Rehabilitation of Runway 06-24 and Holding Bay 06 at Montreal-Mirabel International Airport

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SWIFT CONFERENCE – MONTREAL
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Program

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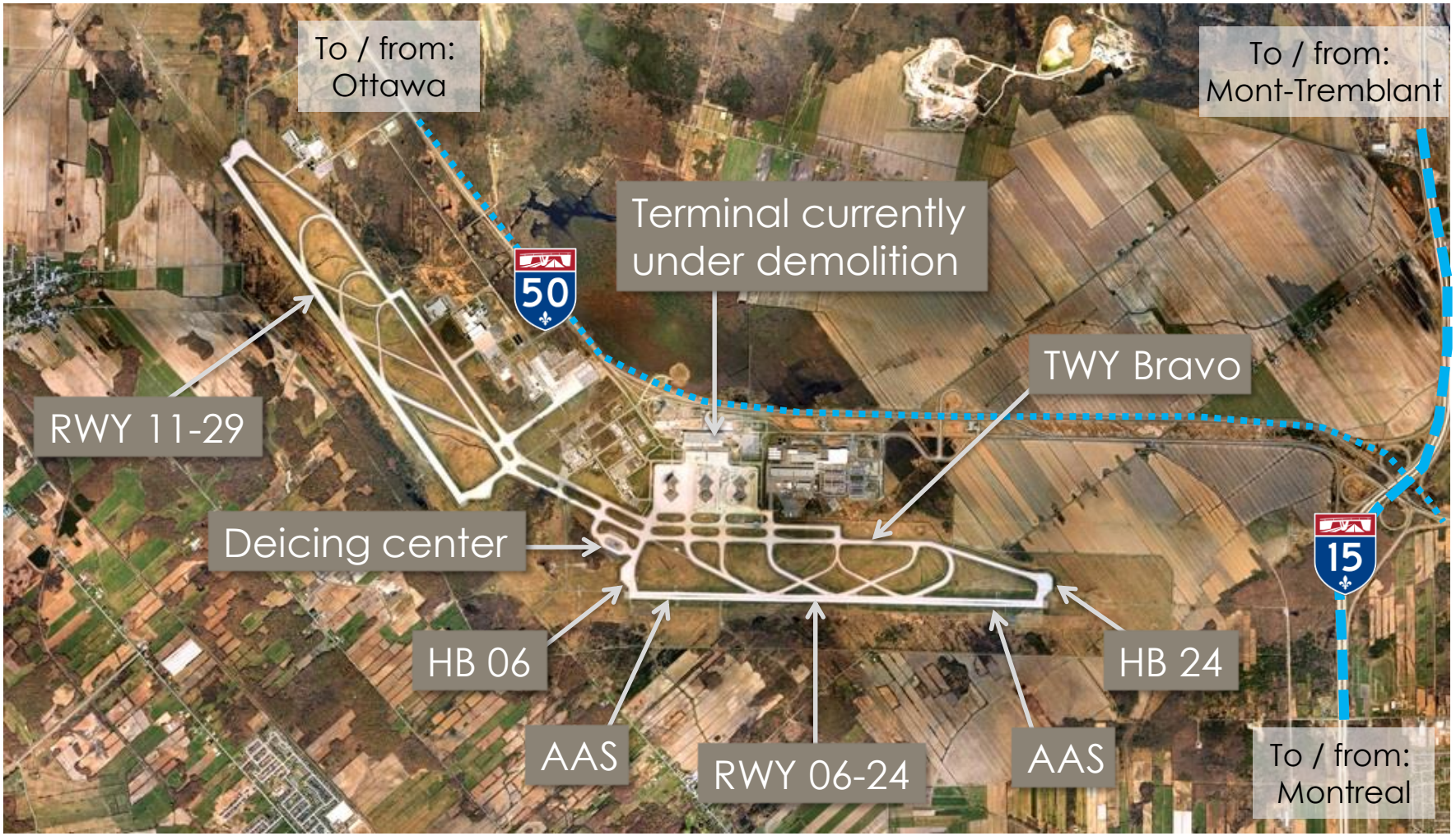
1 Location



AAS: Aircraft Arresting Systems

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2 Current Vocation and Users

Montreal-Mirabel International Airport is a world-class industrial aviation hub, making Montreal the third largest globally, with:

- 2 operational runways
- 23 all-cargo carriers
- A general aviation base
- 30 businesses established on site, totaling 3,700 direct jobs, with 96% in the aeronautics sector
- 10,000 local jobs generated by the airport

2 Current Vocation and Users

A few of the current users:

- Bombardier Aerospace (CSeries, CRJ Series)
- Pratt & Whitney Canada
- Stelia Aerospace
- Nolinor Aviation
- FedEX / DHL / Purolator / UPS
- General Aviation
- SkyLink Express
- Avianor
- L3 MAS Aerospace & Defence
- AéroMag 2000
- Hélibellule

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2 Current Vocation and Users

Aircrafts using the facility:

- Antonov AN-225
- Antonov AN-124
- DC-10
- MD-11
- Bombardier CSeries
- Boeing 727-200 / 737-200 / 757-200 / 767-300
- Boeing 747 SP-B5
- Airbus A300
- CF-18 Hornet

3 History and Characteristics

- **Inauguration: October 4th, 1975**
- **Rigid pavement structure with cement treated base course**
  - 380 mm thick slabs (15")
  - 7.5 m by 6 m (24 ft. by 20 ft.)
- **RWY 06-24 Geometry**
  - 61 m wide (200 ft.)
  - 3,658 m long (12,000 ft.)
  - 223,138 sq.m (2,401,837 sq.ft.)
- **HB 06**
  - 28,500 sq.m (306,771 sq.ft.)

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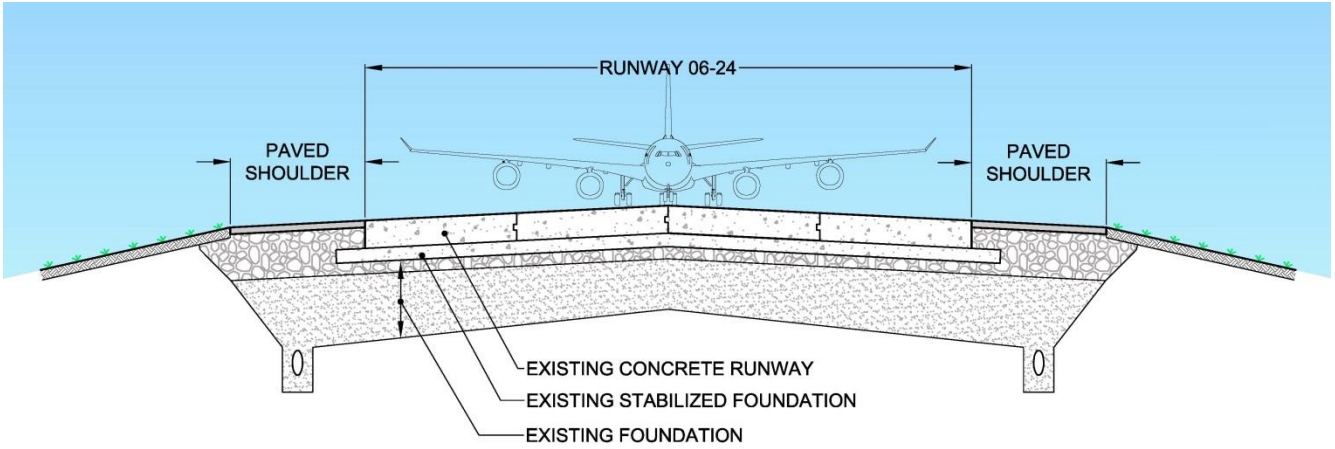
4 Existing Pavement Structure

