

MEMORANDUM FOR OD-R

SUBJECT: Monitoring Program for Regulatory Plan for Commercial Dredging Activities on the Kansas River 2015/2016

1. Introduction and Purpose. The purpose of this memorandum is to document changes in the riverbed elevations of the Kansas River for the Monitoring Program as described in *Commercial Dredging Activities on the Kansas River, Appendix A: Regulatory Plan*. This memorandum documents changes in average bed elevations for purposes of regulating dredging activities per the existing regulatory plan. Baseline data was collected in 1992 and the most recent data was collected from December 2015 to June 2016. The Kansas River dredgers funded the collection of 98 cross-sections from RM 9.4 to 32.9 and 77.0 to 96.5. Of these, 79 match the locations of cross sections collected in 1992, which allows an assessment of bed elevation change in 5-mile reaches that intersect the authorized dredging reaches. Nineteen cross sections collected in 2015/2016 have no 1992 baseline. Of these, the most downstream three (RMs 4.4, 5.9, 7.3) were collected for the first time with this survey, while the remainder have been collected multiple times in previous years. Cross sections without a 1992 baseline are indicated in Table 1. Consistent with analysis performed in previous years, cross sections without a 1992 baseline were not included in the computation of degradation.

2. Survey Quality and Completeness. Landplan Engineering, under contract from the Kansas River dredgers, combined LIDAR (Light Detection and Ranging) data with channel bathymetry to create complete cross sections for analysis. At fourteen cross sections, large data gaps were evident in the initial cross section submittal. Data gaps in six of these cross sections were a result of errors in the LIDAR/bathymetry merging process. Landplan Engineering was able to correct and re-submit these cross sections. At the eight remaining locations (indicated by an asterisk in Table 1), the large data gaps resulted from insufficient survey coverage, i.e., neither the LIDAR nor the bathymetric survey covered that portion of the channel. At these locations, ED-HR (with concurrence from Landplan Engineering) substituted the water surface elevation on the day of bathymetric survey for the missing data. As the missing data was most likely at or above the water surface, assuming the elevation of the missing data to be the water surface elevation results in a conservative (low) bed elevation for comparison against the 1992 survey. As demonstrated later in this memo, these eight cross sections do not cause any 5-mile reach that intersects a dredging reach to exceed 2 feet of degradation since 1992. These eight cross sections should not be used in trend analysis or other geomorphic analyses.

Table 1 lists the average bed elevation and average bed elevation change since 1992 at each cross section. Cross section change since 1992 varied from -5.83 ft (degradation) to 8.46 ft (aggradation). Cross-sections marked with an asterisk are locations with data

CENWK-ED-HR

SUBJECT: Monitoring Program for Regulatory Plan for Commercial Dredging Activities on the Kansas River 2015/2016

filled in at the water surface elevation. Bed change since 1992 is provided graphically in Enclosures 1 and 2.

