

TRUCKEE TAHOE AIRPORT

2020 Pavement Maintenance/ Management Plan

Presentation for the
Truckee Tahoe Airport District

July 28, 2021



BRANDLEY
ENGINEERING

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TRUCKEE TAHOE AIRPORT

Pavement Maintenance / Management Plan

Why is this Study Necessary?

- Required by FAA for Funding of Upcoming Pavement Projects (AIP Typically Funds 90% of Projects).
- Provides Real Data and Forecast Pavement Failure Dates.
- Provides a Comprehensive Plan to Maintain All Airfield Pavements in a Safe Condition (20 Year Plan)
- Provides Basis to Develop the 5-year FAA Airport Capital Improvement Plan (ACIP)
- Assists with Airport Budget Development

TRUCKEE TAHOE AIRPORT

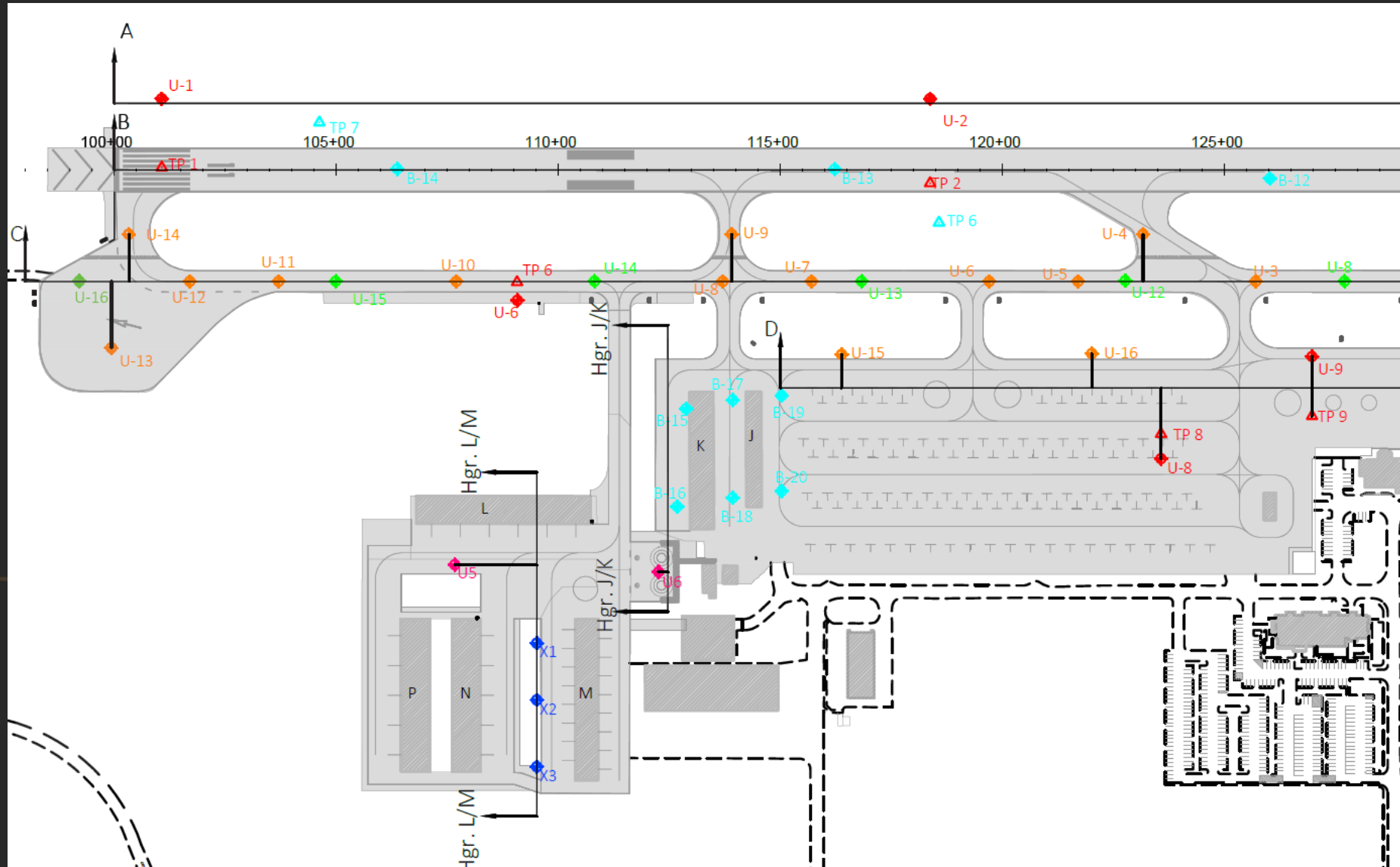
Pavement Maintenance / Management Plan

Key Components to Develop a PMMP

- ➔ Data Collection
 - ➔ Existing Soils Data and Pavement Section Thicknesses
 - ➔ Pavement Visual Surveys
 - ➔ FWD Testing (Non-Destructive Pavement Testing)
 - ➔ Aircraft Traffic Forecasts
- ➔ Data Analysis and Pavement Remaining Life Calculations
- ➔ Surface and Deep-Seated Distress Pavement Rehabilitation Recommendations
- ➔ Recommendations for Pavement Rehabilitation and Reconstruction Schedules
- ➔ Estimated Construction Cost Estimates (Construction Only, Engineering Design & Oversight +30%)

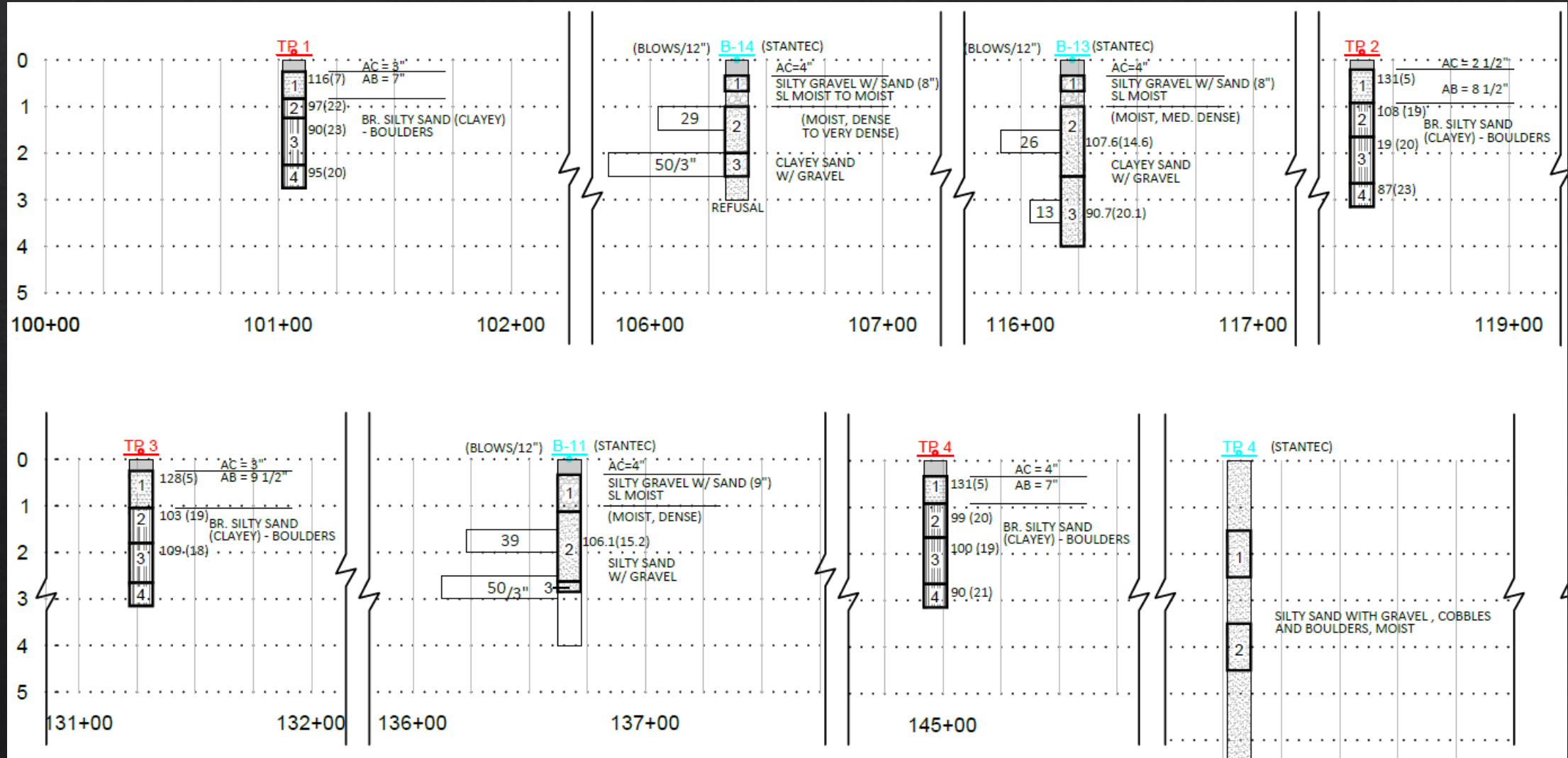
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Soil Boring Location Map



