

**KAHO LWM POSITION UNCERTAINTY FOR EACH YEAR OF PHOTO COVERAGE**

Calculations of uncertainties for imagery of Kaloko - Honokohau National Historical Park.

These 'accuracy' estimates use approximate numbers due to the processing techniques and unique character of the study site. All numbers reported here are estimates based on aerial coverage.

Measurement Error **Em** = square root of  $[(Er)^2 + (Ed)^2 + (Ep)^2 + (Ets)^2]$

Enter a "0" below for blocks where data doesn't exist.

Obtain **Er** (rectification error) values from next worksheet, "RectifyUncert."

**Ed**, digitizing error, values come from table on page 2 of Word file, "Calculating Erosion Rate Uncertainty." If the T-sheet isn't listed

**Ep** = the pixel size for a mosaic, usually 0.5 m.

**Ets** = 5 m = error associated with plotting on the t-sheet, inc. position of planetable (3 m), posit of plotted points (1 m) and field interpretation of MHWL (4 m), from Shalowitz, 1964. Ets applies to T-sheets only and is the root sum of squares of above terms.

year	Er, Rectification Error	Ed	Ep, Pixel Size	Ets	Em	
1950		1.71	1.6794	1.67	0	2.921
1954		1.87	1.6794	1.00	0	2.705
1965		2.72	1.6794	1.00	0	3.349
1968		1.66	0.8403	0.55	0	1.940
1970		2.62	0.8403	0.68	0	2.834
1980		0.92	0.8403	0.60	0	1.383
1987		1.88	0.8403	0.25	0	2.074
1988		4.16	0.8403	0.40	0	4.261
1992		1.25	0.8403	0.80	0	1.705
2000		1.25	1.6794	1.25	0	2.438
2002		5.00	0.8403	0.40	0	5.086
2004		5.00	0.8403	0.60	0	5.105
2006		5.00	0.8403	0.60	0	5.105

Enter a "0" below for blocks where data doesn't exist.

Total Position Uncertainty, **Etp** = square root of  $[(Em)^2 + (Etd)^2 + (Es)^2 + (Ec)^2]$

**Em**, measurement error, is from table above.

**Etd**, tidal fluctuation of the toe position, was found to be 5 m for Honokohau Beach area, and applies to Photomosaic shorelines only,

**Es**, error from seasonal fluctuation of toe position, from the "SeasonalUncert" worksheet.

**Ec**, uncertainty from covering HWL to toe, applies to T-sheets only. Get from "Profile Data" worksheet.

year	Em	Etd	Es	Ec	Etp	Etp (ft)
1950	2.921	0	1.728	0.000	3.394	11.135
1954	2.705	5	1.728	0.000	5.942	19.494
1965	3.349	5	1.728	0.000	6.261	20.543
1968	1.940	5	1.728	0.000	5.635	18.487
1970	2.834	5	1.728	0.000	6.002	19.690
1980	1.383	5	1.728	0.000	5.468	17.940
1987	2.074	5	1.728	0.000	5.682	18.643
1988	4.261	5	1.728	1.000	6.866	22.525
1992	1.705	5	1.728	2.000	5.907	19.380

**Rectification Error from the geoprocessing procedure, Er**

Taken from text files generated from the georeferencing toolbox in ArcMap on received images from the USGS.

All processing uses 3rd order polynomials except 2002 which uses a 5 checkpoint database and 2004 and 2006

Satellite imagery which uses the published RMSE of 5 m (CE90) from the vendor

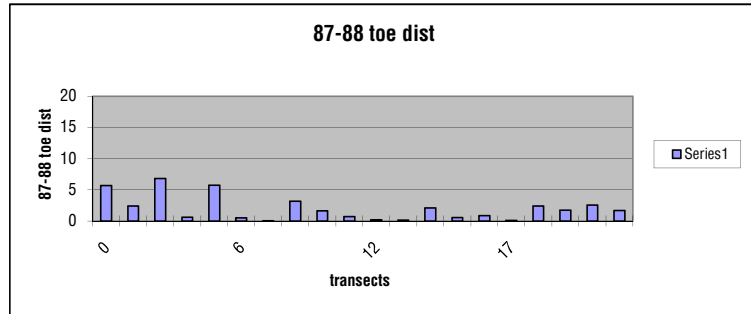
year	x rms (m)	y rms (m)	ttl rms(meter)		
1950	n/a	n/a	1.71	1988 imagery rms values	
1954	n/a	n/a	1.87	1988-i2	1.42
1965	n/a	n/a	2.72	1988-i3	1.28
1968	n/a	n/a	1.66	1988-i5	2.31
1970	n/a	n/a	2.62	1988-i6	1.43
1980	n/a	n/a	0.92	1988-i7	2.5
1987	n/a	n/a	1.88	RMS	4.15761951
1988	n/a	n/a	4.16		
1992	n/a	n/a	2.46	1992 imagery rms values	
2000	n/a	n/a	1.25	1992-2	1.26
2002	n/a	n/a	5.00	1992-35	2.11
2004	n/a	n/a	5.00	RMS	2.45758011
2006	n/a	n/a	5.00		

**Seasonal Fluctuation of Beach Step Crest, Es**

Replace the below data with that from the mosaic area in question. Check the seasonal uncertainty values against seasonal fluctuations from the profiles to make sure profile fluctuations aren't larger, but are similar (see "ProfileData" worksheet).

