

Case Study: REPEX model commisioned for GIG PPP



XI Seminario ALACPA de Pavimentos Aeroportuarios
IX Taller de la FAA
IV Curso Rápido de Mantenimiento de Aeródromos
01 al 05/Set de 2014 Santiago de Chile



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CH2MHILL®

Date: December 2013

To whom it may concern

Dear Sir,

We are pleased to provide a reference for Halcrow Group Ltd for the following project.

Contract title: Galeao International Airport, (Rio de Janeiro, Brazil) advisory services

Contract reference: 480966

Details of scope of works undertaken by Halcrow (a CH2M Hill company): Fixed asset assessment and construction of a Preventive/Corrective Maintenance and Replacement (REPEX) model, benchmark evaluation of Capital investment (CAPEX) to account for new development and social environmental liabilities.

Dates of performance of services: Start: 12/08/2013 End: 15/11/2013

Value of services: £ 135,000

Proportion of services sub-contracted to others: 5%

Value of works: £ 1,000,000,000

Performance of the consultant: We are pleased to confirm that Halcrow completed the services in accordance with the terms of reference and contract requirements.

Yours faithfully,

Richard M. Vacar
Senior Vice President of Business and Project Development

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REPEX model key requirements:

- Built on a bottom up approach to enable a better control and estimate of expenditure
- Model built on a dynamic structure which supports a number of degrees of freedom, such as:
 - Overall group assets REPEX strategy adjustments
 - Particular assets REPEX strategy changes
 - Addition/removal of assets as required
 - Dynamic adjustments to predictive /preventative & corrective expenditure to individual or assets groups
 - Assess amounts of spent as a function of the maintenance strategy and its effect on the assets lifecycle
 - Control assets life cycle/ expenditure and benchmark against past figures and other airports
- If successful, be the base for a risk based “Asset Stewardship process”.



The REPEX model intends to estimate the annual and overall expenditure associated with maintenance & repair costs of the assets (including pavements) that make up a major airport investment

	Corrective	Preventative	Total REPEX
Existing Assets (USD million)	441	470	911
New Assets REPEX (USD million)	100	131	232

REPEX model key features:

- Comprehensive list of infrastructure assets/ sub-assets which represents the majority of infrastructure value
- Assessment of assets quantities
- Qualify each asset condition by assigning them an **equivalent age**.

Equivalent age is the assets age, relative to its prescribed useful life, it would be expected the asset to have given its current condition

- Definition of preventive and corrective maintenance strategies and associated costs to each asset
- Calibration of the strategies to optimize the expenditure along the life of the concession with a view of providing enough residual life in the assets so as to meet the hand back conditions.
- Validation of the model against known REPEX expenditure of well maintained assets worldwide



Assets groups for REPEX policy & strategies assignment:

- Asset Group 1: Passenger Terminals
- Asset Group 2: Airside Infrastructure
- Asset Group 3: Primary Utility Networks
- Asset Group 4: Equipment
- Asset Group 5: IT Systems
- Asset Group 6: Other Buildings



Data Collection

- Desktop analysis of existing documents/ assets
- Prepare site visit & document collection
- Stakeholder meetings
- Infrastructure construction stages contracts & as-built documents
- Existing maintenance, repair and replace policies, contracts & history

LOCAL	SERVIÇO	DESCRIÇÃO - CONTRATADA	VALOR	SERVIÇO	2014												2015		
					AGO	SET	OUT	NOV	DEZ	JAN	FEB	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT
TPS-1	PROJETO	PROJETO EXECUTIVO - TERRUGGI	1.352.202,36	Projeto executivo para reforma	SETOR A / SETOR B														
	OBRA	OBRA DE REFORMA E MODERNIZAÇÃO - CONSÓRCIO NOVO GALEÃO	153.000.000,00	Reforma geral do Terminal															
	FISCALIZ	FISCALIZAÇÃO DO PROJETO EXECUTIVO E OBRAS DO TPS-1 - STCP	7.353.000,00	Fiscalização das obras do TPS-1															
TPS-1 / TPS-2	RR LOTE	ELEVADORES - THYSSEN	12.474.792,78	Substituição dos elevadores do TPS-1, TPS-2, UIAC e TWR	CONCLUÍDO														
	OBRA	REFORMA GERAL EM EDIFICAÇÃO PARA A INST. ELEVADORES - RODOSERV	834.230,44	Obras de arremates dos elevadores	CONCLUÍDO														
	OBRA	ESCADAS ROLANTES - VILLARTA	13.430.000,00	Substituição das escadas rolantes do TPS-1 e instalação de escadas no TPS-2															
TPS-2	2ª ETAPA	AR CONDICIONADO COM ELÉTRICA - ERGO	15.273.782,89	Instalação do Sistema de Ar Condicionado na "área em osso"															
	5ª ETAPA	SINALIZAÇÃO VISUAL - VICTORIGOR	587.000,00	Instalação das placas de sinalização na "área em osso"															
	2ª ETAPA	INSTALAÇÕES ELÉTRICAS - MPE	12.800.000,00	Instalação do Sistema Elétrico na "área em osso"															
	2ª ETAPA	SISTEMAS ELETRÔNICOS E TI - EXPERNET	9.050.000,00	Instalação do Sistema de Eletrônica na "área em osso"															
	5ª ETAPA	FORRO DA CALÇADA E DEMAIS ACABAMENTOS - RODOSERV	3.074.999,87	Instalação do do forro, luminárias e demais acabamentos na calçada															
	OBRA	SERVIÇO DE COMPLEMENTAÇÃO DE ESQUADRIAS - CLIMAX	3.270.000,00	Restauração e Instalação das Esquarrias na "área em osso"															
	OBRA	COMPLEMENTAÇÃO DA 1ª ETAPA - SUD - Construções e Montagens Ltda	4.718.000,00	Execução de obras complementares na "área em osso"															
	OBRA	FORRO COM LUMINÁRIAS - Sistema Engenharia e Arquitetura Ltda	14.500.000,00	Instalação do forro e luminárias na "área em osso" e substituição do forro e luminárias na área operacional															
	4ª ETAPA	TRANSPORTE DE BAGAGENS - TECNENGE & VANDERLANDE	59.500.000,00	Instalação do Sistema de Transporte de Bagagem															
	3ª ETAPA	FISCALIZAÇÃO DAS OBRAS DO TPS-2 - TERRUGGI	4.093.450,09	Fiscalização das obras do TPS-2															
10/28	OBRA	EXECUÇÃO DAS OBRAS DO SISTEMA 10/28 - AMC / EPC	76.484.024,05	Obras de restauração do pátio e pista															
	FISCALIZ	FISCALIZAÇÃO DAS OBRAS DO SISTEMA 10/28 - TERRUGGI	3.991.174,91	Fiscalização das obras do Sistema 10/28															
	TOTAL:			395.786.657,39															

List of existing contracts



GLMN

Nº TC	CONTRATADA	INÍCIO	RESUMO DO OBJETO	EFETIVO ESTIMADO	VALOR MENSAL ESTIMADO
0027-PS/2011/0061	CONSÓRCIO MPE/CONSBEM	23/11/2011	Sistemas Elétricos	178	R\$ 1.091.395,72
0087-ML/2012/0061	CONSÓRCIO IC SUPPLY - CVF	13/11/2012	Sistema de Refrigeração	112	R\$ 538.136,80
0054-SM/2008/0061	OMNISEG	23/06/2008	Controle de Acesso	N/A	R\$ 6.700,00
0012-SM/2009/0061	IC SUPPLY	02/04/2009	Pontes de Embarque	50 (Fixo)	R\$ 286.379,66
0027-SM/2012/0061	IC SUPPLY	23/03/2012	Sistema Civil	247	R\$ 1.086.253,91
0034-SM/2011/0061	IC SUPPLY	01/07/2011	Balanças	04 (Fixo)	R\$ 18.248,00
0010-ML/2013/0061	MPE	06/03/2013	Esteiras de Bagagem	47	R\$ 174.554,44
0064				166	