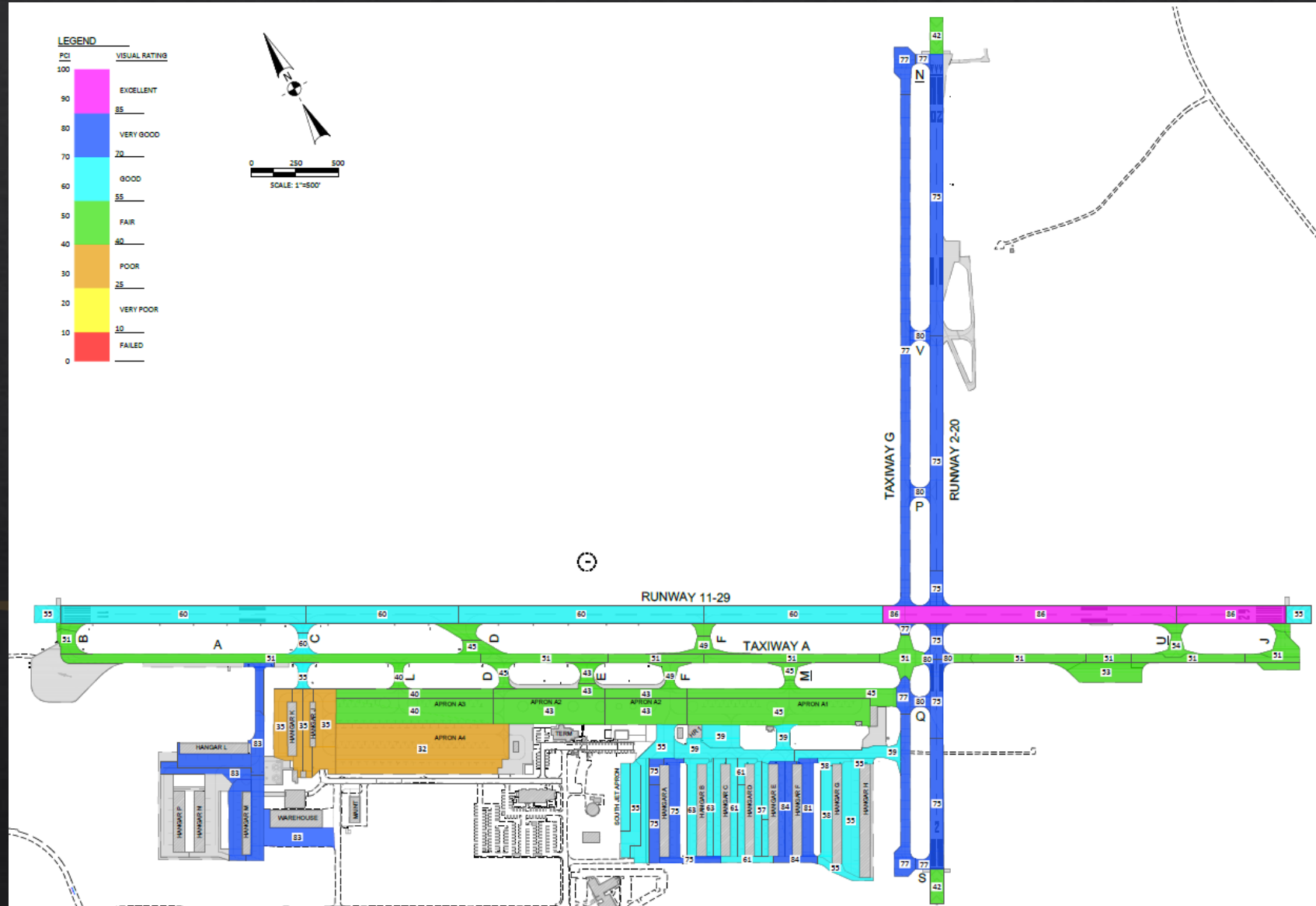
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Typical Soil Boring Profiles



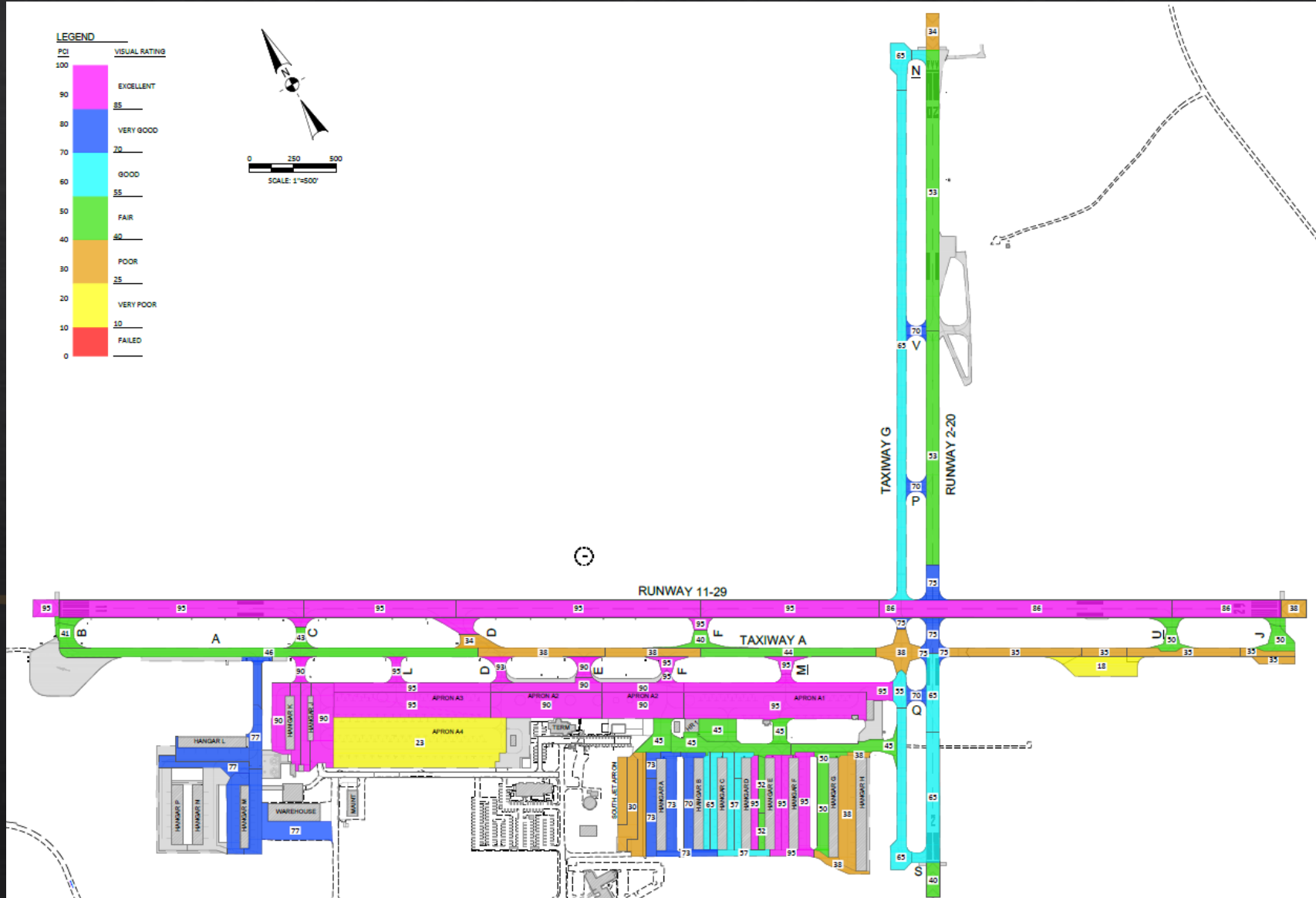
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2011 PCI