Transect no.	1987	1988	87-88 toe dist	absolute
0	16.2764	10.6039	5.6725	5.6725
1	37.2017	34.8271	2.3746	2.3746
2	48.8539	42.04	6.8139	6.8139
3	51.4549	50.8384	0.6165	0.6165
4	56.6955	50.9489	5.7466	5.7466
6	25.71	26.195	-0.485	0.485
7	25.4766	25.442	0.0346	0.0346
8	16.2865	13.1353	3.1512	3.1512
10	58.1499	56.5122	1.6377	1.6377
11	55.7693	56.4753	-0.706	0.706
12	54.9052	55.1142	-0.209	0.209
13	52.898	53.0453	-0.1473	0.1473
14	53.0279	55.1019	-2.074	2.074
15	59.4451	59.9741	-0.529	0.529
16	57.9895	58.8558	-0.8663	0.8663
17	56.2216	56.3241	-0.1025	0.1025
18	54.459	56.8531	-2.3941	2.3941
19	55.4671	57.1762	-1.7091	1.7091
20	54.1913	51.6363	2.555	2.555
21	51.6958	50.0008	1.695	1.695

--- end 1987 coverage ---



Overall 87-88 toe distance stats - for mosaic areas with a single uncertainty value for seasonal toe movement

Mean absolute value 87-88 toe dist = X =	1.975995
Std dev 87-88 toe dist =	2.00481026
x +2*std ( goes to matlab - seasonaluncert.m)	5.98561552

for a 1-sig uncertainty, the standard deviation of the difference between 1988 and 1987 is used.

using the mean absolute value plus 2\*standard deviation, we generated the uncertainty in matlab using seasonaluncert.m. We used synthetic data to calculate Es.

Es= 1.7282

int

**Beachwidth Calculation**

From "EroRateUncert.doc" document describing how to calculate beachwidth uncertainty (**Ev-t**). Beach width uncertainty is used in eigen beaches, px and pxt. These erosion hazard zone calculation methods work on individual beaches, not multiple beaches at once.

$$Ev-t = \sqrt{Etp^2 + Ev^2}$$

**Etp**, total positional uncertainty for the beach toe from the first worksheet of this book.

**Ev**, vegetation line position uncertainty (calculated below)

$$Ev = \sqrt{Em^2 + Evid^2}$$

**Em**, measurement error, is from table on the first worksteet of this book

**Evid**, uncertainty associated with identifying the vegetation line on photomosaics (estimated by John Rooney to be 2m)

Year	Em	Evid	Ev	Etp	Ev-t
2006	2.438316	2	3.15	6.552256	7.271688

For the Eigen beaches routine and px and pxt methods, only the most recent year beachwidth and uncertainty is needed.

Beachwidth = Vegetation position - LWM position

Year = 2006

Transect #	ToeDist	VegDist	Beachwidth(m)
0	19.2108	37.9296	18.72
1	36.5616	47.0481	10.49
2	47.6185	50.2085	2.59
3	54.7194	54.7194	0.00
4	55.4739	58.4757	3.00
6	37.1615	54.3819	17.22
7	36.1921	57.7404	21.55
8	28.8762	45.9112	17.04
10	49.8241	56.0435	6.22
11	50.7581	54.6778	3.92
12	48.6315	57.4045	8.77
13	53.1175	58.2779	5.16
14	55.5895	58.3824	2.79
15	65.9871	65.9871	0.00
16	62.7488	64.3278	1.58
17	59.6043	64.4694	4.87
18	54.9481	62.8404	7.89
19	58.8102	63.4624	4.65
20	56.6873	58.6235	1.94
21	50.7888	59.3154	8.53
22	47.3263	50.223	2.90
23	44.4921	55.6077	11.12
24	43.8937	50.6626	6.77
26	49.6264	56.2161	6.59
27	54.8477	62.6173	7.77
28	55.2941	67.0383	11.74
29	55.9242	71.3568	15.43
30	51.7562	69.1815	17.43
31	49.5091	64.5255	15.02
32	51.3319	63.1088	11.78
33	52.4471	64.6447	12.20
34	51.9309	63.1405	11.21