Rigid pavement with cement treated base course

- 380 mm thick slabs (15")
- Key joints, undoweled
- 200 mm cement treated base course
- 100 mm crushed stone
- 500 mm sand or existing subgrade



Existing Runway

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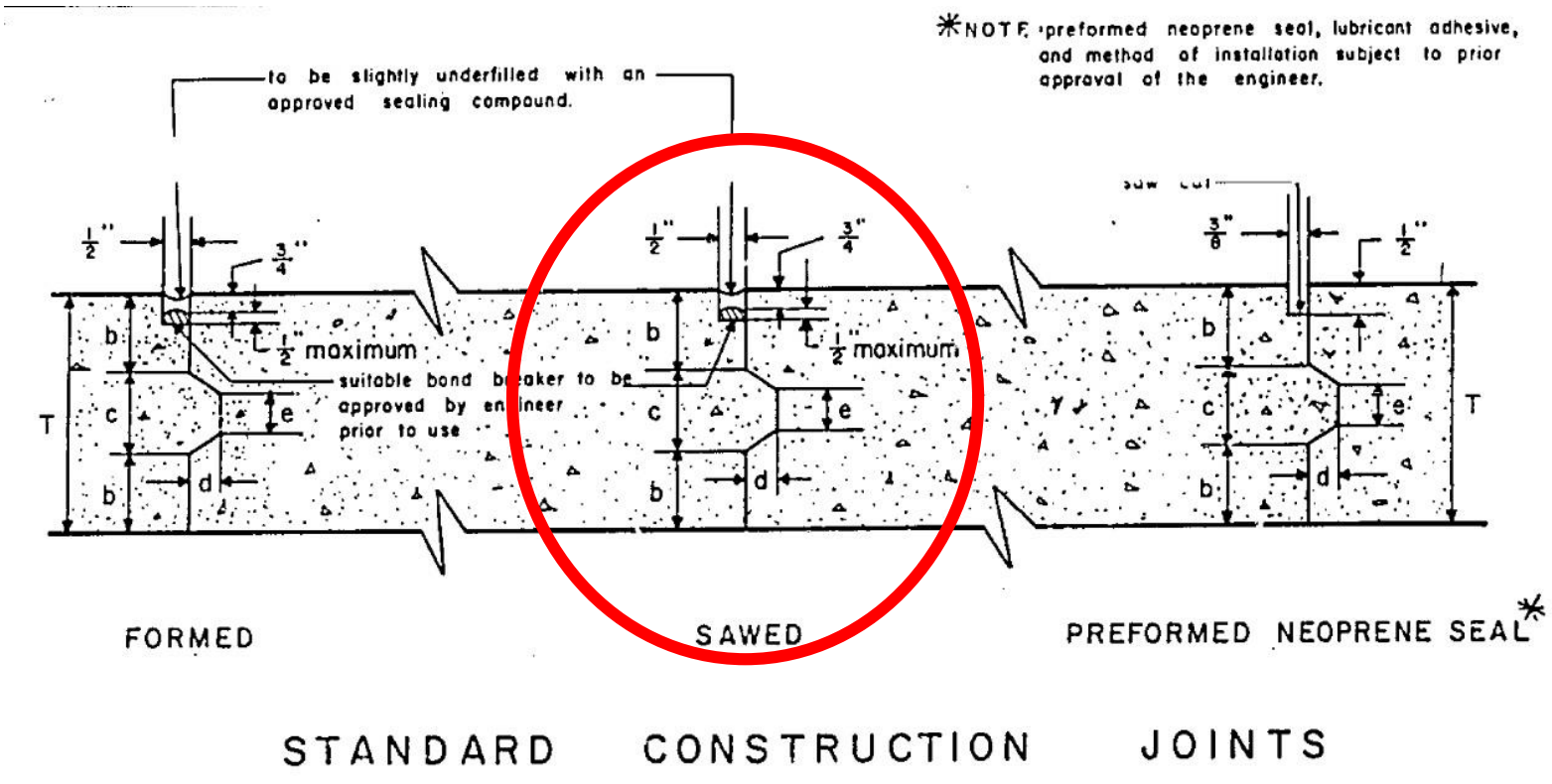
4 Existing Pavement Structure



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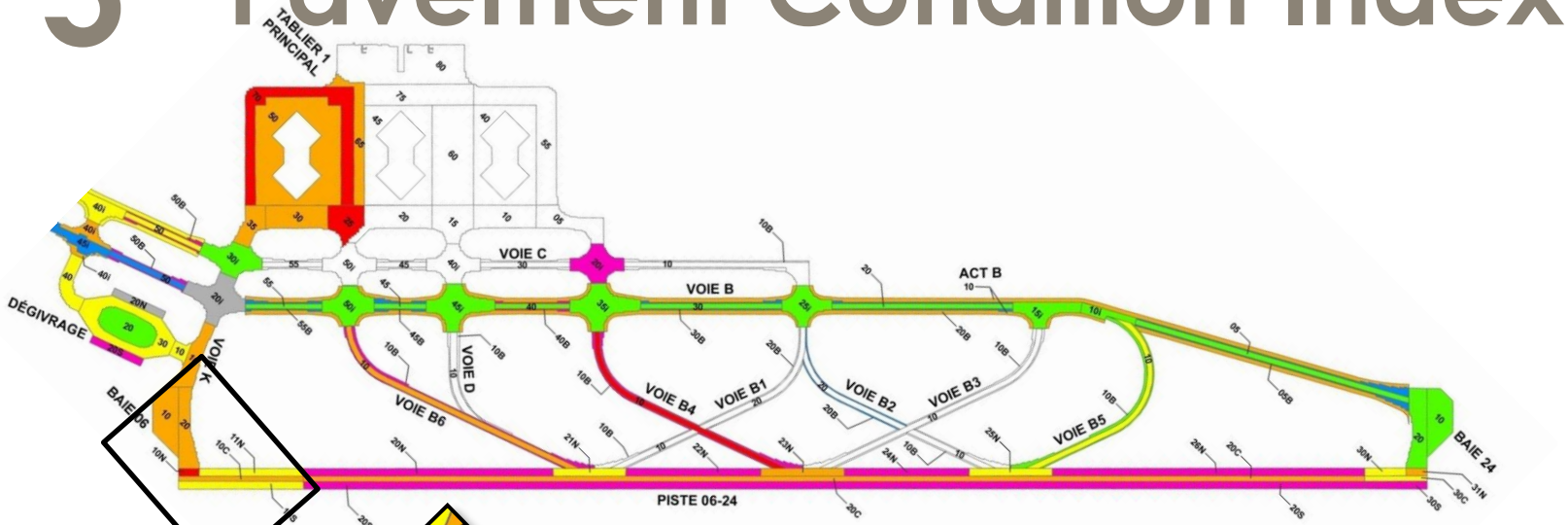
5 Pavement Condition Index