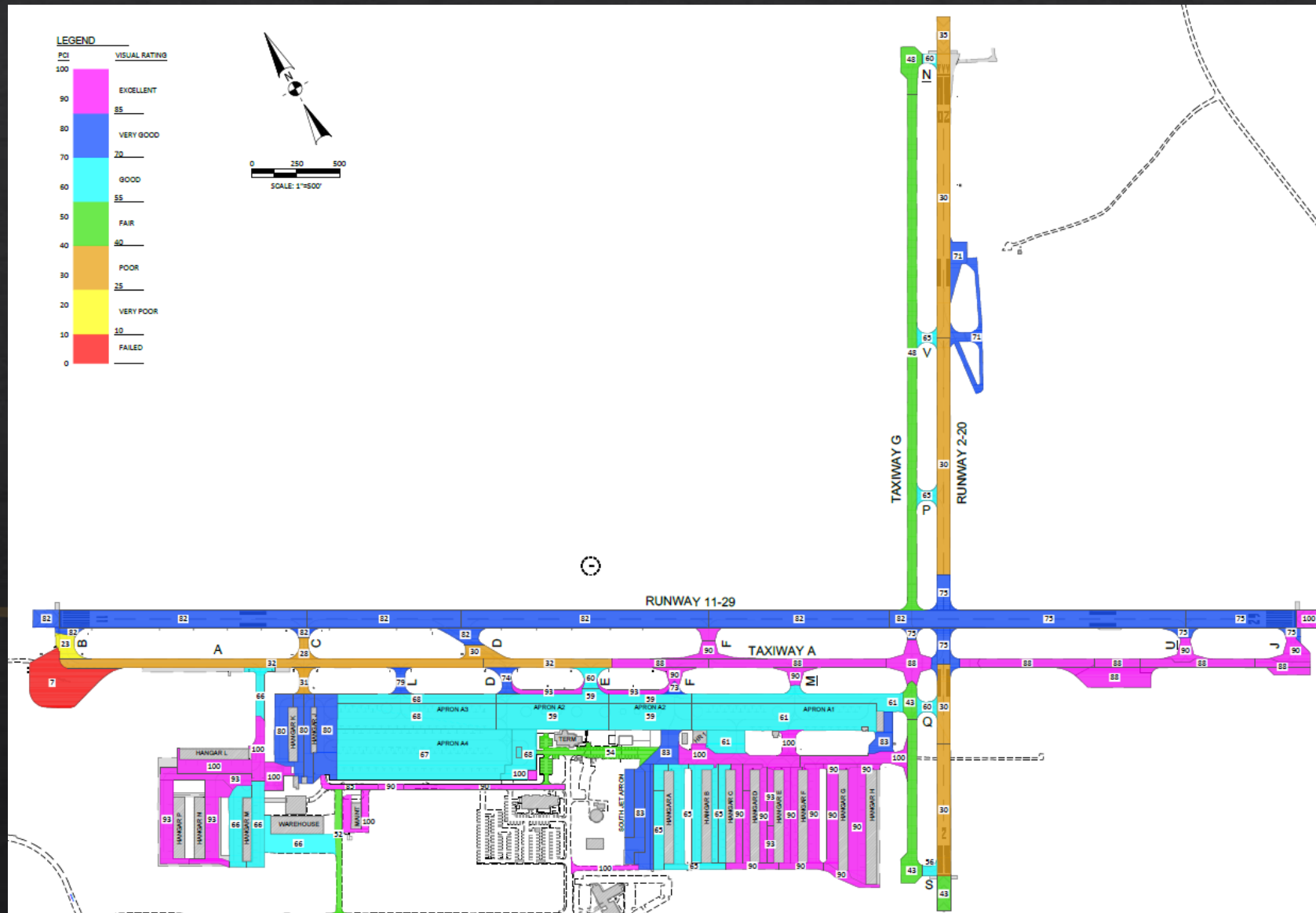
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2014 PCI



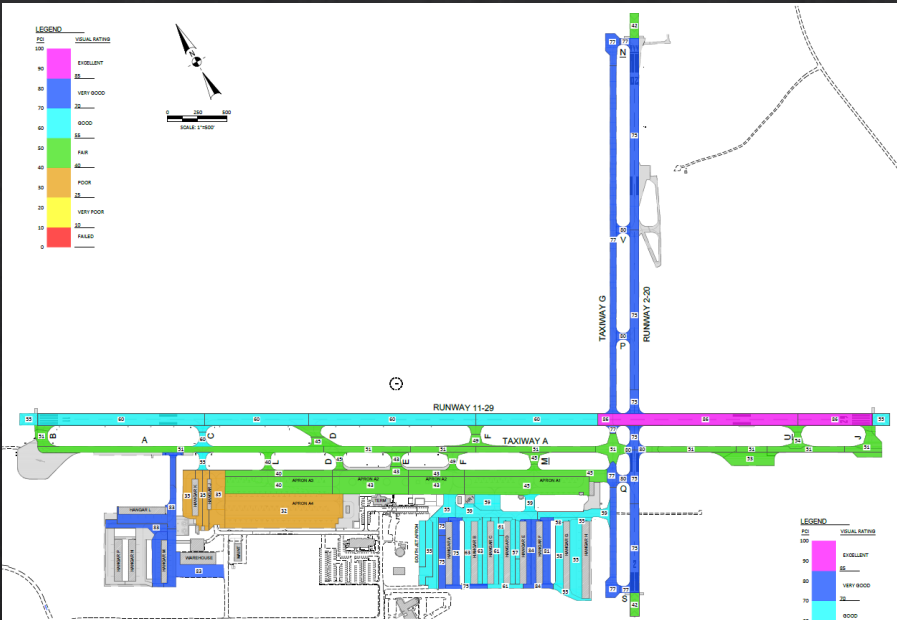
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2020 PCI



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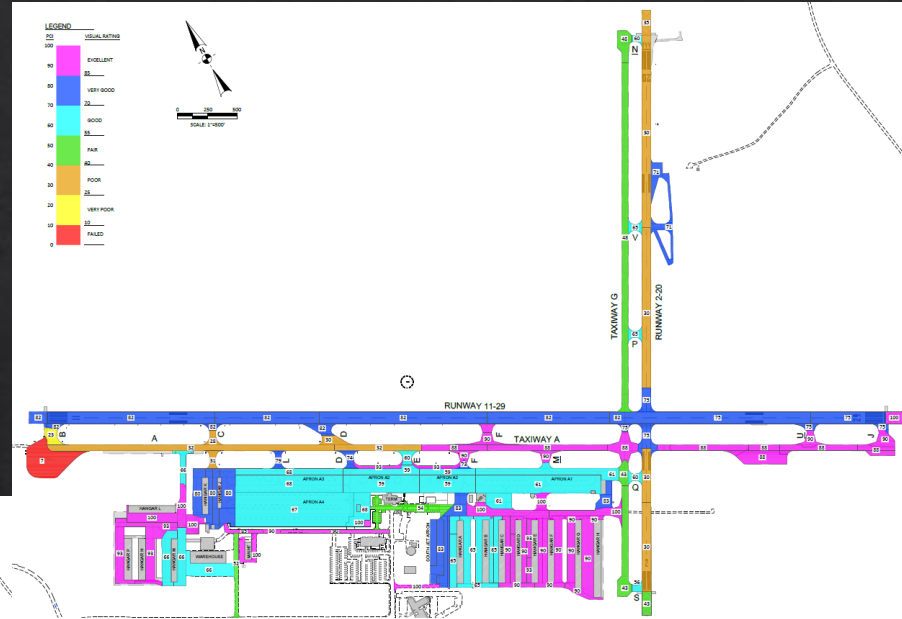
PCI Comparison – 2011, 2014, 2020