Table 1. Average Bed Elevations and Bed Elevation Change Since 1992

RM	Avg Bed Elevation (ft)	Change Since 1992 (ft)	RM	Avg Bed Elevation (ft)	Change Since 1992 (ft)	RM	Avg Bed Elevation (ft)	Change Since 1992 (ft)
4.4	712.76	No 1992	19.95*	734.4	-0.88	75.10	842.2	No 1992
5.9	712.24	No 1992	20.2	735.2	-1.48	76.6	842.5	No 1992
7.3	715.23	No 1992	20.4	735.5	1.19	77.0	843.4	-1.98
9.4	713.85	-5.83	20.6	734.1	No 1992	77.3	843.5	No 1992
9.5	714.71	-5.31	20.75	732.4	-0.71	77.6	842.8	No 1992
9.95	713.58	-2.68	21.1	728.9	-2.33	77.9	844.5	No 1992
10.35	714.24	-1.29	21.3*	737.3	-1.61	78.2	843.3	No 1992
10.65	713.90	-2.04	21.6*	738.2	-1.11	78.5	844.6	-2.13
10.9	715.74	-1.39	22.7*	742.6	-2.14	80.0	847.1	-1.53
12.1	719.10	2.88	24.2	745.2	-1.81	81.5	848.2	0.09
12.3	721.41	No 1992	25.30	747.8	-1.90	83.00	849.2	-0.89
12.6	717.38	-0.54	26.0	743.8	No 1992	84.5	853.5	1.90
12.8	716.47	-0.27	26.1	745.2	No 1992	84.8	855.7	0.05
13.0	717.55	2.00	26.4	752.4	-0.38	85.2	855.4	-3.05
13.3	717.17	-1.00	26.70	749.4	-2.08	85.5	856.6	3.08
13.50	718.12	1.87	27.1	748.2	3.94	85.8	858.0	1.76
13.80	718.02	-4.17	27.40	749.0	-2.79	86.0	859.5	0.74
14.10	720.88	-2.81	27.8*	750.2	-2.73	86.2	857.5	-0.40
14.7	722.76	3.73	29.00	754.5	-3.11	86.4*	858.9	-0.79
15.3	728.40	No 1992	29.3	756.4	-3.46	86.6	858.9	-0.64
15.5	728.10	No 1992	29.60	755.8	-1.92	86.80	861.1	0.50
15.8	724.83	-2.57	29.9	757.4	-1.85	87.5	862.2	-2.62
16.1	727.51	-2.20	30.2	762.3	1.86	89.0	865.0	-1.61
16.4	729.05	-1.38	31.0	755.6	No 1992	89.9	868.1	-2.18
16.8	728.20	8.01	31.10	758.3	-0.99	90.2	869.8	-0.28
17.05	732.12	3.74	31.4	759.4	-3.49	90.5	874.7	1.27
17.95	733.09	1.03	31.60	760.1	-3.36	91.1	871.2	-1.09
18.40	727.63	-1.69	31.75*	761.8	-1.98	91.4	871.5	-0.76
18.7	732.65	No 1992	31.90	760.0	-3.95	92.0	872.4	-0.49
19.0	733.06	7.89	32.0	761.4	-2.15	93.5	877.3	1.13
19.2	734.13	6.45	32.90	761.1	-3.74	95.00	880.7	0.89
19.5	735.17	3.55	72.1	838.8	No 1992	96.5	886.7	-0.61
19.7	736.12	8.46	73.6	841.2	No 1992			

\*Denotes locations with missing data filled in at the water surface elevation

3. Five-mile Reaches. According to “Dredging Restrictions, Section I. Restrictions Concerning Riverbed Degradation,” *Commercial Dredging Activities on the Kansas River, Appendix A: Regulatory Plan, Page A-3*, “If riverbed elevations in a 5-mile-long reach of river approach 2 feet of degradation, dredging activities which adversely affect bed elevations in that reach will be altered or terminated before unacceptable impacts occur. Further, if the average reduction of riverbed elevations in a 5-mile-long reach of river attains 2 feet (regardless of cause), dredging activities which adversely affect bed elevations in that reach will be terminated.” A rolling average for each 5-mile reach was calculated from interpolated values from each tenth of a river mile for the change in bed elevation from 1992 to 2015/2016. 5-mile reach averages from RM 27.3 to 32.9 experienced 2 ft or greater of degradation. Enclosure 3 presents the average bed change from 1992 to 2015/2016 for each 5-mile reach. Table 2 presents bed changes in the 5-mile average reaches associated with stretches of the river where dredging permits have been requested for the next two years. Per this analysis, no 5-mile reach intersecting a proposed dredging reach experienced 2 ft of degradation since 1992.