35	50.5337	65.0638	14.53
36	78.9585	90.7001	11.74
37	81.8576	104.338	22.48
38	85.1861	103.074	17.89
39	86.2534	102.075	15.82
40	85.4835	99.3672	13.88
41	83.1157	99.9032	16.79
43	96.823	108.493	11.67
44	93.7049	108.07	14.37
45	88.7639	103.329	14.57
46	82.7182	96.5564	13.84
47	77.7399	90.2527	12.51
48	77.8221	92.2391	14.42
49	78.8475	93.0827	14.24
50	82.4833	93.9395	11.46
51	84.8884	95.1544	10.27
52	83.9716	93.0909	9.12
53	79.709	89.8303	10.12
54	72.9882	81.9554	8.97
55	74.0792	74.9259	0.85
56	69.9145	80.1549	10.24
57	79.7131	79.7131	0.00
58	81.1829	81.1829	0.00
59	81.1575	81.1575	0.00
60	79.2923	79.2923	0.00
61	80.5978	80.5978	0.00
62	88.2682	88.2682	0.00
63	106.652	106.652	0.00
66	74.95	99.1893	24.24
67	88.2176	99.0361	10.82
68	92.8248	100.988	8.16
69	94.4647	94.4647	0.00
70	92.7826	93.929	1.15
71	91.1516	100.226	9.07
72	81.5274	100.953	19.43
73	79.7981	93.209	13.41
74	84.7643	104.853	20.09
75	94.3242	105.959	11.63
76	97.2994	106.563	9.26
77	108.632	127.492	18.86
78	107.29	127.474	20.18
79	120.557	131.397	10.84
80	118.657	130.06	11.40
81	119.08	125.1	6.02
82	112.867	127.032	14.17
83	118.125	125.004	6.88
84	112.605	126.087	13.48
85	113.816	126.374	12.56
86	109.662	109.662	0.00
87	97.5026	102.697	5.19
89	38.5427	46.4525	7.91
90	44.0374	64.7613	20.72
91	40.9792	60.9582	19.98
92	47.9155	55.1631	7.25
93	51.7086	56.0125	4.30
94	42.3049	57.4232	15.12
95	36.4817	39.3414	2.86

97	29.5394	39.6603	10.12
98	28.8075	43.2348	14.43
99	26.1902	41.8256	15.64
100	28.518	36.8149	8.30
101	19.793	34.5344	14.74
102	16.1682	30.0502	13.88
103	10.9113	27.8641	16.95
104	19.9898	30.9354	10.95
105	22.0586	25.4333	3.37
106	16.2228	26.6713	10.45
107	36.9928	41.3615	4.37
108	42.2505	46.7519	4.50
109	43.8949	47.0448	3.15
110	39.1479	40.0844	0.94
111	40.6034	40.6034	0.00
112	34.6305	34.6305	0.00
113	30.1172	35.039	4.92
114	38.8882	45.58	6.69
115	38.515	53.0918	14.58