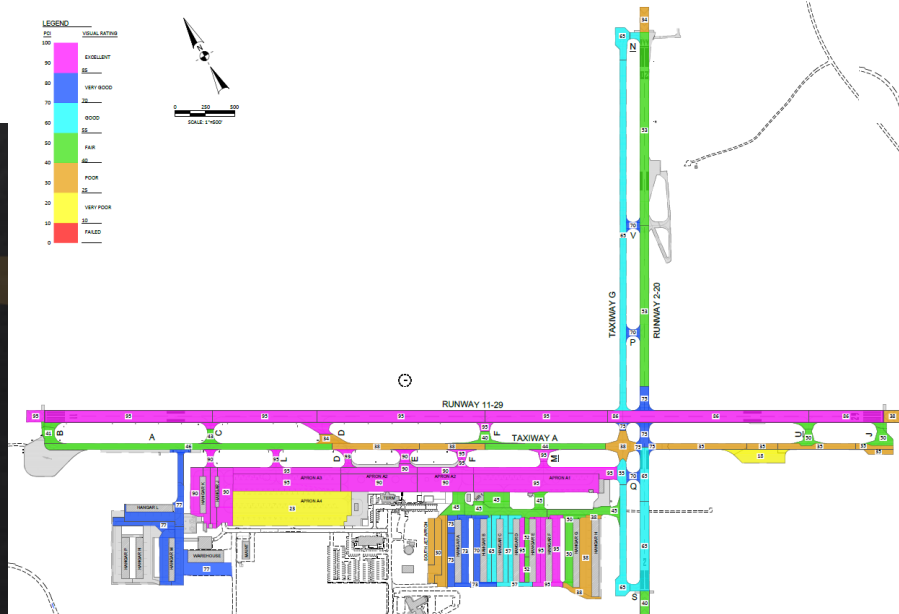
2011 PCI



2014 PCI

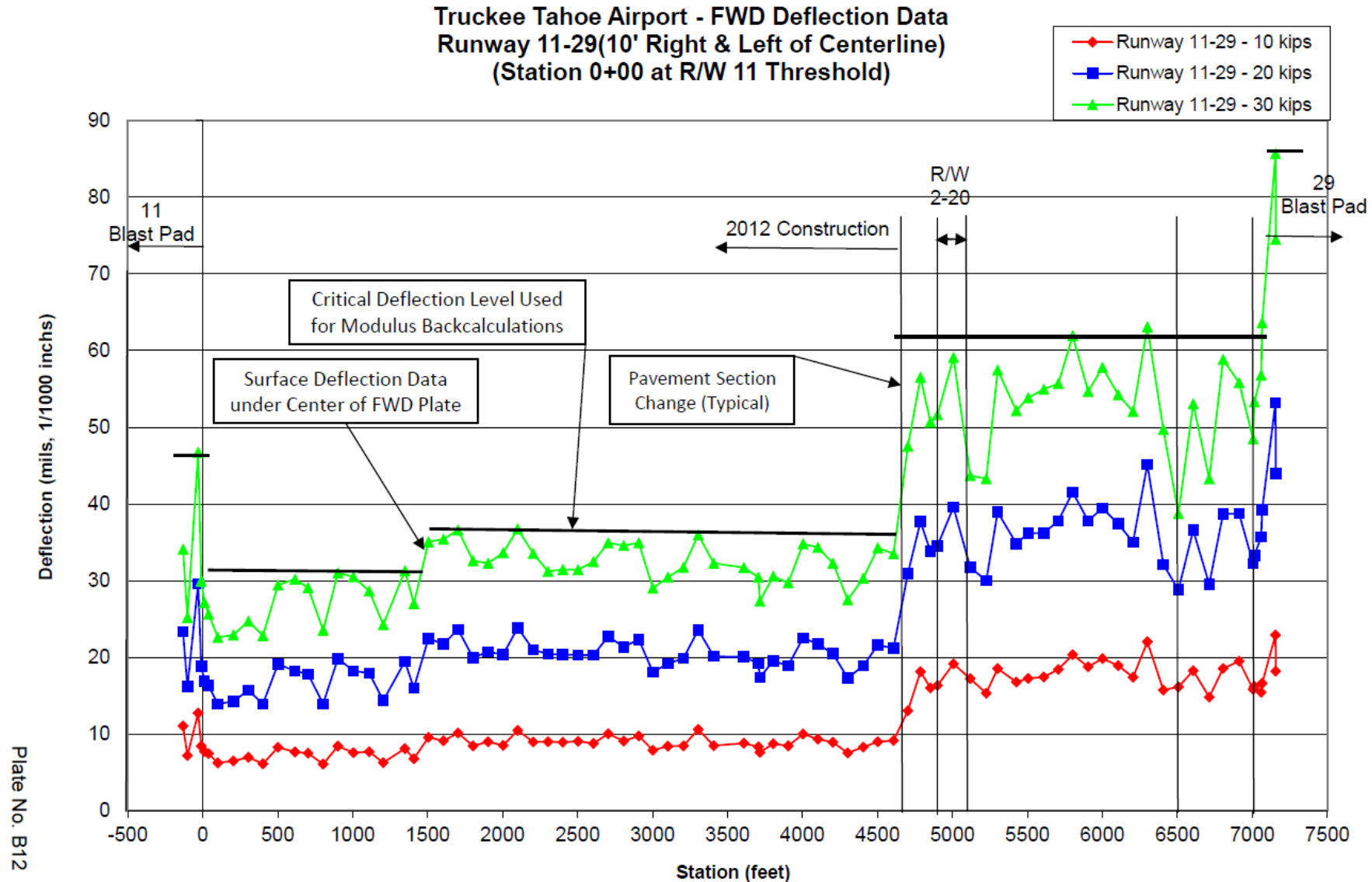


2020 PCI



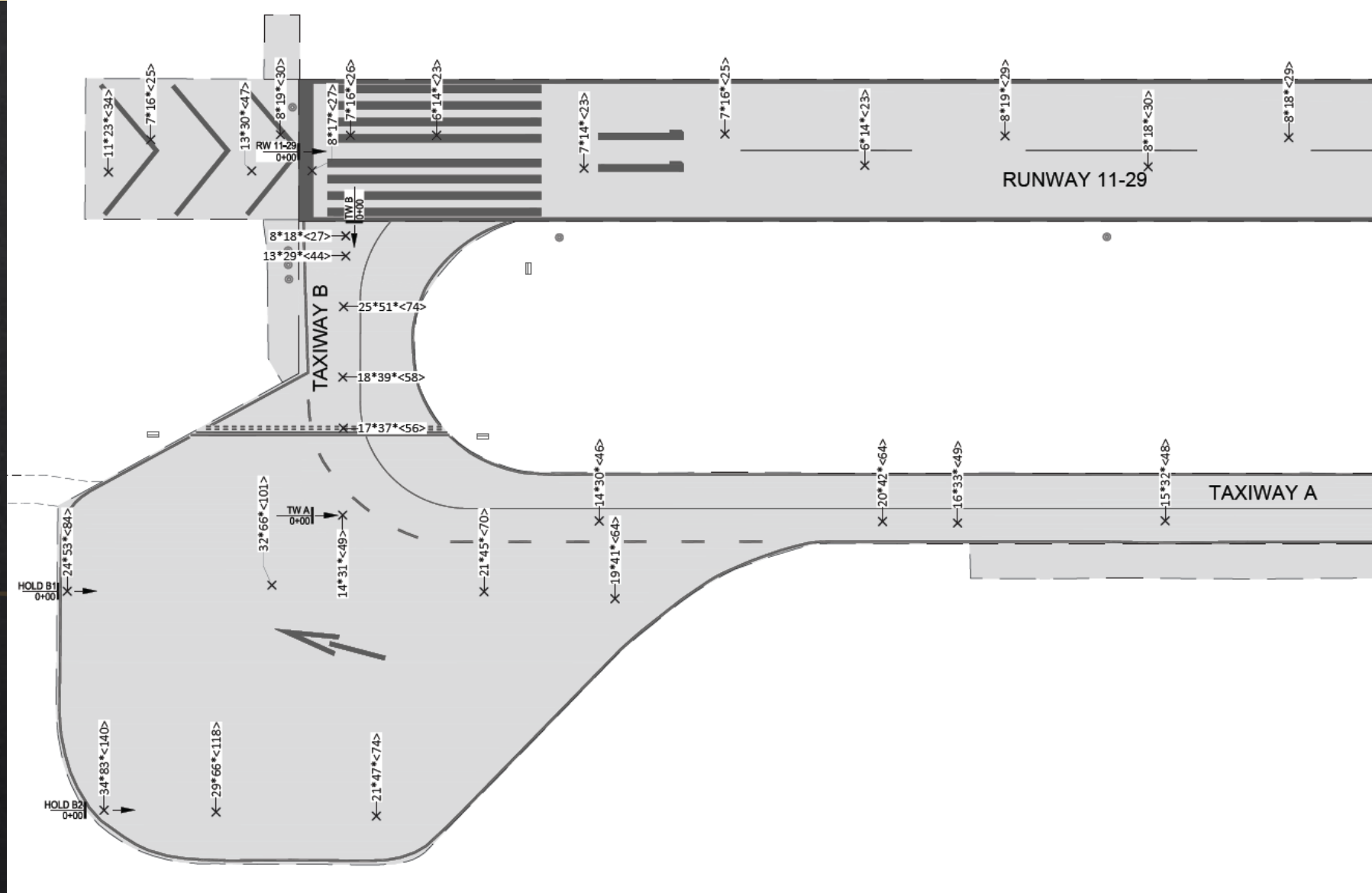
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FWD Data – Center Deflection Graphs



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FWD Data Plan View



TRUCKEE TAHOE AIRPORT (PMMP)

Aircraft Traffic Index Summary

TABLE No. D1 - Traffic Index Summary - Truckee Tahoe Airport

Aircraft Group	Typical Aircraft Type	Aircraft Max Loading (lbs)	Gear Configuration	Traffic Index (Forecast Annual Aircraft Operations in 2019)																
				2019 Annual Operations	Annual Growth Rate	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	
1	Piston	5,500	Single	21,000	1%	15,750	7,875	18,900	3,938	3,938	6,300	3,150	3,150	1,575	2,000	2,000	6,000	10,000	2,000	
2	Turboprop	12,000	Single	7,900	3%	5,925	2,963	7,110	1,482	1,481	2,370	1,185	1,185	593	3,000	3,000	3,000	1,000	5,000	
3	Jet	15,000	Single	440	6%	400	200	440	100	80	40	20	20	10	44	264	44	-	88	