DESCRIPTION	PCI RATING
Very good	85 < PCI <= 100
Good	70 < PCI <= 85
Satisfactory (70 is rwy min)	55 < PCI <= 70
Average (55 is twy min)	40 < PCI <= 55
Poor	25 < PCI <= 40
Very poor	10 < PCI <= 25
Mediocre	0 <= PCI <= 10
Inactive	

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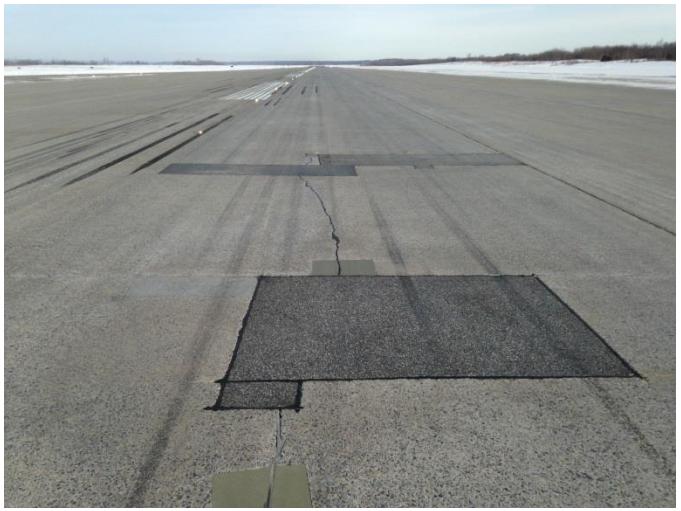
5 Pavement Condition Index



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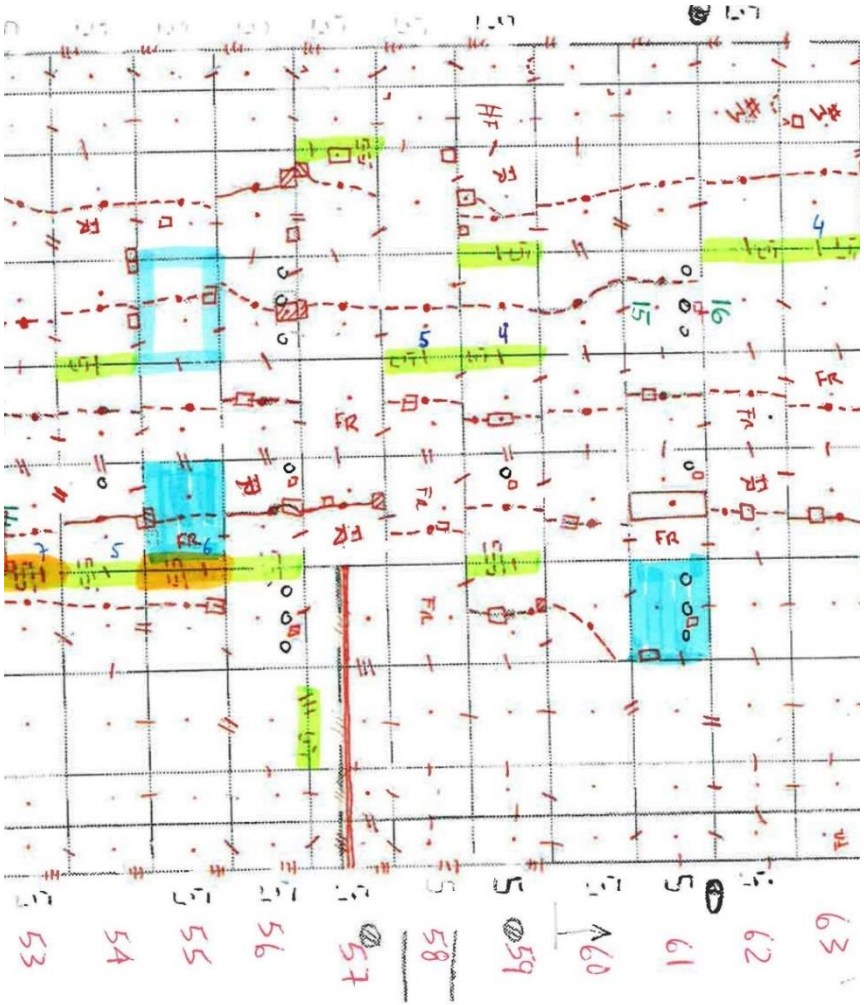
6 Geotechnical Investigation

- **Visual survey of surface conditions including:**
  - Blow up
  - Corner break
  - Longitudinal cracking
  - Transverse cracking
  - Joint seal damage
  - Pop outs
  - Scaling
  - Settlement
  - Shattered slab
  - Joint spalling
  - Corner spalling
  - Electrical trenches



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6 Geotechnical Investigation

- **Joint settlement measurement**

HB 06

Settlement or irregularity	Nb. measures	% measures
< 6 mm	25	43.9%
6 to 13 mm	31	54.4%
> 13 mm	1	1.8%
Total	57	100.0%

RWY 06-24

Settlement or irregularity	Nb. measures	% measures
< 6 mm	203	58.3%
6 to 13 mm	142	40.8%
> 13 mm	3	0.9%
Total	348	100.0%

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6 Geotechnical Investigation

- **Transversal joint opening**

HB 06
Average of 16 mm

Transversal joint opening	Nb. measures	% measures
<= 10 mm	1	7.7%
11 to 13 mm	3	23.1%
> 13 mm	9	69.2%
Total	13	100.0%

RWY 06-24
Average of 14.3 mm

Transversal joint opening	Nb. measures	% measures
<= 10 mm	0	0.0%
11 to 13 mm	83	25.7%
> 13 mm	240	74.3%
Total	323	100.0%

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6 Geotechnical Investigation

Soil Recognition

Drilling and coring

- **7 geotechnical borholes to:**
  - Confirm existing structure
  - Establish the actual CBR values and the resilient modulus with a portable DCP (Dynamic Cone Penetrometer)
- **66 concrete coring samples to:**
  - Confirm existing slab thickness
  - Confirm cement treated base course thickness
  - Determine granular composition of the concrete

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6 HFWD Survey

Total of 184 slabs tested

- Load transfer on joints
  - > 75% : Good
  - 50 to 75% : Average
  - < 50% : Poor
- HFWD modulus back calculation