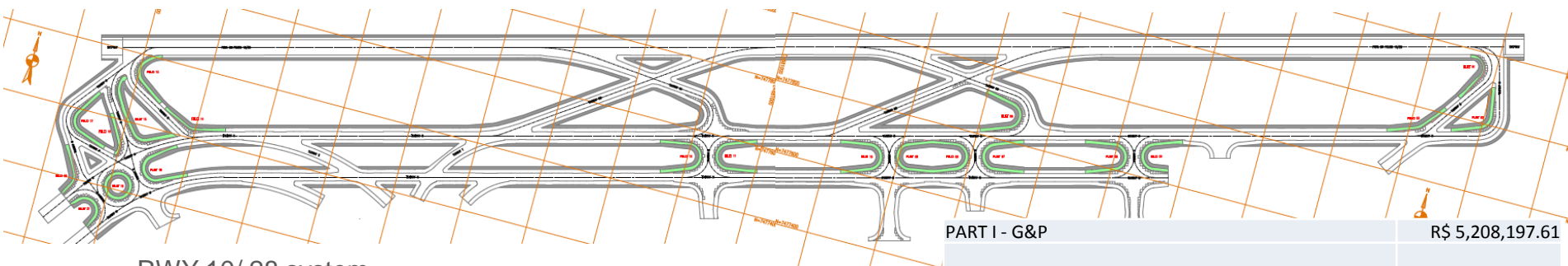
Review of outsourced maintenance contracts

Site Visit

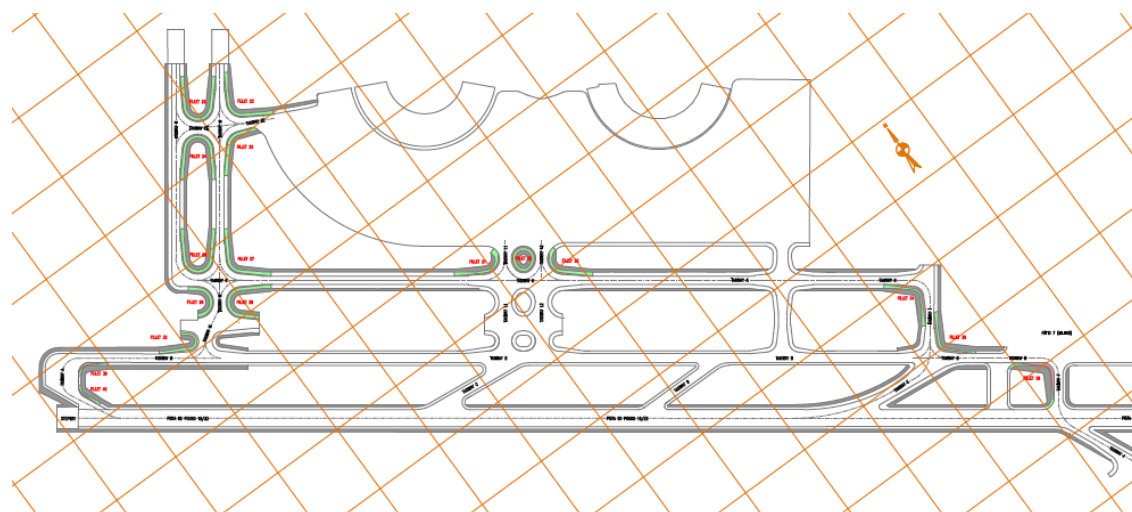
- Gather an understanding of the condition of the existing infrastructure
- Understand the status and scoping of the ongoing works
- Engage with maintenance stakeholders



XI Seminario ALACPA de Pavimentos Aeroportuarios
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RWY 10/ 28 system



RWY 15/ 33 system

In green – main pavement widening
 In darker grey – shoulder widening

PART I - G&P	R\$ 5,208,197.61
PART II - RWY 10/28 RWY SYSTEM - EXTENSION OF TWY M & TWY N (15/33), TWY EE, TWY L1 & TWY L2	
Earthworks	3,920,141.80
Pavements	19,545,175.38
Drainage	486,940.88
Markings	155,130.15
AGL/ Signage	3,243,062.53
Grass protection	904,040.34
PART III - PAVEMENT REFURBISHMENT INCLUDING RUNWAY AND TAXIWAY PRE-STRESSED JOINT REPLACEMENT	
Pre-stressed pavement joint replacement and associated pavement repairs	7,025,697.32
Twys pre-stressed concrete slabs surface repairs	84,829.64
Replacement of 618 concrete slabs by reinforced concrete slabs	23,000,281.62
Markings	984,601.64
TOTAL	R\$ 64,558,098.91



RWY panel being repaired



RWY panel being repaired



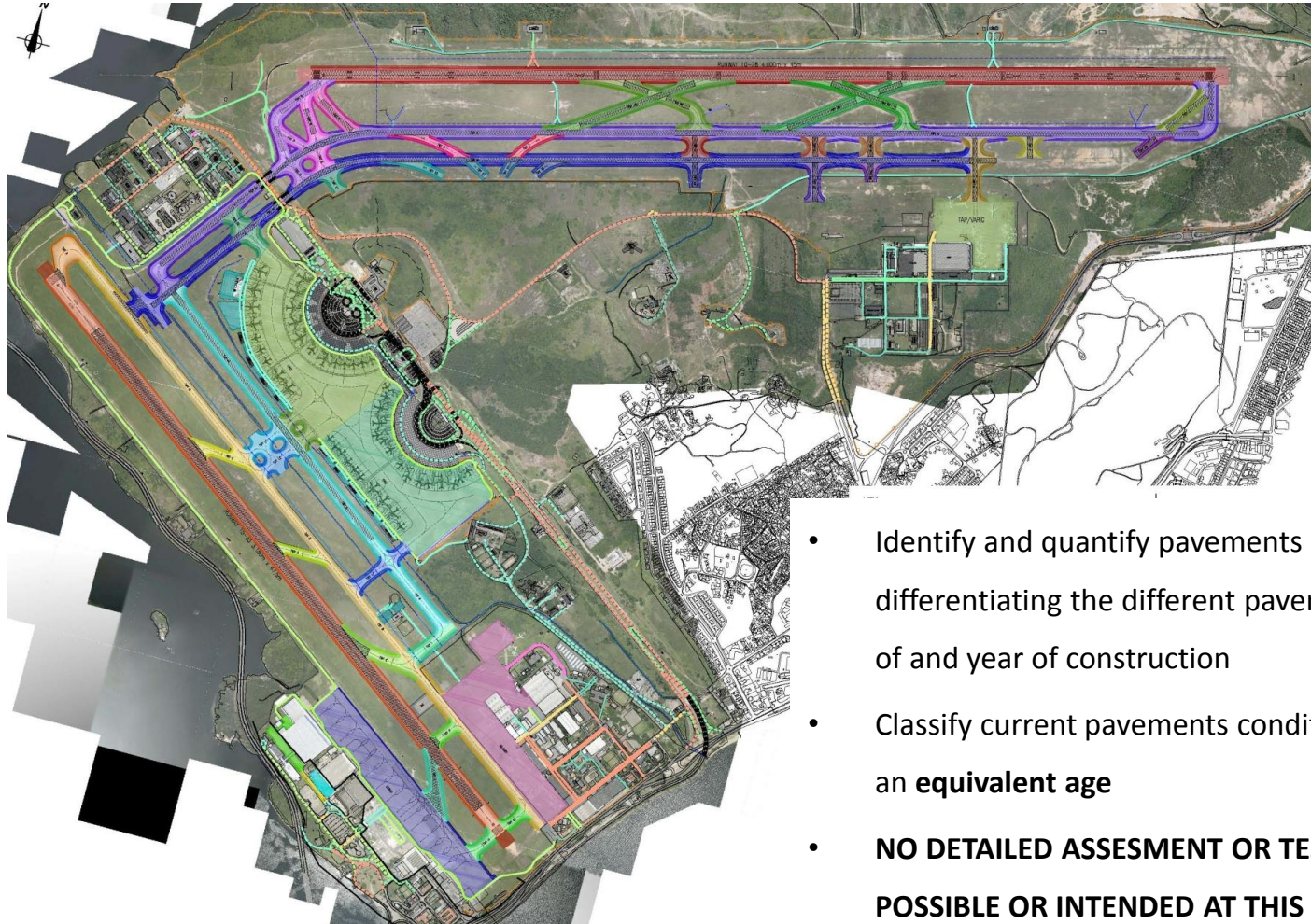
Shoulder
widening



The manholes closer to the runway
are now being corrected/ reinforced
(heights/ cover types)