4	Jet	18,000	Single	480	6%	437	218	480	109	87	43	22	22	11	48	288	48	-	96	
5	Jet	21,000	Dual	870	6%	792	396	870	198	158	78	39	39	20	87	522	87	-	174	
6	Jet	24,000	Dual	600	3%	546	273	600	137	109	54	27	27	14	60	360	60	-	120	
7	Jet	36,000	Dual	650	3%	592	296	650	148	118	59	29	29	15	65	390	65	-	130	
8**	Jet	48,000	Dual	750	3%	683	341	750	171	137	68	34	34	17	75	450	75	-	150	
9**	Jet	72,000	Dual	120	6%	120	60	120	30	-	-	-	-	-	10	108	10	-	-	
10**	Jet	84,000	Dual	120	6%	120	60	120	30	-	-	-	-	-	10	108	10	-	-	
11**	Jet	96,000	Dual	100	6%	100	50	100	25	-	-	-	-	-	5	90	5	-	-	
12	Plow Trucks	40,000	Single	-	0%	200	200	200	200	200	200	200	200	200	200	200	200	50	120	
13	Snow Blowers	50,000	Single	-	0%	120	120	120	120	120	120	120	120	120	60	60	60	20	40	
14	Automobile	4,000	Single	-	2%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
15	Delivery Trucks	38,000	Dual Axle	-	2%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

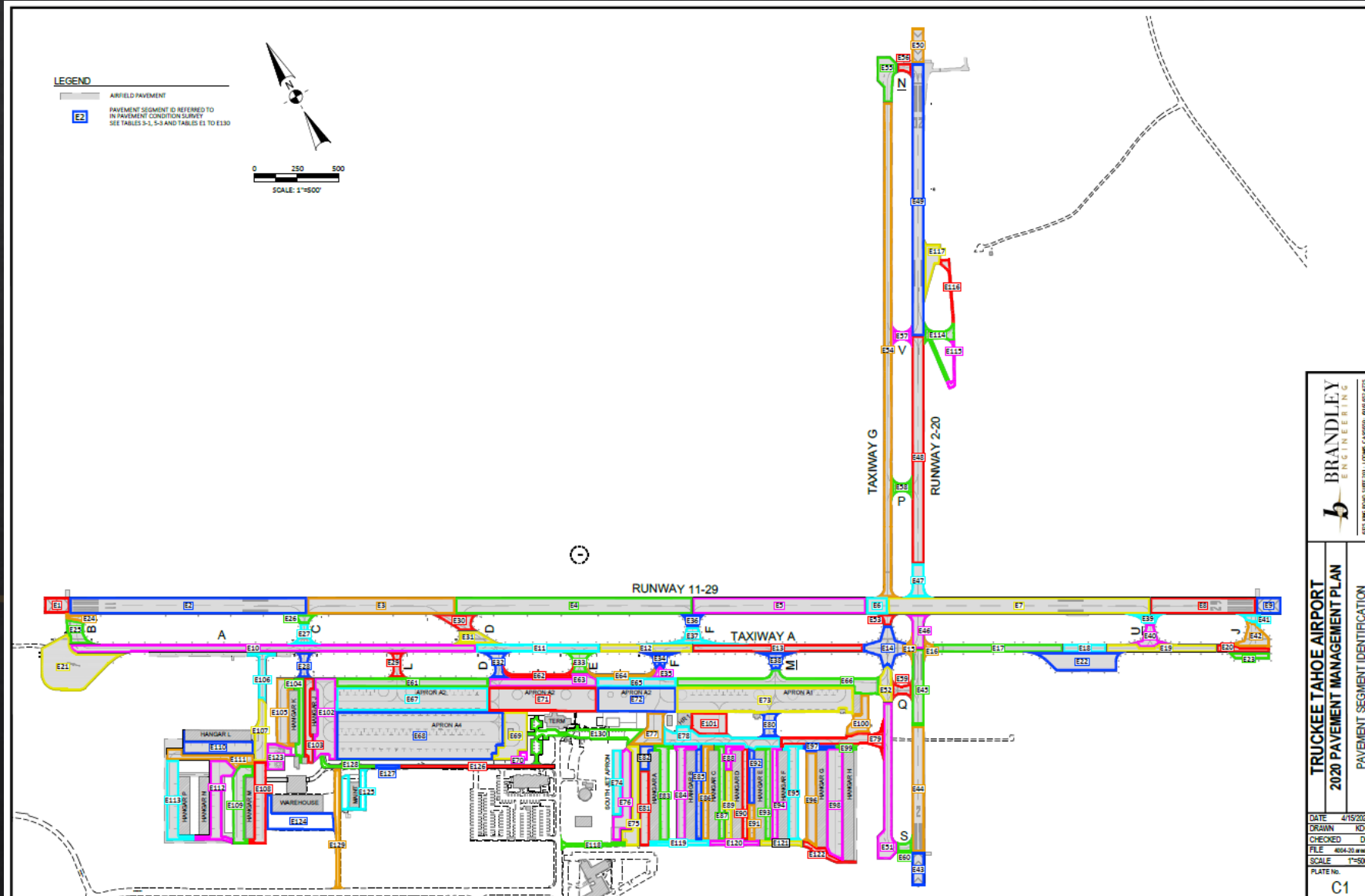
** - Denotes an Aircraft Group that has operations doubled in the "Enhanced Traffic" analysis.

