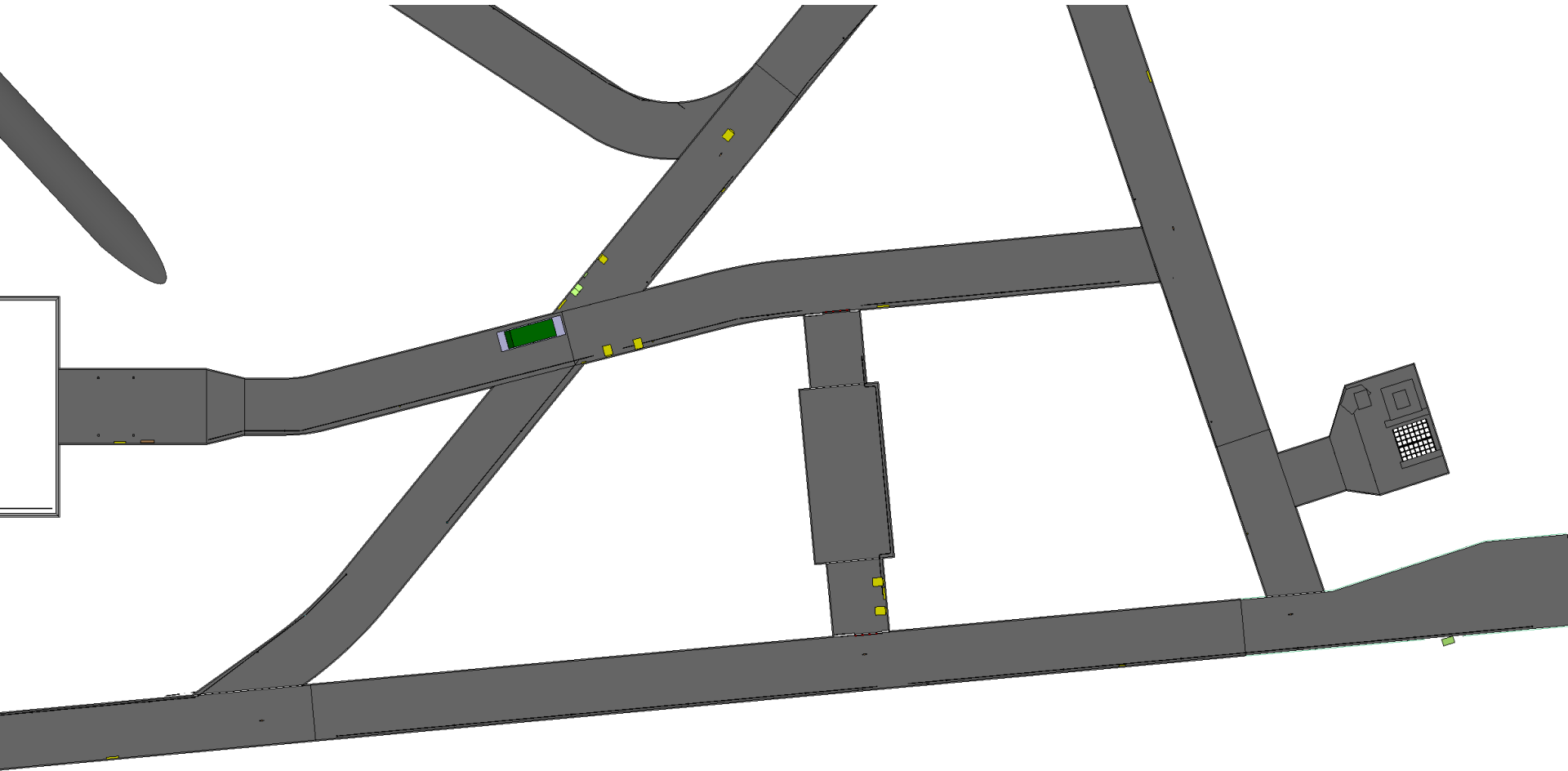
Warm skin lowering



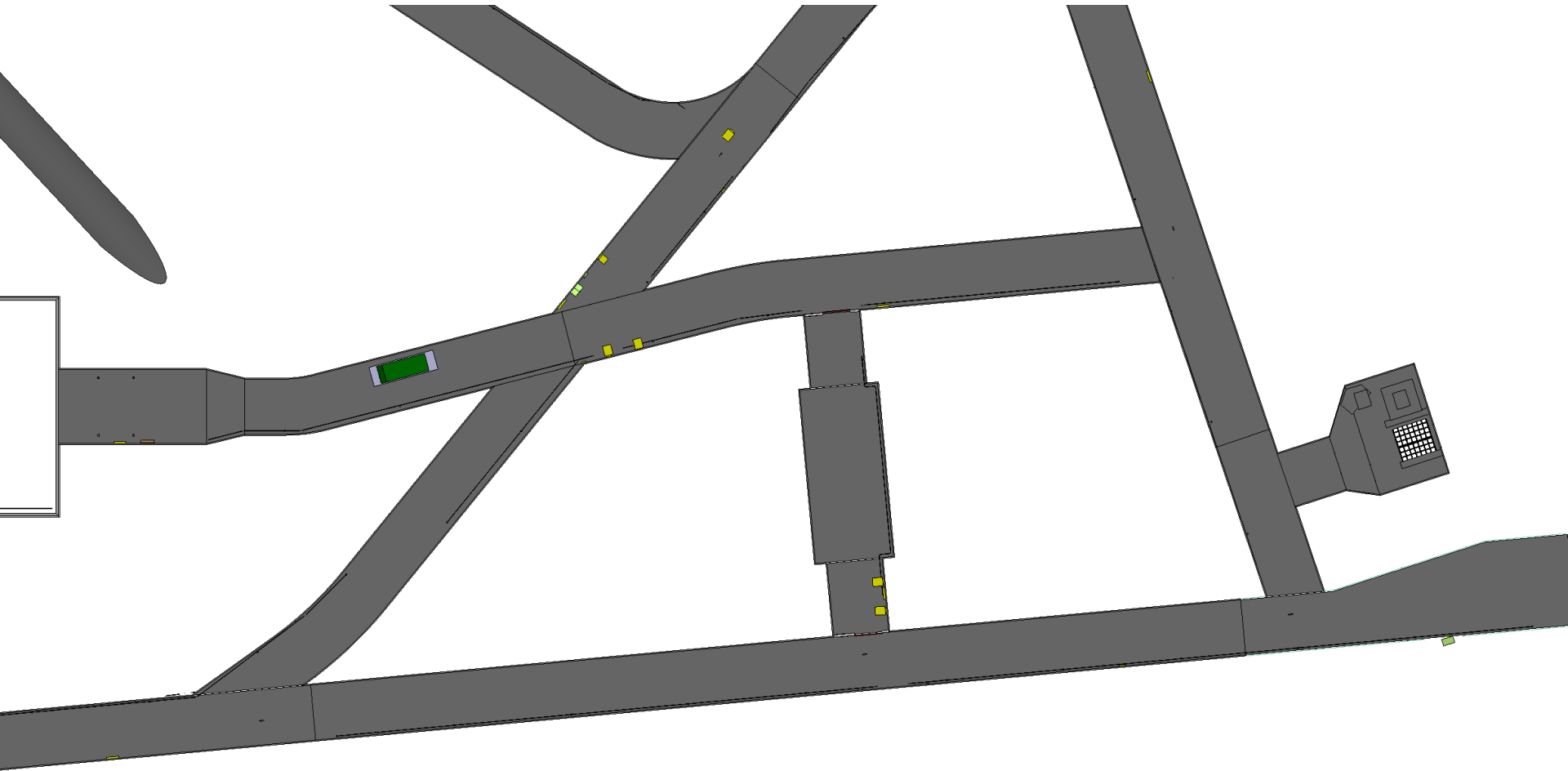
Warm skin lowering