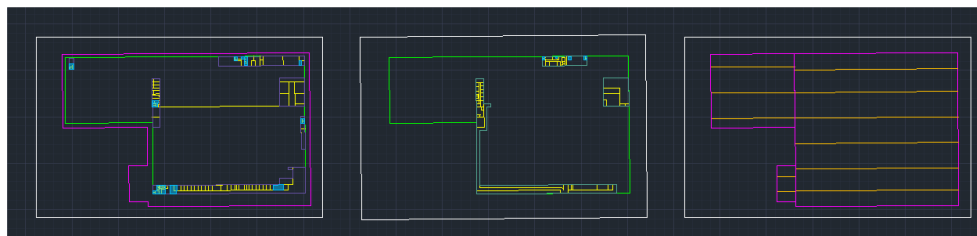
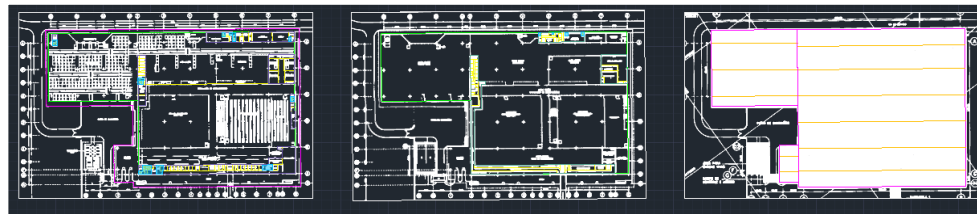
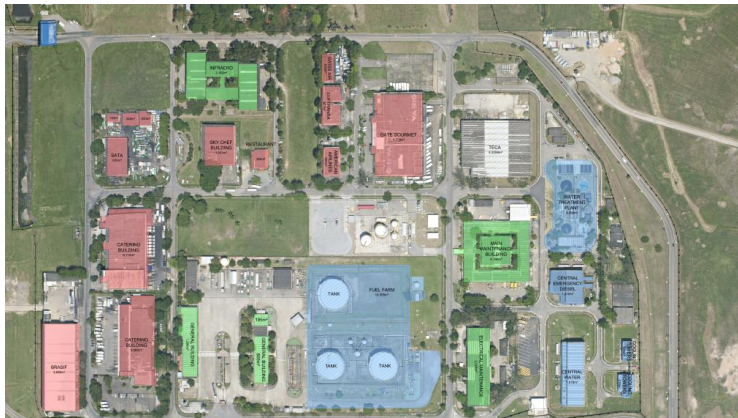
A stretch of 2200m of RWY 10/28 are
currently closed to operations.

A number of pre-stressed pavement
repairs are taking place together with
2x7.5 m shoulder widening project.



- Identify and quantify pavements differentiating the different pavements type of and year of construction
- Classify current pavements condition and with an **equivalent age**
- **NO DETAILED ASSESMENT OR TESTING WAS POSSIBLE OR INTENDED AT THIS STAGE.**

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IV Curso Rápido de Mantenimiento de Aeródromos
01 al 05/Set de 2014 Santiago de Chile



- Identify and quantify different nature assets and sub assets types/ year of construction/ associated maintenance policy, etc.
- Subdivide assets in components.
- Classify current condition and attribute them an **equivalent age**

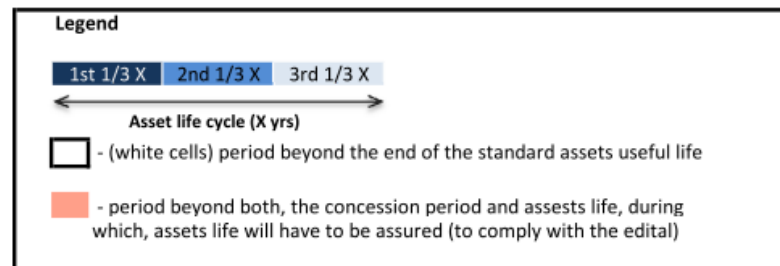


SBGL - Rio de Janeiro International Airport
 Airfield Pavements

Asset Group	Asset Subtype	Quantity	Unit	Equiv. age (yrs)	Life Span (yrs)	Residual life (yrs)	Concession period (years)																										
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Runways	10-28 Main Pavement	180,690	sqm	20	40	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	15-33 Main Pavement (asphalt)	13,963	sqm	5	40	35	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	15-33 Main Pavement (asphalt)	129,227	sqm	15	30	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	10-28 Shoulder Original	53,331	sqm	8	30	22	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	10-28 Shoulder New	34,418	sqm	0	30	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	15-33 Shoulder	41,200	sqm	8	30	22	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Taxiways	15-33 Shoulder New	41,606	sqm	0	30	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (asphalt)	17,875	sqm	5	30	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (asphalt)	3,917	sqm	15	30	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PCC)	7,660	sqm	3	40	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PCC)	33,429	sqm	5	40	35	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PCC)	19,631	sqm	8	40	32	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PCC)	6,639	sqm	10	40	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PCC)	10,985	sqm	12	40	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PCC)	256,942	sqm	15	40	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway main pavement (PSC)	315,148	sqm	15	40	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway shoulder pavement (asphalt)	29,612	sqm	3	30	27	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway shoulder pavement (asphalt)	525,359	sqm	5	30	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Taxiway shoulder pavement (asphalt)	4,520	sqm	10	30	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Taxiway shoulder pavement (asphalt)	59,398	sqm	15	30	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Aprons	TPS 1	257,408	sqm	20	40	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	TPS 2	226,215	sqm	15	40	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	TAP/VARIG	78,200	sqm	20	40	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Cargo	166,206	sqm	15	40	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27

Sample of existing assets list data (pavements):

- Pavement type
- Quantity
- Expected overall life span by assets type
- Assessed equivalent age
- Residual life



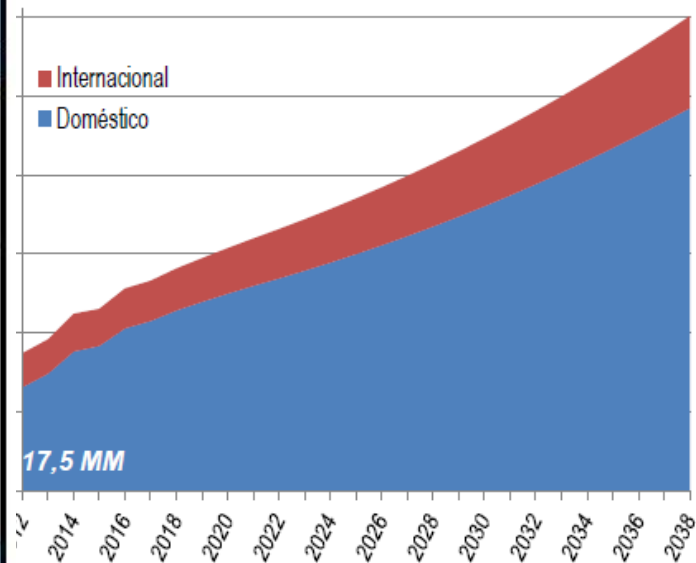
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IX Taller de la FAA
IV Curso Rápido de Mantenimiento de Aeródromos
 01 al 05/Set de 2014 Santiago de Chile