				Traffic Index (Forecast Annual Aircraft Operations in 2019)																
Aircraft Group	Typical Aircraft Type	Aircraft Max Loading (lbs)	Gear Configuration	2019 Annual Operations	Annual Growth Rate	T15	T16	T17	T18	T19	T20	T21	T22	T23	T24	T25	T26	T27	T28	
1	Piston	5,500	Single	21,000	1%	9,000	10,000	1,000	500	500	500	1,500	3,000	-	-	-	-	-	-	
2	Turboprop	12,000	Single	7,900	3%	5,000	5,000	-	750	500	500	500	-	-	-	-	-	-	-	
3	Jet	15,000	Single	440	6%	-	320	-	20	50	50	100	-	-	-	-	-	-	-	
4	Jet	18,000	Single	480	6%	-	360	-	20	20	20	20	-	-	-	-	-	-	-	
5	Jet	21,000	Dual	870	6%	-	750	-	-	300	100	300	-	-	-	-	-	-	-	
6	Jet	24,000	Dual	600	3%	-	550	-	-	-	-	-	-	-	-	-	-	-	-	
7	Jet	36,000	Dual	650	3%	-	200	-	-	-	-	-	-	-	-	-	-	-	-	
8**	Jet	48,000	Dual	750	3%	-	200	-	-	-	-	-	-	-	-	-	-	-	-	
9**	Jet	72,000	Dual	120	6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10**	Jet	84,000	Dual	120	6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11**	Jet	96,000	Dual	100	6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12	Plow Trucks	40,000	Single	-	0%	80	200	120	120	120	120	120	-	400	80	80	80	80	200	
13	Snow Blowers	50,000	Single	-	0%	20	120	-	-	5	-	5	-	240	20	20	20	20	120	
14	Automobile	4,000	Single	-	2%	-	-	-	-	-	-	-	-	-	110,000	10,000	100,000	18,000	-	
15	Delivery Trucks	38,000	Dual Axle	-	2%	-	-	-	-	-	-	-	-	-	-	4,000	2,000	-	-	

** - Denotes an Aircraft Group that has operations doubled in the "Enhanced Traffic" analysis.

TRUCKEE TAHOE AIRPORT (PMMP)

Pavement Segment ID Map



TRUCKEE TAHOE AIRPORT

Pavement Maintenance / Management Plan

BRANDLEY PAVEMENT EXPERTISE

Pavement Maintenance Management Plans

- Evaluates Both Surface Distress and Deep-Seated Distress
- PCI Analysis of Surface Distress
- FWD Testing (Pavement Strength Testing)
- Back Calculate Modulus of Elasticity of Each Pavement Layer
- Traffic Analysis & Apply Traffic to Existing Pavement Sections with Back Calculated Moduli
- Determination of Remaining Life Using Brandley Fatigue Analysis (also Check FAARFIELD)
- Recommended Rehabilitation Schedules

Brandley Fatigue Analysis

- Developed By Reinard W. Brandley as Doctoral Thesis at Harvard University Under Dr. Karl Terzaghi and Dr. Arthur Casagrande
- Utilizes Layered Elastic Theory Under Applied Aircraft Loads
- 68 Year Successful Performance Record with 90-95% Accuracy
- Proven More Accurate than FAA's FAARFIELD Program

TRUCKEE TAHOE AIRPORT (PMMP)

Remaining Life Analysis

BRANDLEY vs. FAARFIELD

HISTORICAL COMPARISON

Airport	Facility	Forecast Remaining Life (Years) (Deep-Seated Distress Only)		Actual Life*
		BRANDLEY	FAARFIELD	
Sacramento International Airport	Runway 16L-34R	5	0.25	5.1
Stockton Metropolitan Airport	Runway 11-29	6 to 8	22	7
Nashville International Airport	Existing Apron Taxiway	3	0.1	3
Truckee-Tahoe Airport	Runway 11-29 (East)	16	1	10+**

*Number of years to actual failure.

**This section of the runway performed under forecast loading for 8 to 10 years with no sign of deep-seated distress. According to FAARFIELD it should have had structural failure 7 to 9 years earlier. This 2020 study indicates this section is forecast for failure in 2029.

2020 KTRK PMMP DATA

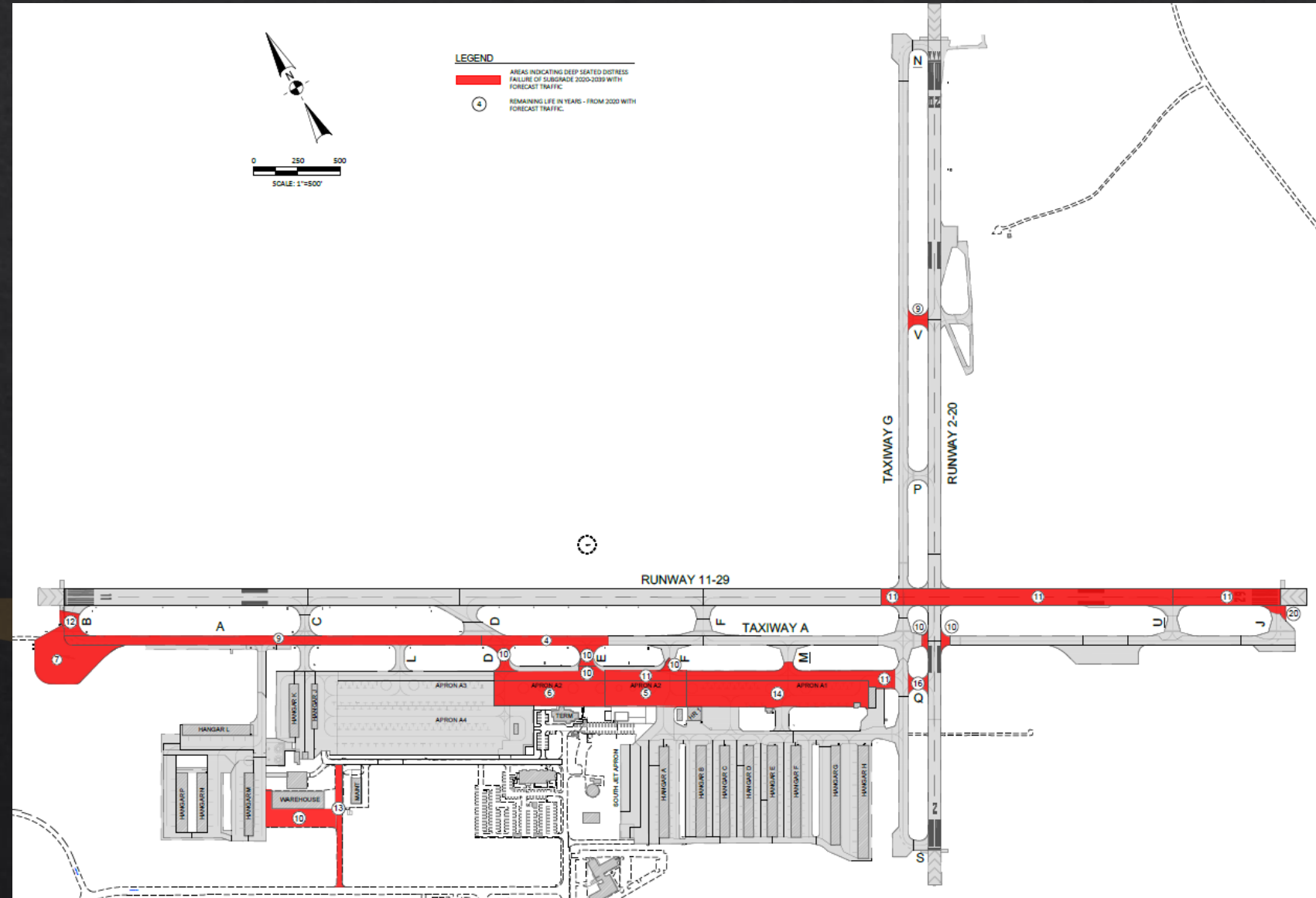
Pavement Element	Station	Forecast Remaining Life (Years) (Deep-Seated Distress Only)	
		BRANDLEY	FAARFIELD
Runway 11-29 (west)	23+00 to 37+00	57	2,490
Runway 11-29 (east)	48+75 to 64+25	11	4
Taxiway A	0+00 to 24+00	9	3
Runway 2-20	17+00 to 30+50	36	150
Taxiway G	9+00 to 11+00	45	101
Apron A1	See Plate 5-1 & 5-2	14	0.5
Apron A2 (west)	See Plate 5-1 & 5-2	6	1.6
Hangar C (east)	See Plate 5-1 & 5-2	47	11
Warehouse	See Plate 5-1 & 5-2	10	2