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6 HFWD Survey Results

Load Transfer on Joints

Row	Chainage	% load transfer									Average load transfer %
		Longitudinal		Transversa		Corners				Fis	
		21	23	22	24	31	32	33	34	11	
1	0+043	45	***24***	88	96	96	90	95	79		91
3	0+055	29	50	45	28	34	52	24	40	41	37
7	0+079	82	26	74	83	65	72	67	65	73	71
7	0+079	65	58	50	46	70	53	35	59	45	52
13	0+116	***52***	55	80	79	62	59	47	50	33	63
13	0+116	55	54	64	63	49	54	30	43		51
19	0+153	***56***	86	97	92	47	88	94	55	33	79
25	0+189	82	***37***	89	84	97	59	70	88	44	81
27	0+201	35	44	90	92	59	66	77	84		78
31	0+226	44	44	88	94	83	74	48	92		80
37	0+262	72	30	90	95	79	92	91	91		90
42	0+293	49	35	83	94	93	70	79	89	55	85
43	0+299	***84***	33	94	95	77	92	93	93	26	91
49	0+336	40	***40***	93	91	89	86	67	91	43	86
55	0+372	40	43	93	96	97	96	96	95	50	96
55	0+372	48	***47***	90	87	89	84	76	83	33	85
61	0+409	45	32	94	93	91	91	90	94		92
67	0+445	***53***	32	90	94	85	90	91	88	77	90
73	0+482	35	***34***	88	91	83	87	87	83	93	87
79	0+519	44	27	92	96	93	95	97	93	40	94
81	0+531	55	44	93	94	97	91	92	93		93
85	0+555	42	38	92	93	92	94	92	93		93
91	0+592	***49***	54	90	84	90	86	89	84	69	87
92	0+598	58	32	92	92	94	91	96	94		93
97	0+628	67	***88***	91	90	90	89	95	87	35	90
103	0+665	52	35	95	94	97	95	94	93		95
541	3+337	66	73	91	92	93	91	93	94		92
547	3+373	***93***	85	97	95	93	95	92	96		95
553	3+410	87	***94***	94	94	89	94	96	92		93
555	3+422	92	83	92	94	96	94	95	92	94	94
559	3+447	94	89	95	96	97	97	95	92		95
565	3+483	92	82	98	95	96	93	99	93		96
565	3+483	84	96	97	95	97	96	95	92		95
571	3+520	***85***	86	89	96	97	92	97	97		95
574	3+538	74	47	94	96	98	93	95	74		92
577	3+556	84	***64***	92	88	98	96	91	94		93
583	3+593	38	48	95	95	98	96	92	97		96
587	3+617	52	39	52	63	92	48	64	98		70
589	3+630	52	71	92	97	100	64	57	85		83
592	3+648	25	57	92	96	68	90	100	83		88
595	3+666	***91***	84	40	73	33	91	58	36		55
595	3+666	86	***96***	97	81	99	104	46	73		83
601	3+703	77	***57***	34	97	30	98	19	97		63
Mini		***15***	***10***	#	***28***	***30***	***48***	***19***	***36***	#	***37***
Maxi		***97***	***97***	#	***99***	***100***	104	***100***	***98***	#	***97***
Moy		***64***	***63***	#	***92***	***89***	***88***	***88***	***88***	#	***89***
Écar		***21***	***23***	***10***	***8***	***12***	***9***	***14***	***10***	#	***8***

Threshold 06

Center of RWY 06-24

Threshold 24

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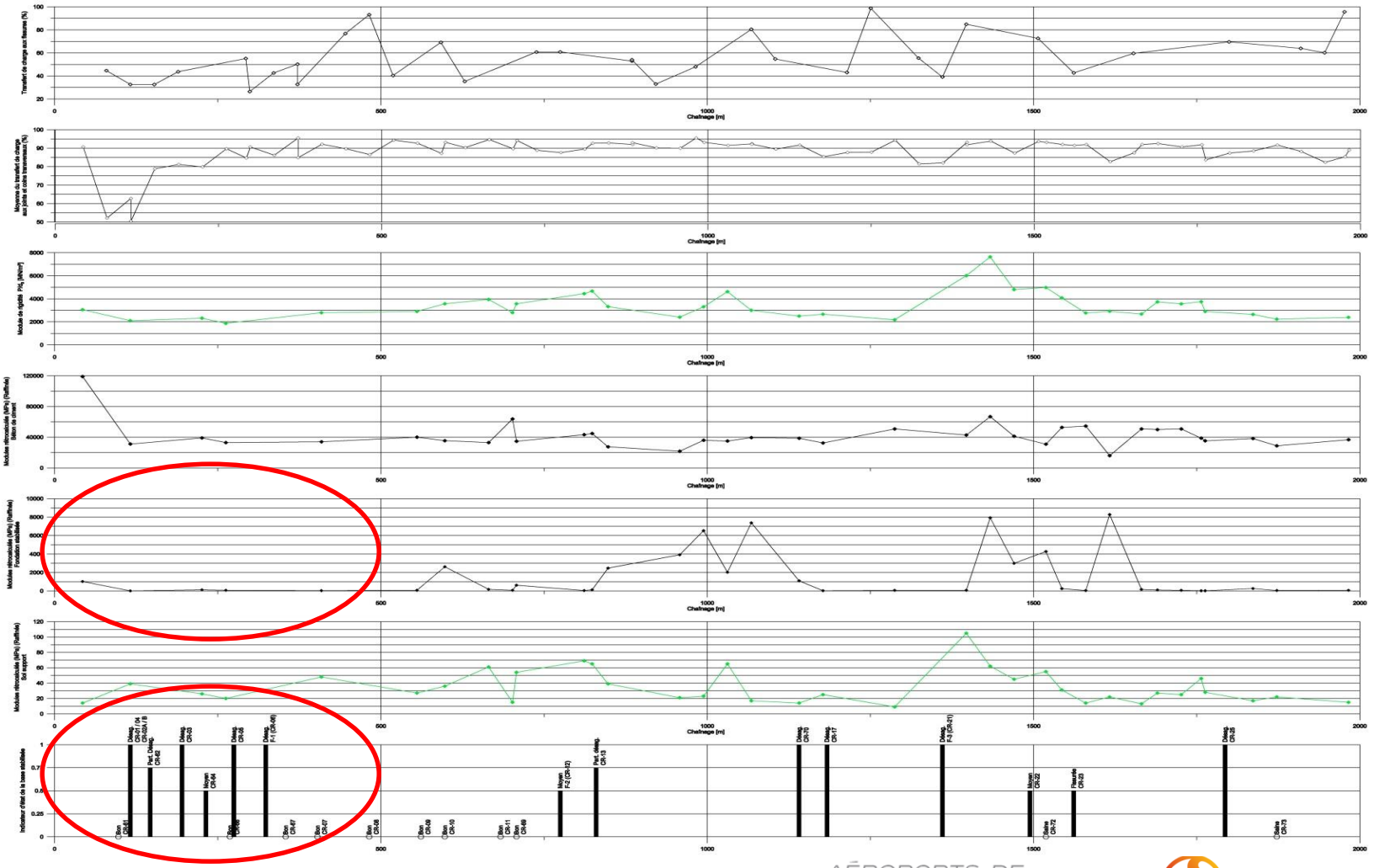
6 HFWD Survey Results