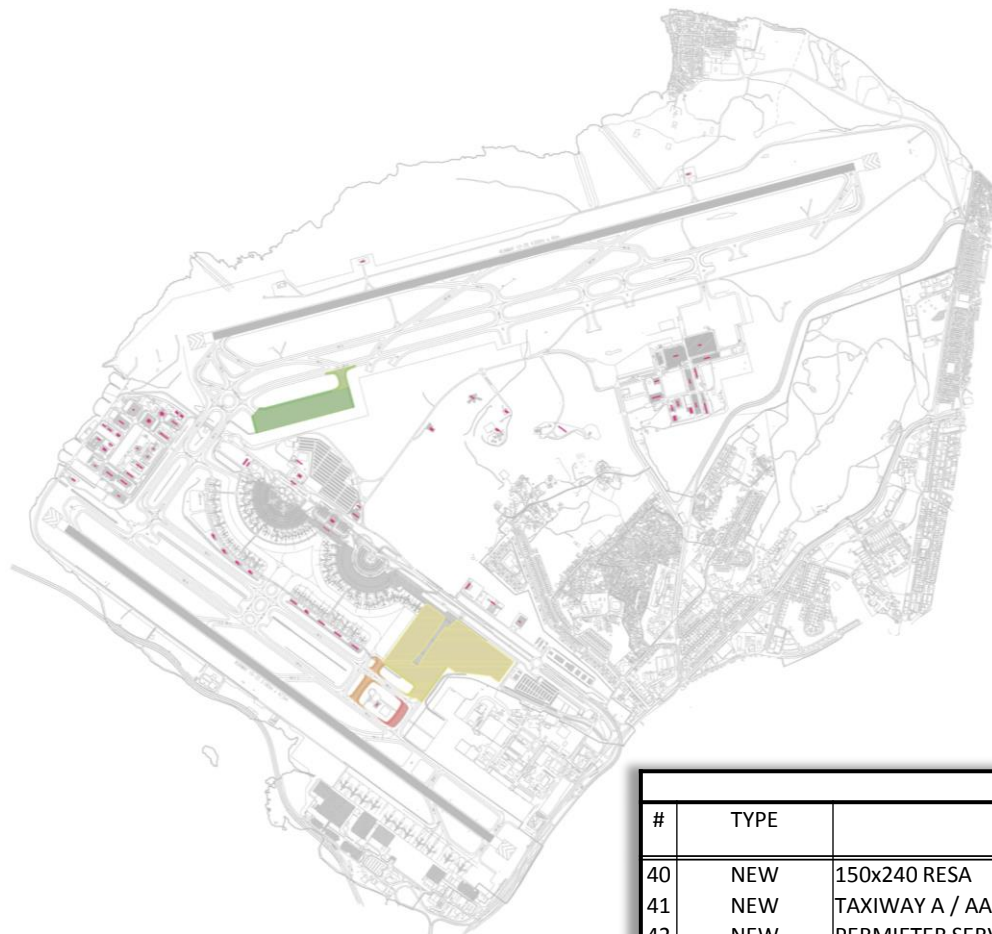
ASSET GROUP	GROUP NAME	ASSET CODE	Sub Component	Asset name	Type / Configuration	Quantity	Unit	area?	Equivalent Age			
									Year open / (if multiple operation items, average)	Expected Design Life	Residual Life	
AG2	INFRASTRUCTURE	2.11	Runway	10-28 Main Pavement	PSC	180180	sqm	1		20	40	20
		2.12	Runway	15-33 Main Pavement P	PCC	13963.1	sqm	1		15	40	25
		2.13	Runway	15-33 Main Pavement A	Asphalt	129226.9	sqm	1		15	30	15
		2.14	Runway	Stopways & RWY shoulders	Asphalt	185831	sqm	1		5	30	25
		2.21	Taxiway	Taxiway Mike main pavement	TAXIWAY - Main pavement Asphalt	3917	sqm	1		15	30	15
		2.22	Taxiway	Taxiways Alfa, Bravo, Charlie, Delta, Echo, Foxtrot	TAXIWAY - Main pavement Asphalt	17875	sqm	1		5	30	25
		2.23	Taxiway	Taxiways 10-28 system main pavement	TAXIWAY - Main pavement PCC	161658	sqm	1		15	40	25
		2.24	Taxiway	Taxiways Golf, Hotel, Main Pavement	TAXIWAY - Main pavement PCC	7660	sqm	1		3	40	37
		2.25	Taxiway	Taxiways Delta + India+ Lima1 + Lima2 Main F	TAXIWAY - Main pavement PCC	33429	sqm	1		5	40	35
		2.26	Taxiway	Taxiways Charlie + Foxtrot + Lijma3	TAXIWAY - Main pavement PCC	19631	sqm	1		8	40	32
		2.27	Taxiway	Taxiway Echo	TAXIWAY - Main pavement PCC	6639	sqm	1		10	40	30
		2.28	Taxiway	Taxiways Alfa	TAXIWAY - Main pavement PCC	10985	sqm	1		12	40	28
		2.29	Taxiway	Taxiway Bravo, Kilo	TAXIWAY - Main pavement PCC	95284	sqm	1		15	40	25
		2.211	Taxiway	Combined Areas of Taxiways : Kilo, Mike, Nov	TAXIWAY - Main pavement PSC	317624	sqm	1		15	40	25
		2.212	Taxiway	All TWY shoulders 10-28 system	TAXIWAY - Shoulders Asphalt	493322	sqm	1		5	30	25
		2.213	Taxiway	Taxiway Shoulders Echo, Golf, Hotel, Juliet, Li	TAXIWAY - Shoulders Asphalt	29612	sqm	1		3	30	27
		2.214	Taxiway	Taxiway SHOULDERS ALFA, CHARLIE, DELTA	TAXIWAY - Shoulders Asphalt	32037	sqm	1		5	30	25
		2.215	Taxiway	Taxiways SHOULDERS FOXTROT OF 15/33 S	TAXIWAY - Shoulders Asphalt	4520	sqm	1		10	30	20
		2.216	Taxiway	Taxiway SHOULDERS BRAVO OF 15/33 SYS	TAXIWAY - Shoulders Asphalt	59398	sqm	1		15	30	15
		2.31	Apron	Apron TPS 1	PCC	257408	sqm	1		20	40	20
		2.32	Apron	Apron TPS 2	PCC	226215	sqm	1		15	40	25
		2.33	Apron	Apron TAPVARIG	PCC	78200	sqm	1		20	40	20
								166206	sqm	1	15	40
						1968	sqm	1	20	40	20	
						9440	sqm	1	15	30	15	
						43002	sqm	1	20	40	20	

The Assets were clustered into 6 major groups for modelling & study purposes

AG1	TERMINAL
AG2	INFRASTRUCTURE
AG3	UTILITY NETWORKS
AG4	EQUIPMENT
AG5	IT SYSTEMS
AG6	BUILDINGS



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PHASE 1B 2014-2016				
#	TYPE	DESCRIPTION	BUILDING AREA	IMPRVMNT. AREA
1	NEW	90x90 RESA		
2	NEW	CARGO BLDG NEW ROOF	10097m ²	
3	NEW	VEHICLE MAINTENANCE FACILITY	10000m ²	13501 m ²
4	NEW	TERMINAL 3 / 1B CONCOURSE	76670m ²	
5	NEW	TERMINAL 3 APRON		230038m ²
6	NEW	ELECTRICAL MAINTENANCE FACILITY	1500m ²	6937 m ²
7	NEW	MAINTENANCE FACILITY	750m ²	3042 m ²
8	NEW	CENTRAL WATER AND CHILLER	1000m ²	2840m ²
9	NEW	STAFF PARKING LOT	100m ²	29757 m ²
10	NEW	PASSENGER PARKING LOT	200m ²	51906m ²
11	NEW	PARKING ROAD CONNECTOR		2431 m ²
12	NEW	TERMINAL SERVICE ROAD		7706 m ²
13	NEW	TERMINAL SERVICE ROAD CHECKPOINT	56 m ²	697 m ²
14	NEW	TRAFFIC CIRCLE		2393 m ²
15	NEW	MAINTENANCE ROAD CONNECTOR		1588 m ²
16	NEW	REMOTE HARDSTAND		146687 m ²
17	NEW	AIRFIELD SERVICE ROAD		1703 m ²
18	NEW	PETROBAS GAS STATION	1052m ²	3798 m ²
19	NEW	OVERHEAD SIGNAGE		
20	NEW	PASSENGER LOADING BRIDGE	1 ea.	
21	RENOVATED	TERMINAL 1 PROCESSOR	31215m ²	
22	RELOCATED	TERMINAL 2 F.I.S.	12080m ²	
23	NEW	HARDSTAND SERVICE BUILDING		2070m ²
24	NEW	APRON LIGHTING TOWER (20 TOTAL)		
25	FUTURE	RAIL R.O.W.		
26	REALLOCATE	DEPARTURES / ARRIVALS CURB		
27	RELOCATED	UNDERGROUND TERMINAL SERVICE ROAD		2436m ²
28	REMOVE	AIRFIELD FRANGIBLE OBJECTS		
29	RESTRIC	EXISTING STAFF PARKING LOT		30061m ²
				8623m ²

PHASE 1C 2017-2018				
#	TYPE	DESCRIPTION	BUILDING AREA	IMPRVMNT. AREA
40	NEW	150x240 RESA		
41	NEW	TAXIWAY A / AA / G / H		21888 m ²
42	NEW	PERMIETER SERVICE ROAD		2801 m ²
43	DISPLACE	RUNWAY 33 THRESHOLD 100M		14670m ²
44	DISPLACE	RUNWAY 15 THRESHOLD 80M		
45	DEMOLISH	TAXIWAY A / G / H		31811 m ²
46	DEMOLISH	PERMIETER SERVICE ROAD		2418 m ²
47	RECLM.	ISLAND EXTENSION		1261 m ²

XI Seminario ALACPA de Pavimentos Aeroportuarios
IX Taller de la FAA
IV Curso Rápido de Mantenimiento de Aeródromos
 01 al 05/Set de 2014 Santiago de Chile