**Boundary File denoting continuous homogenous sections of beach**

0	0
63	0
66	0
87	0
89	0
115	0





63	83.5849	93.8637	95.4395	94.7156	95.4219	88.6959	106.652	106.652	106.652	95.389	106.652
66	77.3649	74.4661	77.4475	75.626	77.8788	NaN	74.2973	71.6711	73.88	74.7097	74.95
67	86.6912	86.9821	81.726	88.4593	88.3166	NaN	88.4968	79.6509	88.6794	89.3899	88.2176
68	89.7036	91.5156	93.1291	91.1289	94.5817	NaN	91.2286	87.8131	92.6537	94.4425	92.8248
69	89.5616	93.9742	96.6281	91.9983	94.5159	NaN	93.1614	89.2012	88.4551	94.2176	94.4647
70	89.7691	92.9341	92.6466	89.9793	94.1367	NaN	92.3466	88.8179	93.8983	94.6077	92.7826
71	91.0399	92.4425	91.5993	93.9912	95.9503	NaN	90.4275	84.5895	93.8165	94.5745	91.1516
72	82.5632	83.8485	86.7547	82.7974	87.5808	NaN	80.8334	77.6916	80.7289	82.4645	81.5274
73	86.3271	81.8325	84.8922	84.2986	82.9528	NaN	82.6288	79.8397	82.8798	80.9311	79.7981
74	86.1402	81.986	86.9854	82.4769	84.148	NaN	84.4485	77.6782	85.8865	85.2382	84.7643
75	89.0534	86.7105	90.7467	90.2948	76.9883	NaN	90.0849	89.7142	93.7447	93.1586	94.3242
76	95.2264	92.6326	96.6344	95.1082	77.9766	NaN	98.1572	95.7395	96.9443	96.6195	97.2994
77	99.4315	96.8596	102.304	100.276	102.573	NaN	103.377	100.099	108.61	108.366	108.632
78	104.875	97.1611	106.304	104.976	108.261	NaN	107.541	101.237	105.888	108.219	107.29
79	118.403	118.1	113.581	119.074	118.598	NaN	116.504	109.216	121.662	121.036	120.557
80	118.578	114.98	122.528	117.956	121.394	NaN	114.556	110.142	118.879	119.096	118.657
81	116.977	117.836	120.16	118.414	119.617	NaN	116.508	105.883	119.324	118.791	119.08
82	114.33	110.518	115.108	110.151	112.486	NaN	110.538	108.324	113.26	112.676	112.867
83	116.902	111.603	115.307	115.157	115.989	NaN	114.894	108.318	118.565	119.496	118.125
84	117.55	109.288	114.566	114.297	113.469	NaN	114.926	105.341	NaN	115.349	112.605
85	108.453	104.642	106.835	109.477	108.824	NaN	111.199	105.622	NaN	114.453	113.816
86	104.064	99.1417	106.722	104.584	104.725	NaN	104.795	102.102	NaN	109.549	109.662
87	96.7616	90.4337	92.6853	93.4549	97.732	NaN	97.0647	93.3227	NaN	99.0115	97.5026
89	24.523	11.6651	26.0789	18.4021	NaN	NaN	NaN	25.4672	NaN	39.3213	38.5427
90	38.4262	26.5904	29.3583	30.8126	NaN	NaN	NaN	36.2433	NaN	44.4448	44.0374
91	42.3838	37.5184	42.2182	37.4451	NaN	NaN	NaN	36.5957	NaN	41.2993	40.9792
92	49.1101	41.6297	47.9215	44.1302	NaN	NaN	NaN	40.3303	NaN	51.663	47.9155
93	47.6126	41.6543	50.199	47.9859	NaN	NaN	NaN	31.5451	NaN	52.0644	51.7086
94	44.5919	41.5639	39.5097	41.9452	NaN	NaN	NaN	37.5441	NaN	42.9941	42.3049
95	40.2325	31.9406	37.4679	40.2799	NaN	NaN	NaN	22.8203	NaN	37.2398	36.4817
97	31.8968	30.8428	35.1729	29.0917	NaN	NaN	NaN	26.5697	NaN	30.9758	29.5394
98	27.7939	29.9236	30.5958	29.5269	NaN	NaN	NaN	25.3132	NaN	28.8127	28.8075
99	27.5973	28.5294	28.018	24.7225	NaN	NaN	NaN	21.0024	NaN	26.8043	26.1902
100	28.1904	31.3147	30.1863	26.5861	NaN	NaN	NaN	24.2079	NaN	28.4685	28.518
101	22.5567	25.9823	24.5627	21.7286	NaN	NaN	NaN	16.8323	NaN	23.0045	19.793
102	12.6367	16.2472	14.0595	14.9615	NaN	NaN	NaN	7.47909	NaN	11.6166	16.1682
103	8.00505	5.73758	6.10387	9.183	NaN	NaN	NaN	8.7432	NaN	11.8559	10.9113
104	19.3332	19.7744	18.7102	18.0331	NaN	NaN	NaN	16.208	NaN	23.5904	19.9898
105	17.9748	20.5773	19.7179	20.02	NaN	NaN	NaN	15.2319	NaN	22.5453	22.0586
106	18.3601	19.2421	21.2466	16.2355	NaN	NaN	NaN	15.7048	NaN	25.7175	16.2228
107	36.6969	36.9792	36.1125	34.9969	NaN	NaN	NaN	28.6974	NaN	39.9195	36.9928
108	41.4859	42.7494	42.513	41.8367	NaN	NaN	NaN	34.4351	NaN	44.224	42.2505
109	42.6725	45.3033	45.2965	42.4649	NaN	NaN	NaN	40.4495	NaN	44.7692	43.8949
110	41.3373	42.3087	43.3577	40.1554	NaN	NaN	NaN	35.7736	NaN	42.1619	39.1479
111	38.8579	42.8745	43.1341	39.6871	NaN	NaN	NaN	35.894	NaN	41.8127	40.6034
112	30.8624	40.4627	32.3193	29.4951	NaN	NaN	NaN	26.759	NaN	36.5191	34.6305
113	27.7974	31.4984	23.1268	27.0642	NaN	NaN	NaN	19.9486	NaN	31.3304	30.1172
114	24.5316	40.8838	34.5736	37.4713	NaN	NaN	NaN	37.7964	NaN	41.2181	38.8882
115	37.3567	38.5834	38.8051	40.0483	NaN	NaN	NaN	38.2935	NaN	49.2098	38.515