HFWD Modulus Back Calculation



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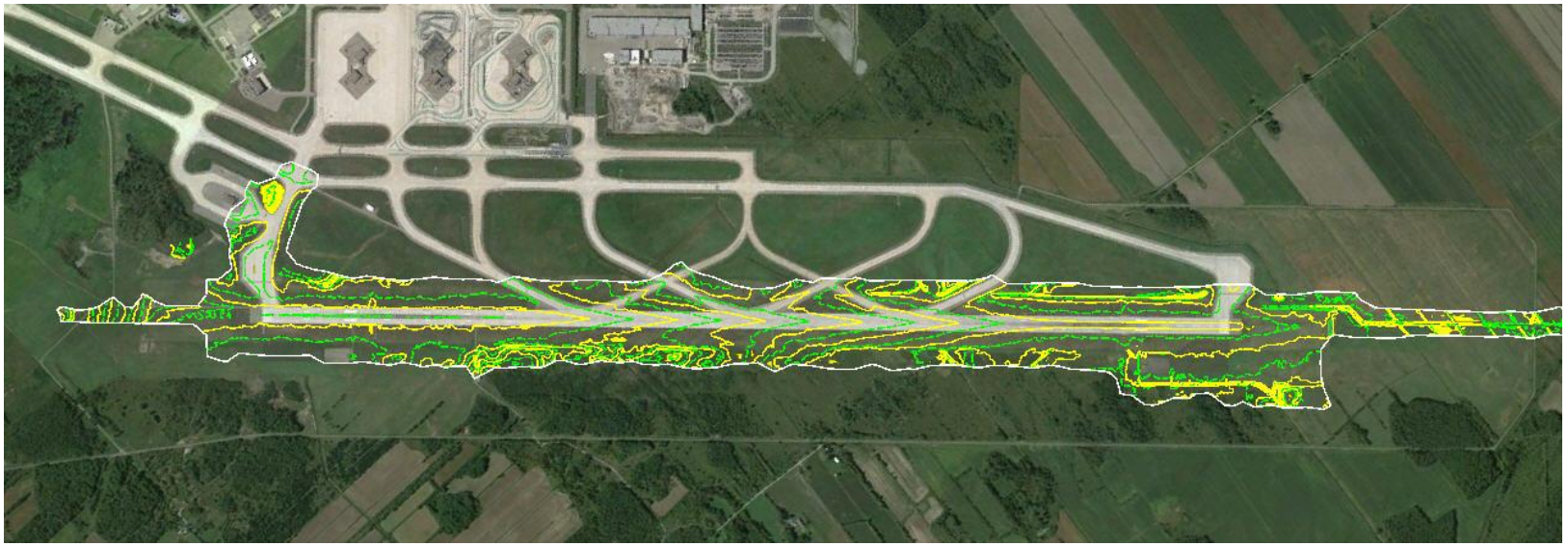
6 Site Surveying

A complete site survey covering the RWY, TXY's, HB's 06 & 24, approach systems, perimeter access roads, utilities and aircraft arresting systems was made using:

- Conventional survey using a total station with 3 mm accuracy
- Lazer survey with 2 mm accuracy
- GPS survey used in grassed areas
- Over 230,000 survey points taken



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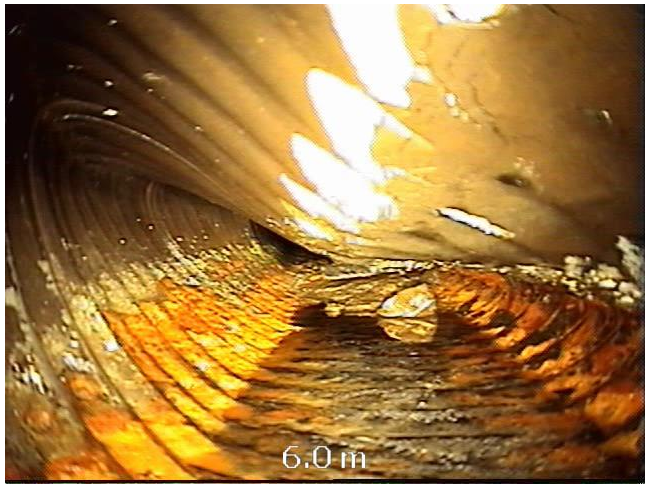
7 Drainage

- A complete inspection campaign was initiated before the actual design phase started
- This campaign was used to determine the condition of:
  - existing foundation drains
  - existing main collectors
  - culverts
  - catch basins
  - manholes
  - ditches
  - wetlands



- Over 12,000 m of drains and 130 manholes were inspected

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8 Electrical Work

- A full inspection campaign was completed by the electrical team
- All electrical systems of the RWY have to be replaced
- Approximately 750 lights, over 150,000 m of wirings, and over 38 electric circuits affected

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9 Design Options

1. Asphalt overlay on existing concrete surface
2. Rigid pavement overlay on existing concrete surface
3. Reconstruction of the keel section and intersections with TWY & HB
4. Rubblizing of existing rigid pavement with flexible/rigid pavement overlay

9 Design Options

After the preliminary studies, the results allowed the following conclusions and decisions:

- Option 1 was excluded because:
    - it would not solve the weak stabilized foundation
    - reflective cracking will occur
- Option 4 was excluded because of the complexity and scale of the electrical installations in the rubbilized materials
- Options 2 and 3 were identified as technically feasible

9 Design Options

	Option 2 Rigid pavement overlay	Option 3 Reconstruction of the keel section and intersections with TXY and HB
Budget	Costs are 10 to 15% less	Costs are 10 to 15% more expensive
	Savings for reuse of demolition waste	Additional costs for the disposal of demolition waste
	The cost overrun risk is low according to the stabilized foundation quality	The cost overrun risk is high according to the stabilized foundation quality
Duration	Possibility of construction on a continuous 11 month period	Construction on a 2-year period
Quality	Complete construction: new runway	Partial construction : partially new runway
Sustainable development	On-site reuse of concrete waste from the demolition	Considerable volume of waste materials from the demolition to dispose elsewhere