Asset Group	GROUP NAME	ASSET CODE	ASSET CODE	Sub Component	Type / Configuration	YEAR OPENING	Quantities	Unit
AG1	TERMINAL		Passenger Terminal 3	Substructure	Concrete	2016	38,133	sqm
			Passenger Terminal 3	Frame		2016	76,670	sqm
			Passenger Terminal 3	Roof & rainwater disposal	Two Types: R-1 Sloped Roof - Standing seam batten metal roofing, pre-finished coil coated aluminum to match existing & R-2 Flat Roof - Membrane Roofing, 50 mil KEE single ply, similar to Fibertight-XT, traffic coating at all equipment areas	2016	38,133	sqm
			Passenger Terminal 3	External walls	EW-1 Exterior Walls, cement board over cold formed studs, EW-2 Exterior Soffit, composite metal panel, EW-5 Exterior Walls, precast concrete panels to match existing, EW-6 Exterior Walls, composite metal panel, EW-7 Exterior Walls, decorative metal panel, Exterior Walls, GL-1 (multi-colored) glazed aluminum curtain wall system, including support system & Low-E treatment, Exterior Walls, GL-4 glazed aluminum curtain wall system with louvers, including support system & Low-E treatment	2016	41,222	sqm
			Passenger Terminal 3	Internal walls		2016		sqm
			Passenger Terminal 3	Floor Finishes Type 1 - Public Areas	Granite, Tiles, Carpet	2016	30,025	sqm
			Passenger Terminal 3	Floor Finishes Type 2 - Service Areas	Concrete, cement, block paving. Includes basement car park	2016	16,537	sqm
			Passenger Terminal 3	Ceiling finishes	Standard tiles (foam + metallic frames), gypsum, fiberglass, etc	2016	46,223	sqm
			Passenger Terminal 3	External windows, glazed panels and doors	GL-2 - Storefront glazing, GL-3 - Glazed skylight system, including support system & Low-E treatment, Gate Doors - 27(6.5 M2), Gate Doors - 27(6.5 M2), Glass Doors - Holding Rooms for Bussing Operation - 4(2.16 M2), Stair Doors - 9(2.16 M2)+ 2(6.5 M2),	2016	1,362	sqm
			Passenger Terminal 3	Internal partitions, windows, panels and doors	Wall finishes PGAL BoQ	2016	46,562	sqm
			Passenger Terminal 3	Toilets, kitchens and other support areas		2016		sqm
			Passenger Terminal 3	Electrical Installations		2016		sqm
			Passenger Terminal 3	Building utilities,		2016		



General Rules for REPEX Strategy/ Policy Definition and Costing

- Replacement periods and work intervals used in the models are based on published/ internal benchmark data (USD/m²/pa), feedback from buildings in use and our experience.
- Sensitivity analysis have been undertaken taking account of the impact on corrective and preventative asset maintenance procedures relative to the service life frequency and the percentage change in the lifecycle fund. This is particularly relevant for the M&E services and the specific in-use conditions of operation.
- The amounts included for Life Cycle Replacements take account of Main Asset and Sub-components only. They do not include for spare parts and consumables replaced as part of Frequent Maintenance.
- The life cycle costs have been calculated based on the following assumptions:
 - All workmanships / installations / maintenances / operations / uses are in accordance with manufacturers' recommendations.
 - Like-for-like performance replacement with best value for money solution
- Replacement periods assume that the appropriate planned maintenance is carried out in accordance with good industry practice and manufacturers' recommendations. Some assets are replaced at the end of foreseen obsolescence (i.e. IT systems).
- General lifecycle on-cost allowances:
 - LC Management fee
 - Design Fees
 - FM Manage Fee
 - LC Prelims
 - Contractor's overhead and profit
 - Strip Out
 - Risk / Contingencies
- Exclusions:
 - Inflation
 - Taxes
 - Capital Allowances
 - Decant costs
 - Condition surveys & inspections, structural and heritage surveys



REPEX Model

XI Seminario ALACPA de Pavimentos Aeroportuarios

IX Taller de la FAA

IV Curso Rápido de Mantenimiento de Aeródromos

01 al 05/Set de 2014 Santiago de Chile



INPUT -- ASSET STRATEGIES, BY GROUP

CORRECTIVE REPEX
PREVENTATIVE REPEX
REPLACEMENTS

Variables / levers : Unit cost, asset coverage%, start, end
frequency, distribution

GLOBAL INPUTS

COST EFFICIENCY
PASSENGER NUMBERS
STRATEGY RELATIONSHIPS
HAND BACK CONDITION

ASSET GROUPS

AG1 TERMINAL
AG2 INFRASTRUCTURE
AG3 UTILITY NETWORKS
AG4 EQUIPMENT
AG5 IT SYSTEMS
AG6 OTHER BUILDINGS
NEW INFRAS

See asset list tab

CALCULATION -- ASSET REPEX, BY GROUP

CORRECTIVE REPEX
PREVENTATIVE REPEX
REPLACEMENT
RESIDUAL LIVES

COMPARISON -- REPEX / PAX

PORTUGAL MODEL
OTHER RATES

OUTPUT -- ASSET REPEX COST PROFILES

CORRECTIVE REPEX
PREVENTATIVE REPEX
REPLACEMENT

OUTPUT -- ASSET LIFE PROFILES

ASSET RESIDUAL LIFE

OUTPUT -- ASSET GROUP COST PROFILES

Also shown as per pax rates

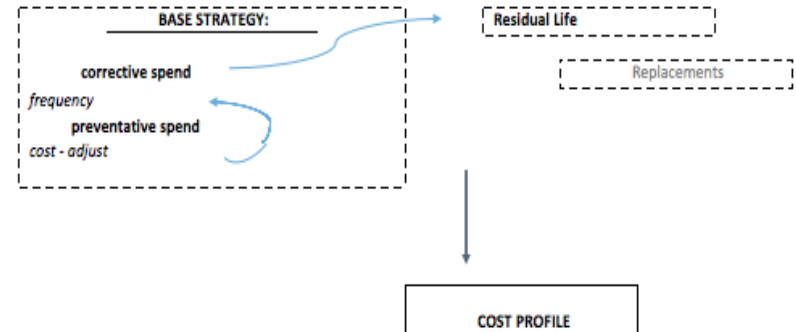
OUTPUT -- ASSET GROUP LIVES

Key logic / relationships in the model

**as defined - see global inputs*

- / **corrective spend** impacts asset residual life
- // **preventative spend** where adjusted it impacts corrective intervention frequency **as defined*
- / **weighted residual life** the % of the asset area, as defined by the occurring corrective spend, becomes new
- /// **limit 1 on corrective spend** where **user specifies they don't want corrective spend from year x*
- /// **limit 2 on corrective spend** where design life hits certain points, this spend is adjusted **as defined*
- /// **limit 1 on preventative spend** where design life hits certain points, this spend is adjusted **as defined*

// where defined by asset inputs, a residual life hitting 0 will bring forth a full replacement cost



XI Seminario ALACPA de Pavimentos Aeroportuarios
IX Taller de la FAA
IV Curso Rápido de Mantenimiento de Aeródromos
01 al 05/Set de 2014 Santiago de Chile



INFRASTRUCTURE		TPS1 apron	
Total Area		257,408	00
Equivalent age (2014)		20	
Asset life		40	
Asset's residual life		20	
Replacement value \$		\$	
Concession year of asset addition (default is 2013)		2013	
Intervention %	P/C	Type	% of RV
		Type 1	0.00%
		Type 2	0.00%
		Type 3	0.00%
		Type 4	0.00%
Intervention Area	P/C	Type	AREA
	P	RMS-01	2,574.1
		Type 2	-
		Type 3	-
		Type 4	-
Intervention Quantity/frequency	P/C	RMS	Quantity [un]
	P	RMS-02	19,306
	P	RMS-03	257,408
	C	RMS-04	12,870
	C	RMS-05	30,889
	C	RMS-06	10,296
		Repair	-

General Asset Info

Concession Year	1	2	3
Calendar Year	2014	2015	2016
Life Cycle Yr	20	21	22

Strategy costing

Yr changes to std (%)	1	1	1
MAINTENANCE COSTS BY % OF REPLACEMENT VALUE	\$ -	\$ -	\$ -
MAINTENANCE COSTS BY INTERVENTION AREA AND ASSOCIATED COST	\$ 10,811	\$ 10,811	\$ 10,811
DECRETE MAINTENANCE	\$ 1,081,114	\$ -	\$ -
TOTAL	\$ 1,091,925	\$ 10,811	\$ 1,280,991

REPEX Strategy

The above pictured templates were used to input the defined base case maintenance/repair strategy into the model for each component.