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Pavement Remaining Life – Forecast Traffic

Remaining Life

- Forecast Traffic
- Predicted Failures in 20 years
- Brandley Fatigue Analysis

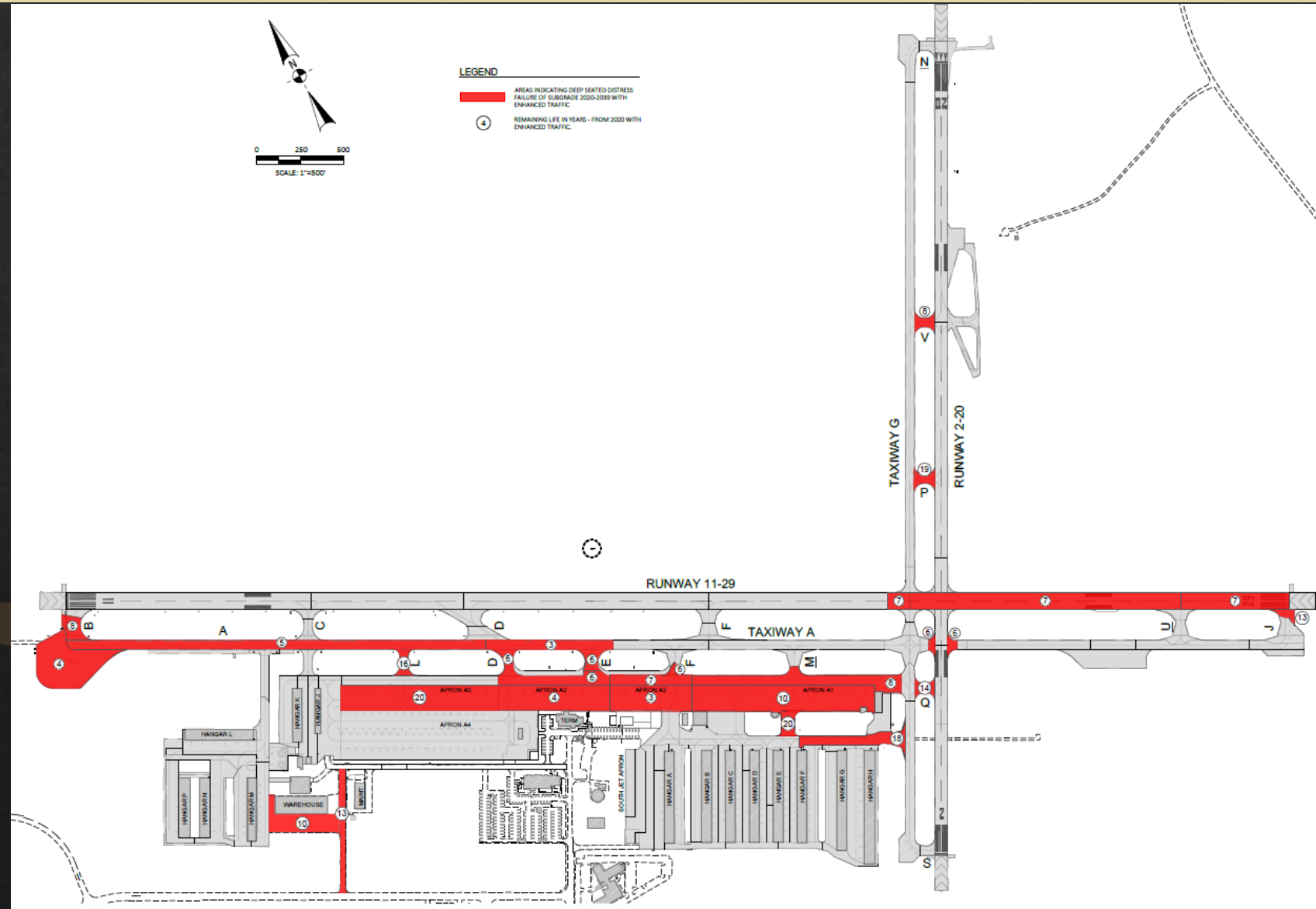


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Pavement Remaining Life – Enhanced Traffic

Remaining Life

- Enhanced Traffic (2 x 40k Jets)
- Predicted Failures in 20 years
- Brandley Fatigue Analysis



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Deep Seated Distress – Remaining Pavement Life

TABLE NO. 4-2
TRUCKEE TAHOE AIRPORT
REHABILITATION PLAN - DEEP-SEATED DISTRESS

Estimated Date of Rehabilitation	Element	Station	Remaining Life (Years) from 2020	Estimated Year of Failure	Recommended Rehabilitation	
					Code*	Description
2021	Taxiway A	0+00 to 24+00	9	2029	A1	Reconstruction
2021	Taxiway A	24+00 to 31+25	4	2024	A1	Reconstruction
2021	Taxiway B Runup	See Plates 5-1 & 5-2	7	2027	A1	Reconstruction (with Taxiway A)
2021	Taxiway B	0+50 to 1+75	12	2032	A1	Reconstruction (with Taxiway A)
2023	Taxiway V	0+00 to 1+25	9	2029	A2	Reconstruction (with Runway 2-20)
2023	Taxiway Q	0+00 to 1+25	16	2036	A2	Reconstruction (with Runway 2-20)
2024	Apron A2	See Plates 5-1 & 5-2	6	2026	A3	Reconstruction
2024	Taxiways D(south), E, & F(south)	See Plates 5-1 & 5-2	10	2030	A3	Reconstruction (with Apron A2)
2024	Taxilane Q	12+50 to 25+50	10-11	2030-2031	A3	Reconstruction (with Apron A2)
2026	Runway 11-29 (East)	47+00 to 70+00	11	2031	A4	Reconstruction and Groove Runway
2026	Taxiway A	49+50 to 49+75 50+50 to 51+00	10	2030	A4	Reconstruction (with Runway 11-29 (East))
2026	Taxiway J	0+00 to 0+50	20	2040	A4	Reconstruction (with Runway 11-29 (East))
2029	Apron A1	See Plates 5-1 & 5-2	14	2034	A3	Reconstruction
2029	Warehouse	See Plates 5-1 & 5-2	10	2030	A5	Reconstruction
2032	Aviation Way	See Plates 5-1 & 5-2	13	2033	A5	Reconstruction
2038	Taxiway L	0+25 to 1+75	21	2041	A3	Reconstruction (with Apron A3)

* - See Table 4-1 or 4-3 for Rehabilitation Code details.

NOTE: Rehabilitation of pavement sections should be scheduled a minimum of 2 to 3 years before estimated date of failure.