9 Design Options

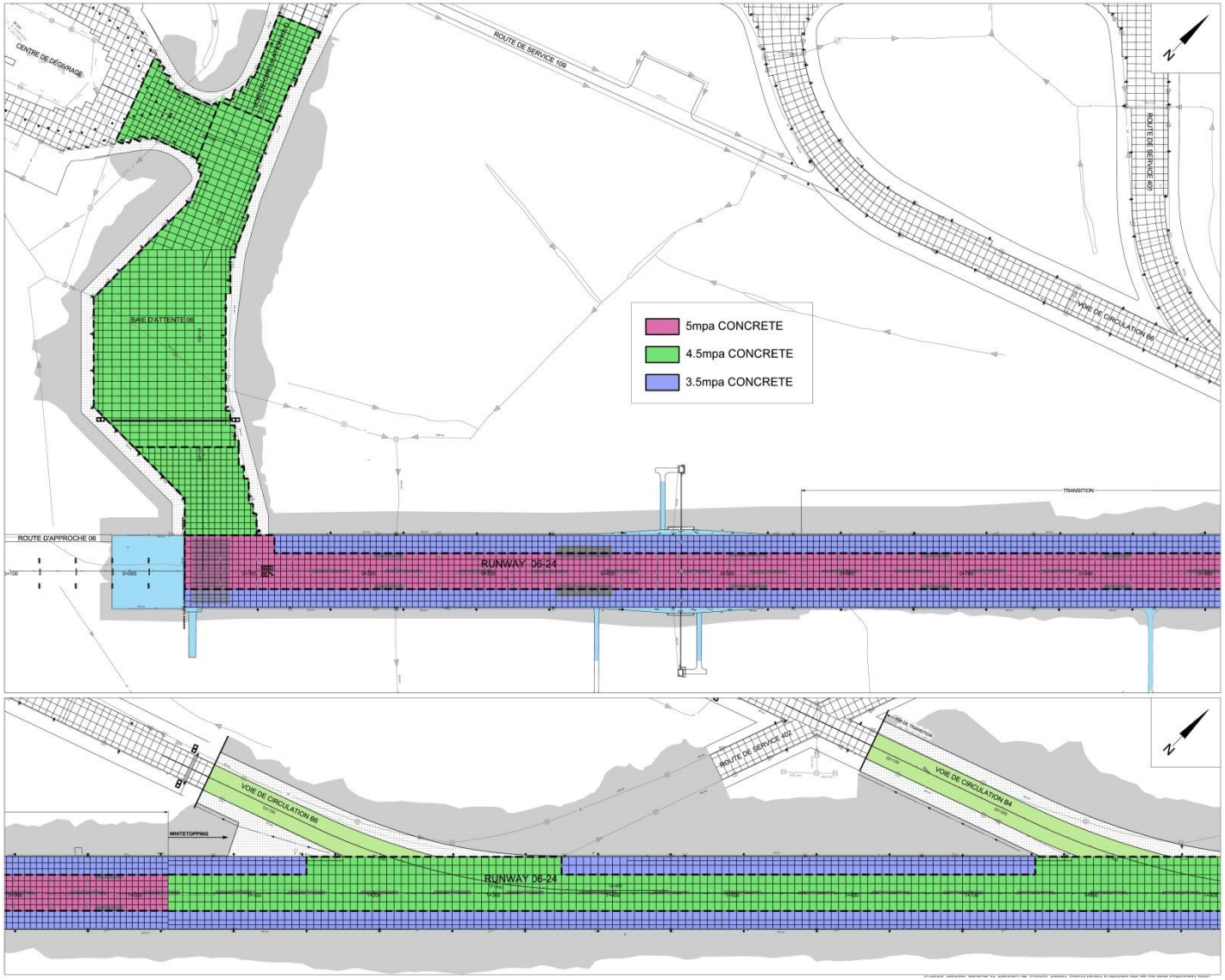
Final decision, a hybrid one:

- Complete reconstruction of the thresholds was decided following the poor coring results, particularly those of threshold 06 which demonstrated that the stabilized foundation required an intervention and eliminating any intervention on the existing aircraft arresting systems (AAS).
- The rigid pavement overlay was reduced to the center portion of the RWY, with replacement of shattered slabs and stitching of longitudinal cracks.
- Transitions toward rapid exit TWYs B6, B5 and B4 are in asphalt cement overlay on existing rigid pavement.
- Edges of the RWY, HB and safety area are filled with recycled material from the demolition of both thresholds.

10 Final Concept

- LEDFAA was used to design the pavement requirements
- Based on the actual and projected traffic for YMX, a 360 mm thick concrete slab is enough
- The existing slabs are 7.5 m by 6 m, demanding a minimum slab thickness of 410 mm
- Concrete being made using a limestone aggregate makes the concrete less sensitive to temperature variation
- Use a membrane on all surfaces to provide:
    - A degree of unbonding to the underlying existing pavement and Stabilizing base limiting the transferring of stresses
- In each threshold, the slabs are 5 m x 5 m and 380 mm thick

10 Final Concept



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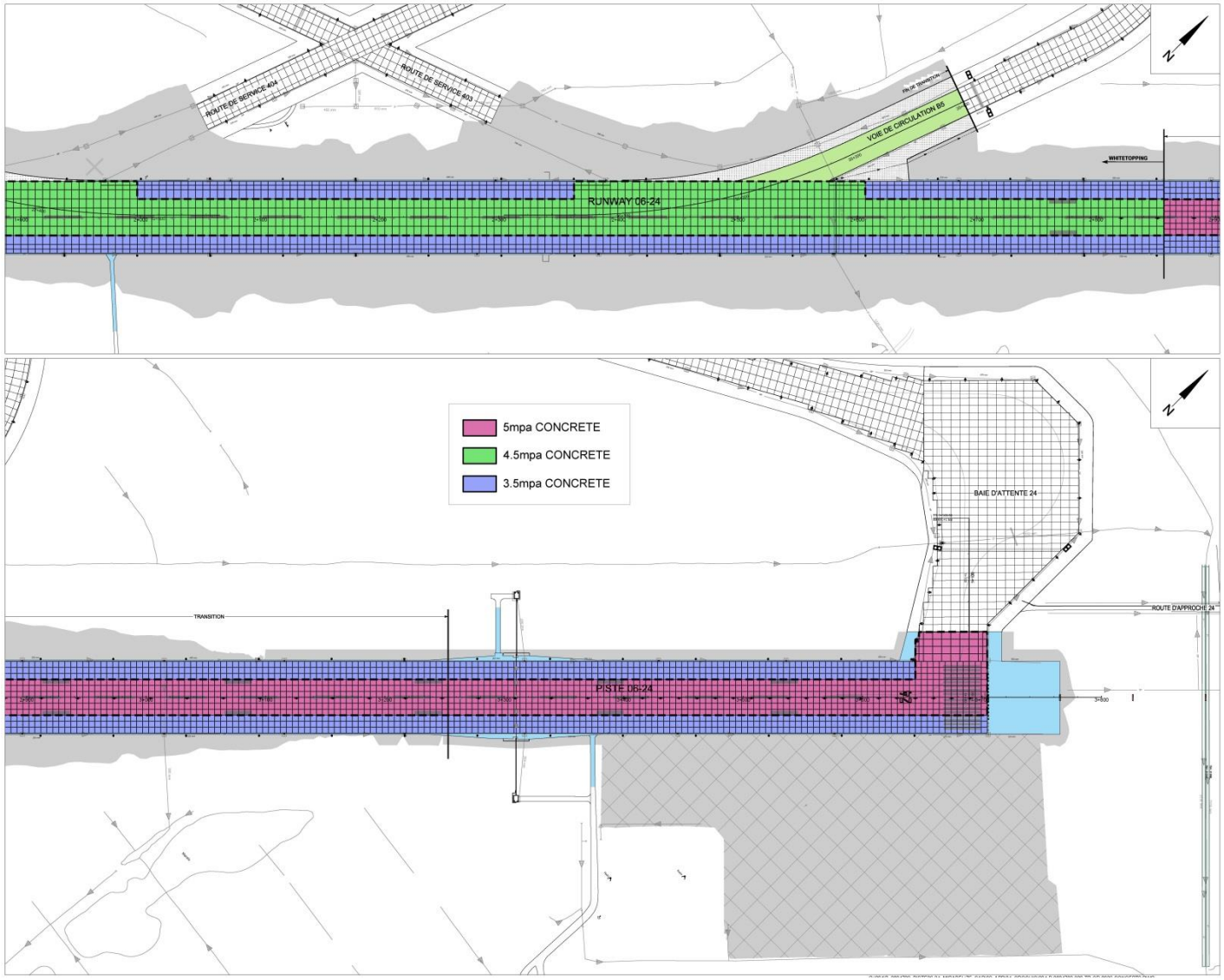
10 Final Concept