ALL ASSETS

GLOBAL INPUTS

Start	2013
Concession end	2038

Hand back asset life years

Discount factors

year 1 - 10	5.10%
year 11 - 20	5.10%
year 21 - 30	5.10%

	1	2	3
	2014	2015	2016
	1.0000	0.9490	0.9006

Picked up in cost profile sheet - where private sector brings cost efficiency gains

Cost efficiency factors	1	2	3
CORRECTIVE	2014	2015	2016
AG1	0.95	0.95	0.95
AG2	0.95	0.95	0.95
AG3	0.95	0.95	0.95
AG4	0.95	0.95	0.95
AG5	0.95	0.95	0.95

Cost efficiency factors	1	2	3
PREVENTATIVE	2014	2015	2016
AG1	0.95	0.95	0.95
AG2	0.95	0.95	0.95
AG3	0.95	0.95	0.95
AG4	0.95	0.95	0.95
AG5	0.95	0.95	0.95

- Hand back asset life reflects the contractual obligation
- Discount factors are standard government economic discount rates
- Cost efficiency factors represent the general impact that reflects efficiency gains expected from a private entity running the airport



ALL ASSETS

GLOBAL INPUTS

Passenger annual growth	1
1 to 5	5%
5 to 10	5%
10 to 20	5%
20 to 30	5%

Passenger forecast profile	1	2	3
	2014	2015	2016
	20,000,000	20,000,000	20,000,000
2012	LEK		

Cost inflation	1	2	3
	2014	2015	2016

- Passenger forecast numbers can be used to calculate REPEX/ PAX rates to benchmark the model's outcome against other airports
- Inflation can be considered within the model
- Strategies (1 & 2): the user can specify two periods where preventive spent deviates from the base case (e.g. -20% to + 20% to each asset ground). These changes on preventive spent affect the frequency of corrective maintenance interventions. The underlying relationship is being adjusted by the team of experts.

STRATEGY CHANGE 1

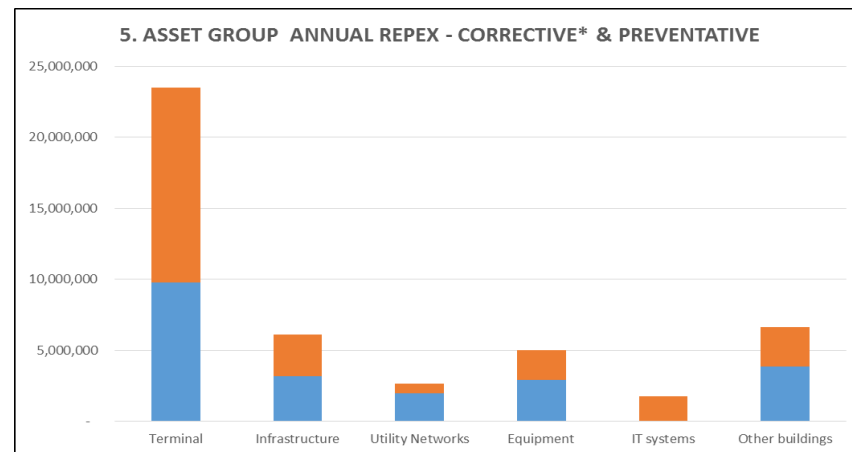
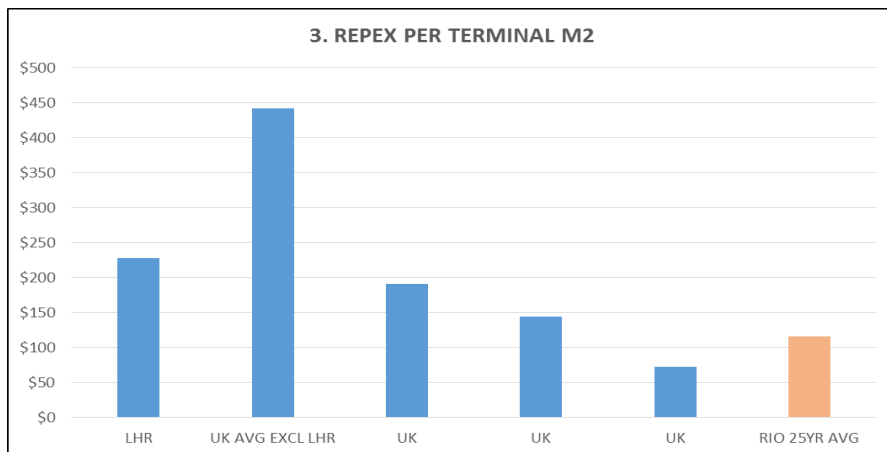
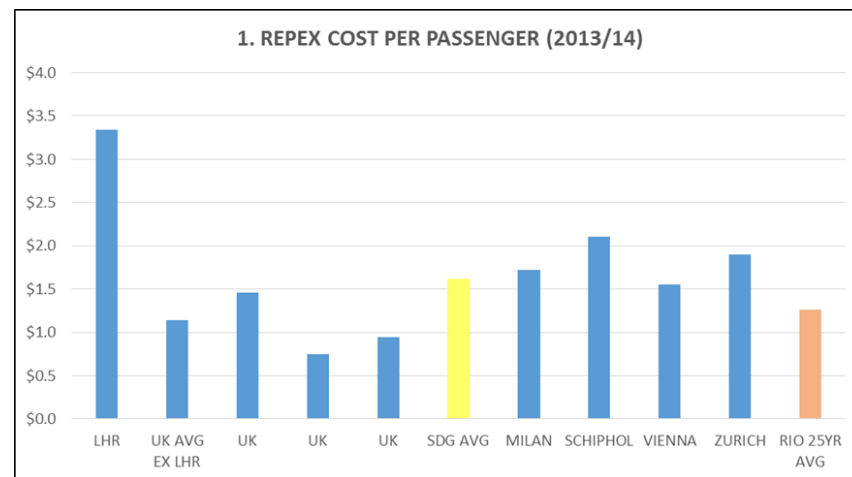
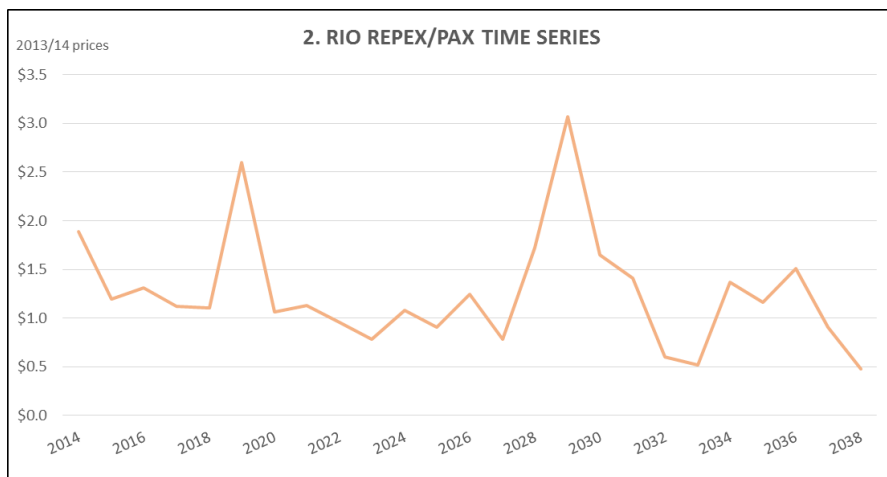
STRATEGY CHANGE 2

Asset group	STRATEGY CHANGE 1				STRATEGY CHANGE 2			
	start year	end year	Preventative spend change	Corrective frequency change	start year	end year	Preventative spend change	Corrective frequency change
AG1	2014	2025	0%	1.00	2033	2038	0%	1.00
AG2	2014	2030	0%	1.00	2033	2038	0%	1.00
AG3	2014	2025	0%	1.00	2033	2038	0%	1.00
AG4	2014	2025	0%	1.00	2033	2038	0%	1.00
AG5	2014	2025	0%	1.00	2033	2038	0%	1.00
AG6	2014	2025	0%	1.00	2033	2038	0%	1.00

XI Seminario ALACPA de Pavimentos Aeroportuarios
IX Taller de la FAA
IV Curso Rápido de Mantenimiento de Aeródromos
 01 al 05/Set de 2014 Santiago de Chile