TRUCKEE TAHOE AIRPORT (PMMP)

Pavement Section Summary Data Sheets

TABLE No. E7 - PAVEMENT DATA AND REHABILITATION SCHEDULE						
Airport:	Truckee Tahoe Airport				Date of Survey:	October 17-19, 2019 & May 2020
Element:	Runway 11-29					
Station:	48+75 to 64+25					
Dimensions:	1,550' x 100'					
Layer		Thickness (inches)	E (ksi)	μ	K (pci)	Remarks
Existing Pavement Section:	PCC	-	-	-	-	
	AC	4	300	0.35	-	
	CTB	-	-	-	-	
	AB	8	60	0.35	-	
	ASB	-	-	-	-	
	n/a	-	-	-	-	
	n/a	-	-	-	-	
	Subgrade	48	12	0.35	-	
Subsoil	Semi-Infinite	20	0.35	-		
Construction Record:		Date	Type			
		1963	Original Construction			
		1986, 2008	Reconstruction			

Pavement Condition Survey Data:			
Surface Condition:	Weathering: Light	Ravelling: None	Rutting: None
AC Pavement, Grooved, Joints @ 12.5' spacing. Older joints 3/4" wide, up to 1.5" wide. New joints 1/2" wide. Band-aid sealant in tact. Sealant depressed in older joints. Few very fine cracks on corners.			
PCI (2011) = 86		PCI (2013) = 86	PCI (2020) = 75
Visual Pavement Rating (PCI 2020) = Very Good			PCN (2020) = 10 F/C/Y/T
Pavement Remaining Life Analysis		Brandley - Fatigue Analysis	
Traffic Index Used		T1	
FWD Critical Center Plate Deflection (Range) - 30 K Load		62 (38-63)	
Pavement Layer Analyzed (Forecast/Enhanced Traffic)		Subgrade (Forecast Traffic)	Subgrade (Enhanced Traffic)
Pavement Structure Layer Remaining Life - Years		11	7
Recommended Pavement Rehabilitation Schedule:			
Time Period	Rehab. Code	Date and Description	
2021-2025		None Scheduled	
2026-2030	A4	2026 - Reconstruction, Groove	
2031-2035		None Scheduled	
2036-2040	F, G1	2040 - New Joints, Seal Coat	
Remarks: See Plates B1 thru B11 for FWD test data and locations. FWD deflection used is the critical value for section - See FWD Graphs, Plates B12 thru B94. See Plates E1 & E2 for Location and Station of this Section. For Traffic Index see Table D1. Enhanced Traffic doubles the operations of jets that are 48,000 lb or heavier.			

TRUCKEE TAHOE AIRPORT (PMMP)

Pavement Rehabilitation Schedules



Rehab Schedules

- ➔ Graphical Depiction by Year
- ➔ Individual Project Costs
- ➔ Type of Rehabilitation

TRUCKEE TAHOE AIRPORT (PMMP)

Summary of Pavement Section Changes

Table 5-1
Summary of Pavement Section Changes from 2011 to 2020
Truckee Tahoe Airport

Pavement Segment ID (2020) (See Plate 5-1)	Element	Station (2020) (See Plate 5-2)	Pavement Surface Data (PCI)			Modulus of Elasticity (E) - ksi				Remaining Pavement Life - Years from 2020		Comments
			2011 PCI	2013 PCI	2020 PCI	2011 AC / AB	2020 AC / AB	2011 Subgrade/ Subsoil	2020 Subgrade/ Subsoil	Fatigue Analysis (Brandlev)	Fatigue Analysis (Brandlev)	
										2011 Remaining Life / Anticipated Date of Failure- Subgrade (Forecast Traffic)	2020 Remaining Life / Anticipated Date of Failure- Subgrade (Forecast Traffic)	
E7	Runway 11-29	48+75 to 64+25	86	86	75	250 / 40	300 / 60	10 / 25	12 / 20	18 years, Failure in 2029	11 years, Failure in 2031	Significant Jet Traffic Increase, Subsoil Strength Decrease
E11	Taxiway A	24+00 to 31+25	51	38	32	250 / 30	250 / 65	15 / 25	15 / 30	20+ years, Failure in 2031+	4 years, Failure in 2024	Significant Jet Traffic Increase
E21	Taxiway B Runup	Runup Apron	-	22	7	n/a	150 / 25	n/a	12 / 25	n/a	7 years, Failure in 2027	Significant Jet Traffic Increase
E25	Taxiway B	0+50 to 1+75	51	41	23	250 / 30	350 / 50	15 / 30	18 / 30	20+ years, Failure in 2031+	12 years, Failure in 2032	Significant Jet Traffic Increase
E32	Taxiway D (south)	0+25 to 1+75	45	93	74	350 / 80	350 / 70	15 / 25	20 / 25	20+ years, Failure in 2031+	10 years, Failure in 2030	Significant Jet Traffic Increase
E33	Taxiway E	0+25 to 1+50	43	90	60	350 / 80	350 / 80	15 / 25	20 / 25	20+ years, Failure in 2031+	10 years, Failure in 2030	Significant Jet Traffic Increase
E44	Runway 2-20	0+00 to 7+50	75	65	30	250 / 40	150 / 30	12 / 25	12 / 20	20+ years, Failure in 2031+	20+ years, Failure in 2040+	Increase in Traffic, AB & AC Strength Decrease
E49	Runway 2-20	30+50 to 46+54	75	53	30	350 / 70	250 / 50	11/25	12 / 20	20+ years, Failure in 2031+	20+ years, Failure in 2040+	Increase in Traffic, AB & AC Strength Decrease
E52	Taxiway G	9+00 to 11+00	77	55	43	250 / 40	150 / 30	12 / 25	12 / 20	20+ years, Failure in 2031+	20+ years, Failure in 2040+	Increase in Traffic, AB & AC Strength Decrease
E57	Taxiway V	0+00 to 1+25	80	70	65	100 / 20	200 / 30	7 / 25	10 / 20	21 years, Failure in 2032	9 years, Failure in 2029	Traffic Increase, Subsoil Strength Decrease
E72	Apron A2	Apron A2 (east)	43	90	59	250 / 70	200 / 40	20 / 25	10 / 20	16 years, Failure in 2027	5 years, Failure in 2025	Significant Jet Traffic Increase, AC, AB, Subsoil Strength Decrease
E73	Apron A1	Apron A1	45	95	61	250 / 70	150 / 30	20 / 25	15 / 30	11 years, Failure in 2022	14 years, Failure in 2034	2011 PMMP assumed too much Jet Traffic, AC, AB, Subsoil Strength Decrease
E83	Hangar A (east)	All	75	73	65	250 / 20	200 / 40	10 / 25	8 / 20	20+ years, Failure in 2031+	20+ years, Failure in 2040+	AC, AB, Subsoil Strength Decrease
E87	Hangar C (east)	All	61	57	90	250 / 70	150 / 30	20 / 25	10 / 20	20+ years, Failure in 2031+	20+ years, Failure in 2040+	AC, AB, Subsoil Strength Decrease

TRUCKEE TAHOE AIRPORT

Pavement Maintenance / Management Plan

Summary of Findings

- ➔ Pavements are in good condition, Previous PMMP has been followed very well
- ➔ Full Reconstructions vs. Surface Rehabilitations
- ➔ 20 Year Rehabilitation Plan – Approximately \$41,000,000 of Pavement Construction Costs
- ➔ Recommended Pavement Rehabilitation and Maintenance for All Pavement Sections
- ➔ Significant Recommended Projects and Timeline
 - ➔ 2023 Reconstruct Runway 2-20
 - ➔ 2024 Terminal Apron A2 Reconstruction
 - ➔ 2026 Reconstruct Runway 11-29 (East) Including Runway Intersection
 - ➔ 2027 Mill and Fill Runway 11-29 (West)
 - ➔ 2029 Reconstruct Apron A1 (East of Terminal Apron)
 - ➔ 2038 Reconstruct Apron A3 (West of Terminal Apron)

Questions?



Damon Brandley



You Hire Brandley,
You Get Brandley



Melissa Brandley