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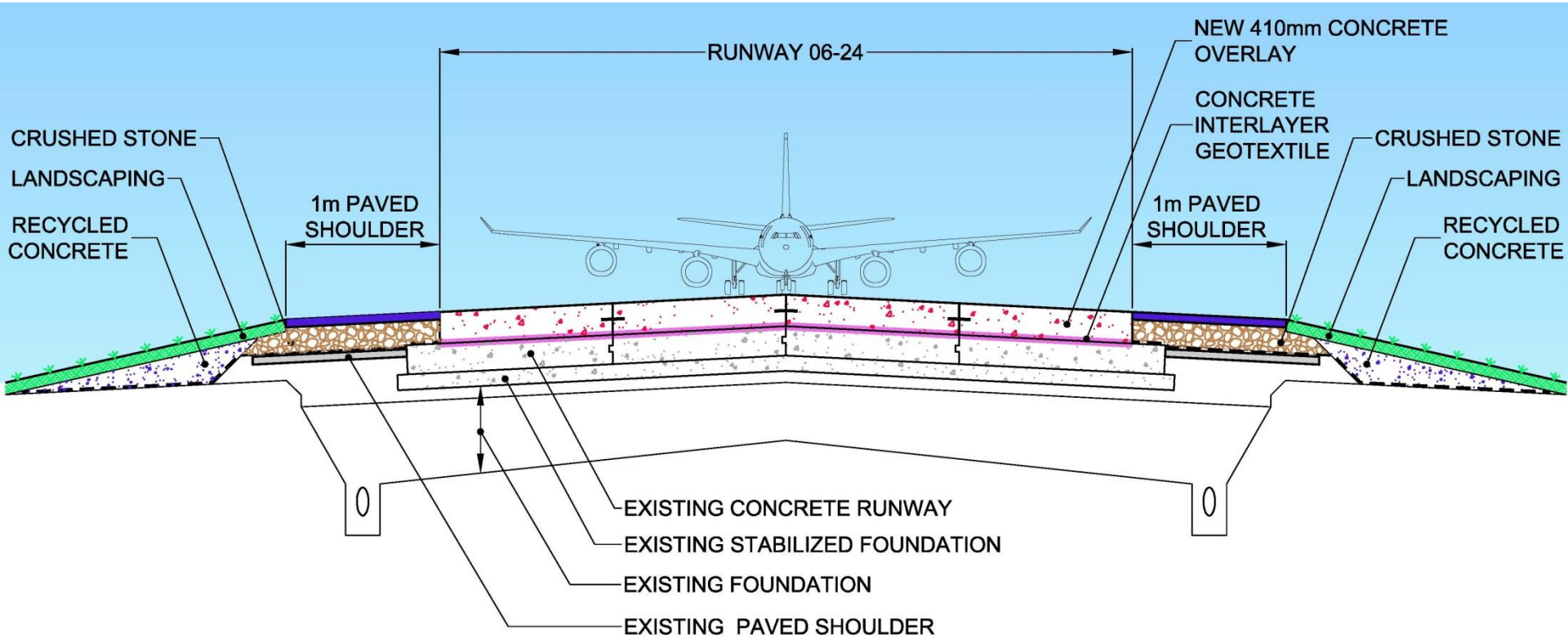
10 Final Concept



Rigid pavement overlay

Typical cross-section

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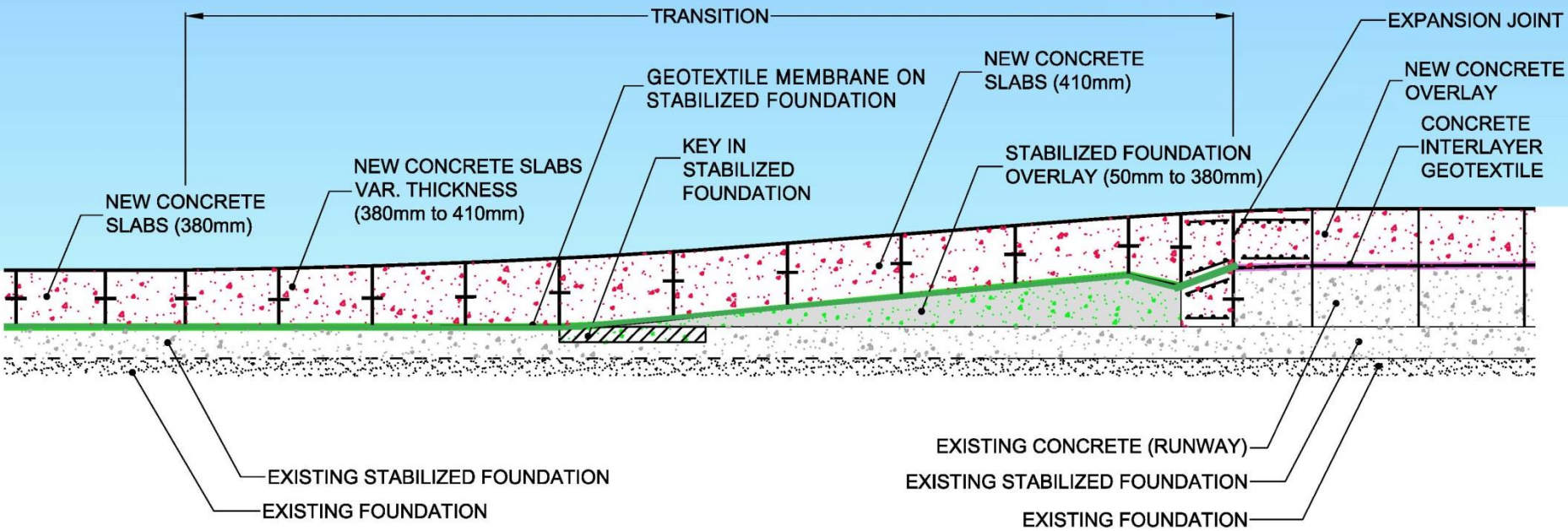
10 Final Concept



Transition (between rigid pavement overlay and reconstruction)