ASSET GROUP LEVEL - NEW AND EXISTING			1.000	0.949	0.901	0.855	0.811	0.770	0.730	0.693		
COST PROFILE			1	2	3	4	5	6	7	8		
			Concession Year	Calendar Year	2014	2015	2016	2017	2018	2019	2020	2021
	PV	TOTALS										
TERMINALS	-	-	REPLACE	-	-	-	-	-	-	-	-	-
	94,884,043	244,478,250	CORRECTIVE	1,445	-	5,690	-	-	1,937,716	2,699,853	-	-
	188,213,427	343,333,787	PREVENTATIVE	10,564,988	9,166,528	9,464,039	11,661,228	11,661,228	22,832,401	11,661,228	11,994,105	-
	283,097,470	587,812,037	TOTAL	10,566,432	9,166,528	9,469,729	11,661,228	11,661,228	24,770,118	14,361,081	11,994,105	-
			REPEX/PAX	0.58	0.48	0.44	0.52	0.50	1.01	0.55	0.44	-
		REPEX/M2	37.46	32.50	26.40	32.51	32.51	69.05	40.03	33.44	-	
INFRASTRUCTURE	6,408,261	15,619,482	REPLACE	-	-	-	-	-	-	-	92,660	-
	31,755,305	63,465,948	CORRECTIVE	24,181	37,920	3,355,679	189,090	113,084	2,763,033	2,495,790	3,088,277	-
	41,216,812	74,047,443	PREVENTATIVE	2,799,804	672,935	7,829,748	615,249	683,863	3,907,503	684,802	7,133,372	-
	79,380,378	153,132,873	TOTAL	2,823,985	710,855	11,185,427	804,339	796,948	6,670,537	3,273,252	10,221,650	-
			REPEX/PAX	0.16	0.04	0.52	0.04	0.03	0.27	0.13	0.37	-
UTILITY NETWORKS	614,250	614,250	REPLACE	614,250	-	-	-	-	-	-	-	-
	34,003,773	48,562,809	CORRECTIVE	1,732,500	4,410,001	680,400	3,704,060	4,548,023	10,124,342	2,253,110	2,098,337	-
	9,531,242	17,093,157	PREVENTATIVE	514,926	514,926	514,926	715,672	688,872	688,872	688,872	690,774	-
	44,149,265	66,270,216	TOTAL	2,861,676	4,924,927	1,195,326	4,419,732	5,236,895	10,813,213	2,941,982	2,789,111	-
			REPEX/PAX	0.16	0.26	0.06	0.20	0.23	0.44	0.11	0.10	-
EQUIPMENT	14,419,165	29,157,453	REPLACE	1,839,285	-	-	491,518	181,440	5,486,856	181,440	177,811	-
	24,500,349	43,317,621	CORRECTIVE	5,475,372	1,332,166	346,560	1,626,029	346,560	833,591	1,332,160	339,631	-
	29,551,052	53,116,686	PREVENTATIVE	1,787,588	1,814,182	1,845,871	1,776,126	2,216,806	2,014,957	2,136,695	1,908,860	-
	68,470,565	125,591,761	TOTAL	9,102,245	3,146,348	2,192,431	3,893,672	2,744,806	8,335,404	3,650,295	2,426,302	-
			REPEX/PAX	0.50	0.16	0.10	0.17	0.12	0.34	0.14	0.09	-

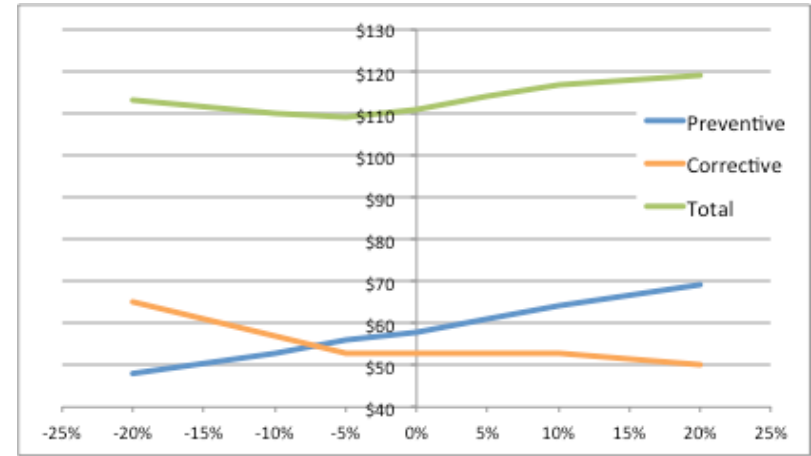
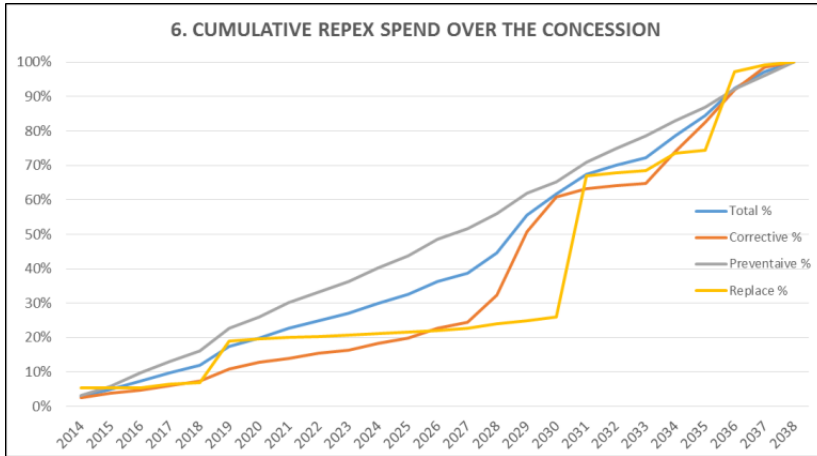