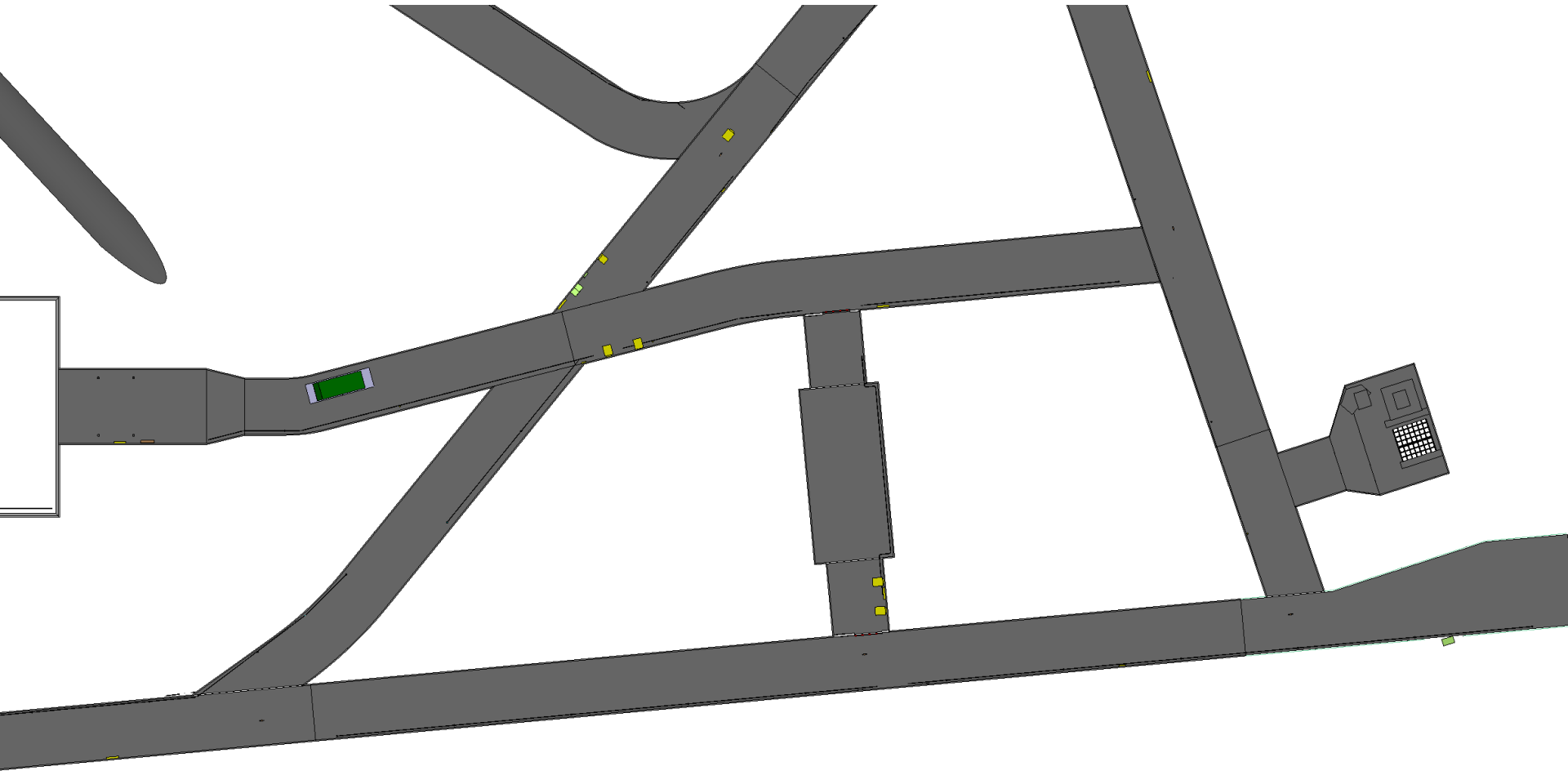
Warm skin lowering



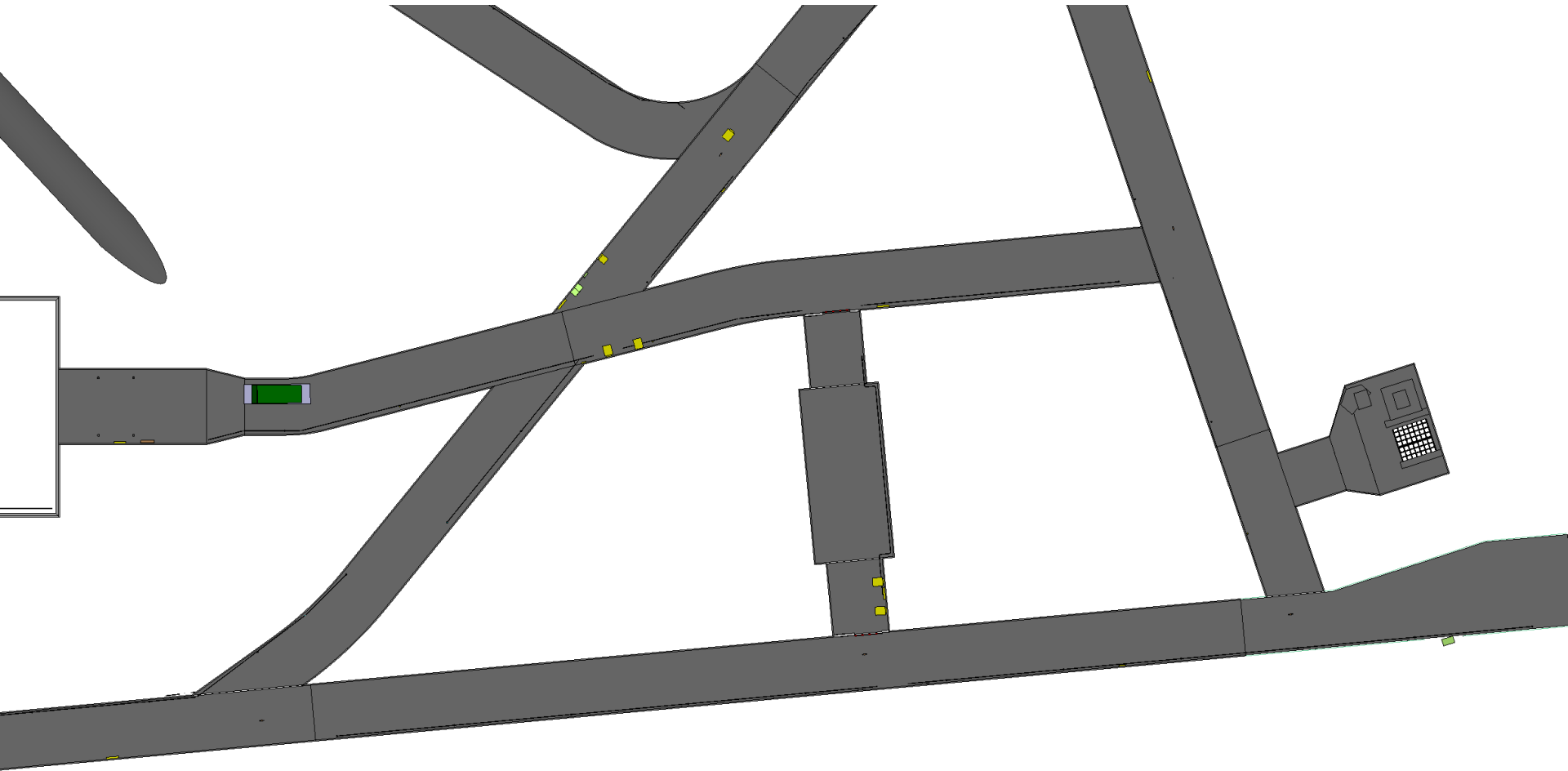
Warm skin lowering



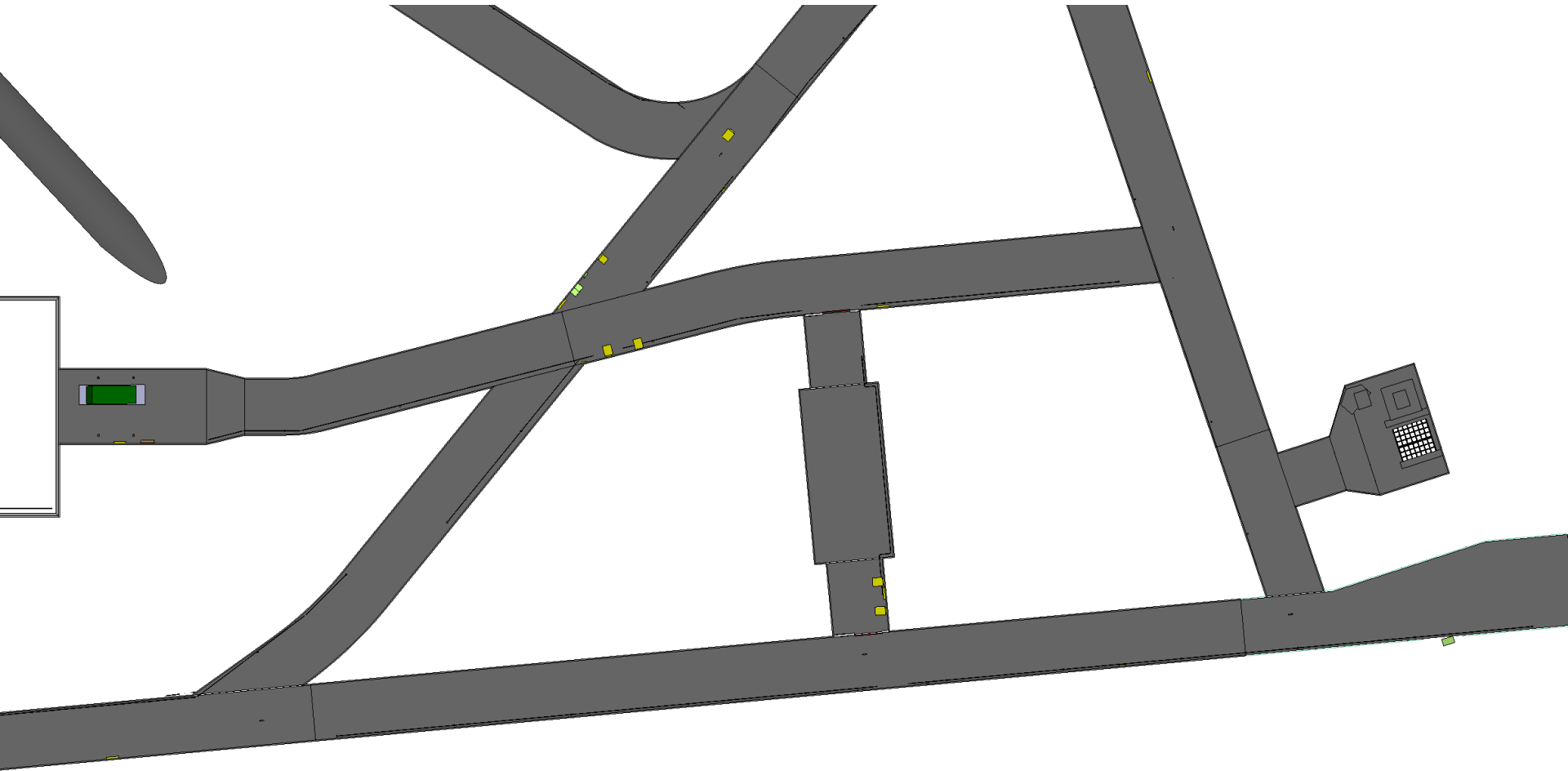
Warm skin lowering



Warm skin lowering



Warm skin lowering



Documents and references

- EDMS

Summary

- The number, the sizes and the weights of the components to be lowered in the cavern is well defined and understood
- All infrastructure limitations are taken into account
- The time needed to lower 1'500m down, all the 1'800 cryostat's elements, and to transport them to the cavern, is realistic.