Typical profile

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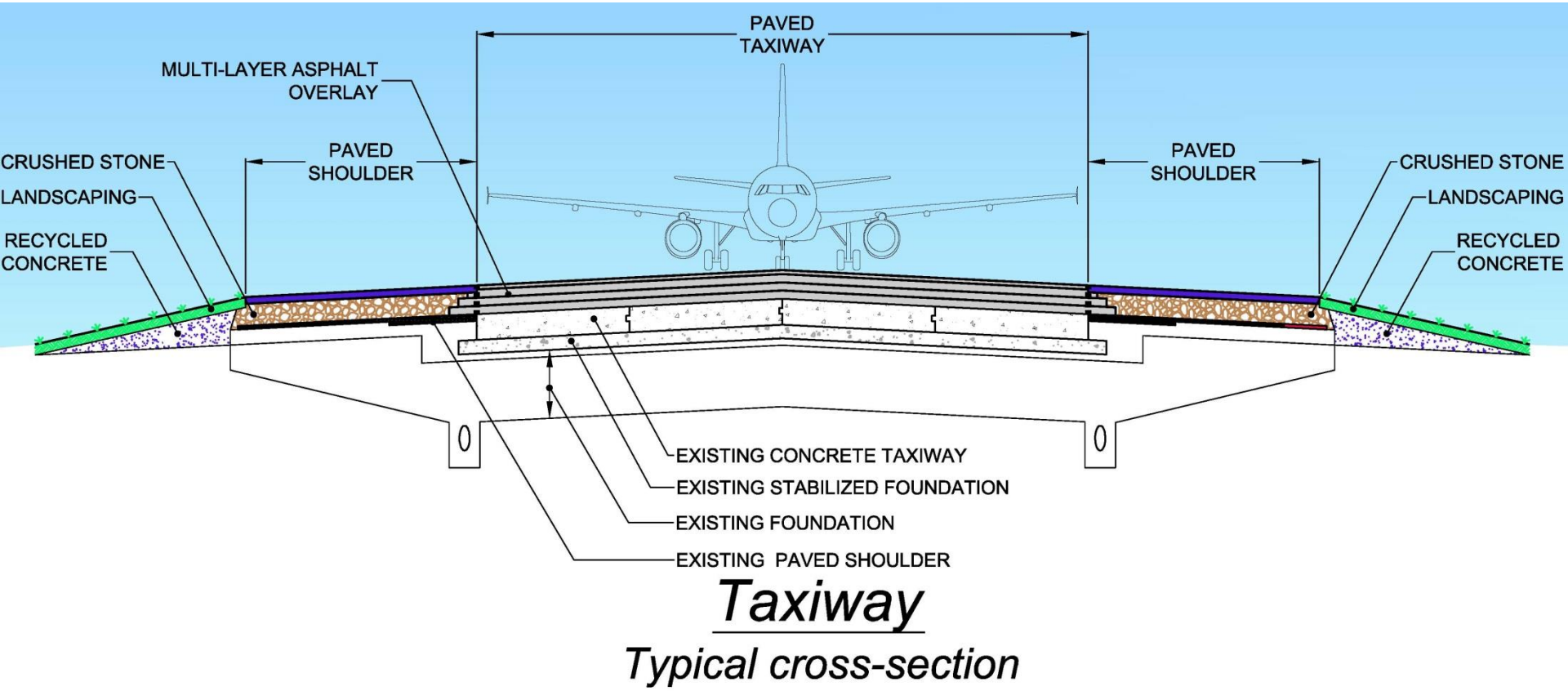
10 Final Concept



Taxiway

Typical cross-section

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10 Final Concept: Storm Drainage

- Replacement of all existing grates
- 5 type D manholes must be replaced
- 90 manholes (type B, D and F) must be adjusted and/or raised in concrete overlay section
- 2,000 m of ditches to be reprofiled
- 1,300 m of ditches to be cleaned
- 2,000 m of drains must be replaced
- 500 m must be reinspected

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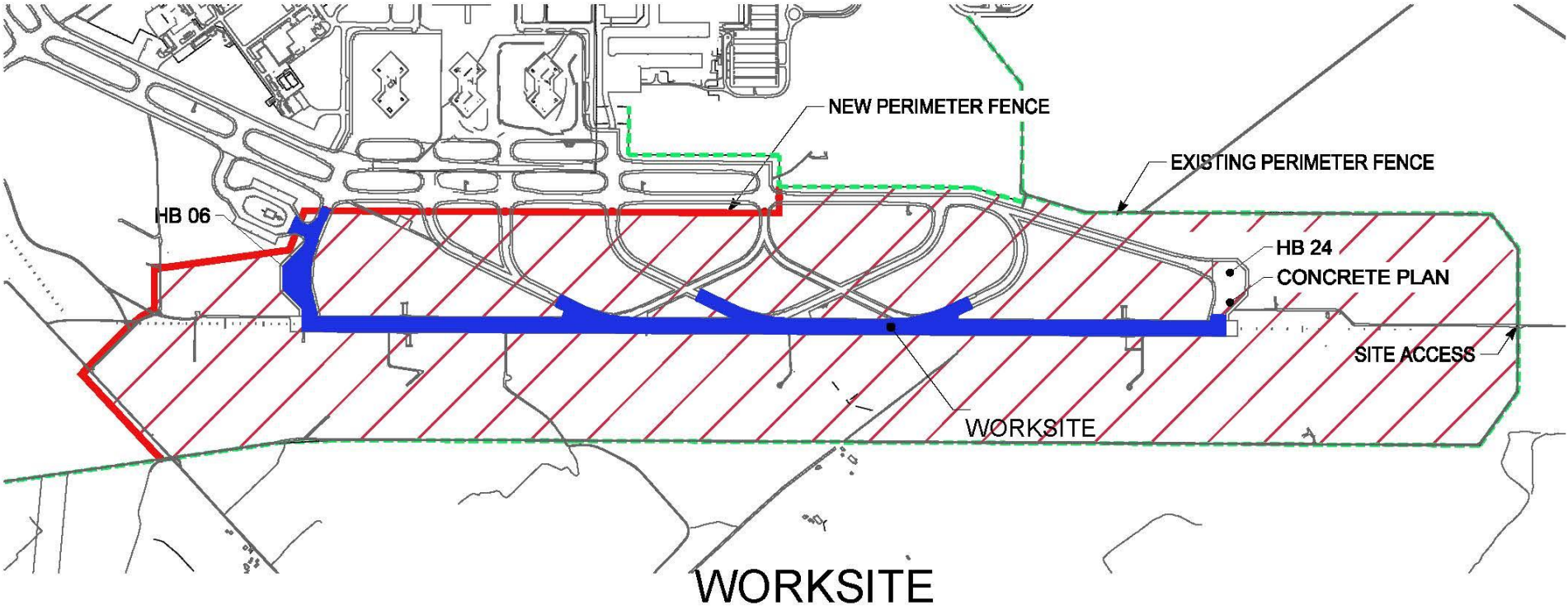
10 Final Concept: Worksite Layout



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11 Procurement Strategies

A prequalification for potential bidders was decided, screening potential contractors on the basis of:

- experience in similar projects
- staff qualification
- equipment inventory and availability

3 contractors were selected at the end of this process.

These 3 contractors received an invitation-to-bid (ITB), and the lowest bidder was selected.

12 Construction Schedule

Preliminary work :

- October & November 2015

Construction duration:

- December 1st, 2015 to November 16th, 2016

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Questions?

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