XI Seminario ALACPA de Pavimentos Aeroportuarios

IX Taller de la FAA

IV Curso Rápido de Mantenimiento de Aeródromos

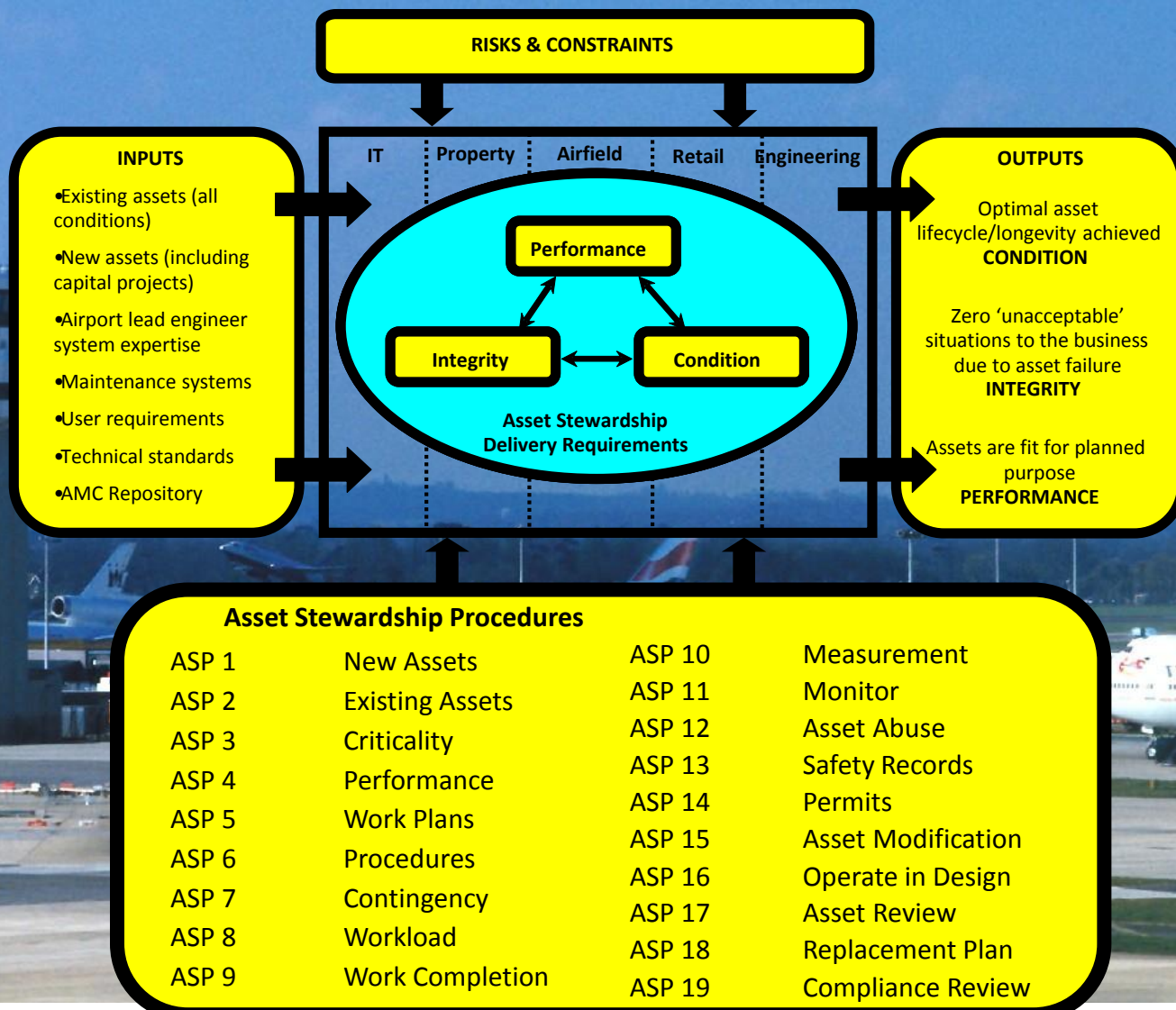
01 al 05/Set de 2014 Santiago de Chile



OUTPUT - EXISTING ASSETS											
ASSET VALUE											
				Concession Year							
				Calendar Year							
				1	2	3	4	5	6	7	8
				2014	2015	2016	2017	2018	2019	2020	2021
	% RV	ASSET VALUE BEGINNING CONCESSION									
AG1	5%	\$811,527,045									
AG2	5%	\$153,099,265									
AG3	5%	\$34,738,060									
AG4	0%	\$113,548,754									
AG5	0%	\$11,420,000									
AG6	5%	\$139,113,484									
WHERE AV = (RV - RV%) * (RESIDUAL LIFE / TOTAL LIFE) + %RV											
ASSET GROUP	CC	NAME	ASSET VALUE YEAR 1								
AG1	1.11	Substructure	26,501,475	26,501,475	26,149,358	25,797,240	25,445,123	25,093,005	24,740,888	24,388,770	24,036,653
AG1	1.12	Frame	39,758,070	39,758,070	38,950,152	38,142,234	37,334,316	36,526,398	35,718,480	34,910,562	34,102,644
AG1	1.13	Roof & rainwater disposal	41,736,640	41,736,640	40,721,280	39,705,920	38,690,560	37,675,200	36,659,840	35,644,480	34,629,120
AG1	1.14	External walls	38,624,324	38,624,324	38,160,148	37,695,972	37,231,796	36,767,620	36,303,444	35,839,268	35,375,093
AG1	1.15	Internal walls	39,346,336	39,346,336	38,248,568	37,150,799	36,053,031	34,955,262	33,857,494	32,759,726	31,661,957
AG1	1.16	Floor Finishes Type 1 - Public Areas	23,059,457	23,059,457	22,191,874	21,324,290	20,456,707	19,589,123	18,721,540	17,853,956	16,986,373
AG1	1.17	Floor Finishes Type 2 - Service Areas	5,861,787	5,861,787	5,590,143	5,318,500	5,046,856	4,775,212	4,503,568	4,231,924	3,960,281
AG1	1.18	Ceiling finishes (being replaced 2014)	11,191,399	11,191,399	10,633,298	10,075,196	9,517,095	8,958,994	8,400,893	7,842,791	7,284,690
AG1	1.19	External windows, glazed panels and doors	1,648,243	1,648,243	1,505,972	1,363,702	1,221,431	1,079,161	936,890	794,619	652,349
AG1	1.111	Internal partitions, windows, panels and doors	7,758,083	7,758,083	7,569,346	7,380,609	7,191,872	7,003,135	6,814,398	6,625,661	6,436,924
AG1	1.112	Toilets, kitchens and other support areas	521,989	521,989	489,472	456,954	424,437	391,920	359,402	326,884	294,367
AG1	1.21	Substructure	38,230,694	38,230,694	37,807,147	37,383,600	36,960,053	36,536,506	36,112,959	35,689,412	35,265,865
AG1	1.22	Frame	49,787,734	49,787,734	49,068,368	48,349,001	47,629,635	46,910,268	46,190,902	45,471,535	44,752,169



WHAT IS NEXT ?



LONDON HEATHROW...Comprehensive Asset Management Program

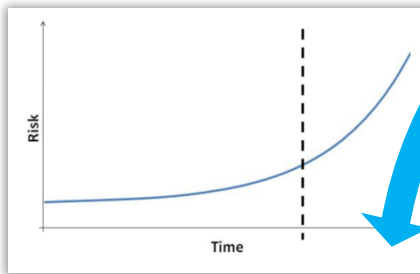
Maintenance Cost Drivers

Maintenance Drivers

- Asset Base:** Mix: type, orbitality and complexity of asset base
Number of assets (new / disposed assets)
Newer assets tending to be technologically more complex
- Age:** "Bath tub" effect
Average age of mix influenced by replacements / disposals
- Performance Standard:** What levels of performance e.g. OSMs required – influences frequency of interventions
- Sourcing Strategy:** Identifying the optimal mix for in house and third party activity

Heathrow Making every journey better

Risk Management

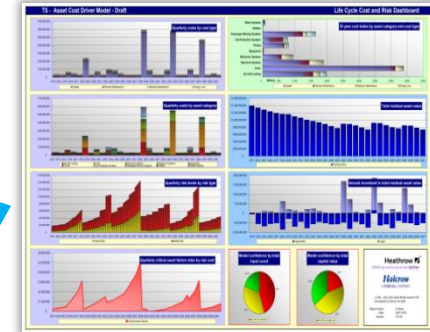


Engineering and Asset Management Strategy

Engineering Operations Strategy

Asset Performance	Asset Maintenance	Infrastructure Delivery	Whole Life Asset Management	System Management
<ul style="list-style-type: none"> Asset performance is a function of asset age, condition and complexity. Asset performance is a function of asset age, condition and complexity. Asset performance is a function of asset age, condition and complexity. 	<ul style="list-style-type: none"> Asset maintenance is a function of asset age, condition and complexity. Asset maintenance is a function of asset age, condition and complexity. Asset maintenance is a function of asset age, condition and complexity. 	<ul style="list-style-type: none"> Infrastructure delivery is a function of asset age, condition and complexity. Infrastructure delivery is a function of asset age, condition and complexity. Infrastructure delivery is a function of asset age, condition and complexity. 	<ul style="list-style-type: none"> Whole life asset management is a function of asset age, condition and complexity. Whole life asset management is a function of asset age, condition and complexity. Whole life asset management is a function of asset age, condition and complexity. 	<ul style="list-style-type: none"> System management is a function of asset age, condition and complexity. System management is a function of asset age, condition and complexity. System management is a function of asset age, condition and complexity.

Asset Cost Model



Q6 Solution Sheets



- Re worked Capital asset replacement plans and optimized primary maintenance cost drivers
- Strategic balancing of OPEX and CAPEX has delivered £4m benefit in 2011 and £7m+£2m in 2012

Total Savings for the first 2 years: **£13M**

Atlanta Facilities Management



CH2M HILL's 88-person team operates and maintains infrastructure critical to airport operations including boiler and chiller plants, HVAC systems, power distribution/lighting systems, plane de-icing controls, life-safety equipment, plumbing systems, and buildings.

Atlanta Airlines Terminal Corporation

Date: 20 July 2013

To whom it may concern:

Dear Sirs

We are pleased to provide a reference for CH2M HILL, Inc. for the following project.

Contract title: Atlanta Hartsfield Airlines Terminal Corporation Facilities/Asset Management O&M

Details of scope of works undertaken by CH2M HILL: CH2M HILL was awarded a multi-million-dollar, multi-year contract to provide facilities Operations & Maintenance services for the Hartsfield-Jackson Atlanta International Airport. CH2M HILL's scope includes the airport's 5.6 million-square-foot Central Passenger Terminal Complex, which comprises the landside Terminal Building, Concourses (T, A, B, C, D, E), mechanical plants (Terminal Plant, E Concourse chiller and boiler rooms), train tunnels and passenger mall, Delta GSE, and all related building systems.

In May 2012, CH2M HILL also began to provide Operations & Maintenance services for the new 1.2 million-square-foot Maynard Holbrook Jackson International Terminal.

Dates of performance: 2010 –2015

Proportion of services subcontracted to others: 0%

Project Manager for CH2M HILL: Jay Morvay, PE

Performance of CH2M HILL, Inc: we are pleased to confirm that CH2M HILL continues to proactively execute the services in accordance with the terms of reference and contract requirements.

Sincerely,



Kirk Hale, Manager of Maintenance

Atlanta Airlines Terminal Corporation (AATC)



ENR Ranks **#1**
CH2MHILL
 in Program Management
 since 2004

RANK		TRANSPORTATION
2014	2013	Top 10 Revenue: \$5,753.7 Mil. Sector's Revenue: \$12,232.8 Mil.
1	1	AECOM TECHNOLOGY CORP.
2	2	DAR AL-HANDASAH CONSULTANTS
3	5	CH2M HILL
4	4	EGIS
5	6	MOTT MACDONALD
6	**	JACOBS
7	8	ATKINS
8	3	PARSONS BRINCKERHOFF
9	7	ARUP GROUP LTD.
10	9	URS CORP.