Table 2. Most Degraded 5-mi Reaches Intersecting Potential Dredging Reaches

Requested Dredging Reach	Most degraded 5-mi reach associated with the dredging reach	Average bed change (1992 to 2015/16) in associated 5-mi reach, ft
9.4 - 10.4	9.4 - 14.4*	-0.84*
12.8 - 13.9	9.4 - 14.4	-0.84
15.4 - 16.9	11.6 - 16.4	0.03
18.65 - 20.15	20.2 - 25.2	-1.58
20.55 - 21.15	20.9 - 25.9	-1.76
26.1 - 27.1	27.1 - 32.1	-1.82
77.1 - 78.6	77 - 82*	-1.38*
89.7 - 91	87 - 92	-1.27

\*see limitations section below

4. Limitations. A limitation to the analysis of 5-mile reaches in two stretches of the river is the lack of baseline and monitoring data. For example, the analysis for dredging reach RM 9.4 to 10.4 should include cross-sections from 4.4 to 15.4 (5 miles upstream and downstream of dredging reach) in order to assess all 5-mile reaches intersecting the dredging reach. Cross sections for this reach were collected in the 2015/2016

CENWK-ED-HR

SUBJECT: Monitoring Program for Regulatory Plan for Commercial Dredging Activities on the Kansas River 2015/2016

survey, but as the 1992 baseline data do not extend below RM 9.4, this data could not be included in the analysis. The dredging reach itself (9.4 to 10.4) has degraded 3.26 ft since 1992 with generally increasing degradation in the downstream direction. Similarly, necessary 1992 baseline data between RM 72.1 and 77, needed for assessing some of the 5-mile reaches associated with dredging reach 77.1 to 78.6, are not available. The dredging reach itself (77.1 to 78.6) has degraded 2.06 ft.

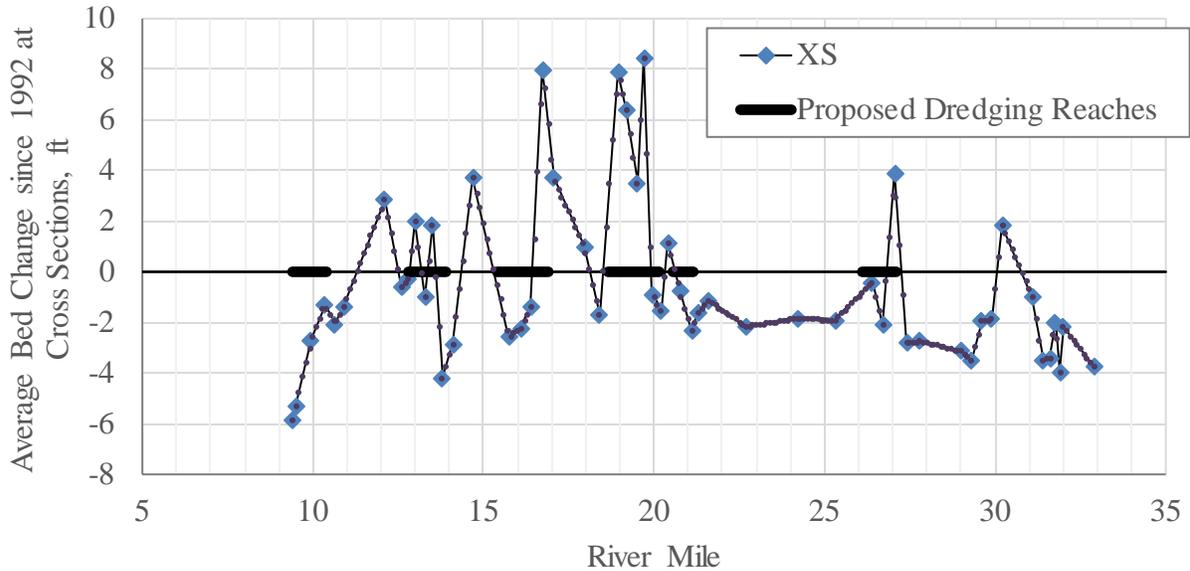
5. Conclusion. Using consistent analysis to previous years, no 5-mile reach intersecting one of the proposed dredging reaches listed in Table 2 degraded more than 2 feet since 1992.

6. Point of contact for this memorandum is Mr. John Shelley, Hydraulic Engineer, ED-HR, 816-389-2310.

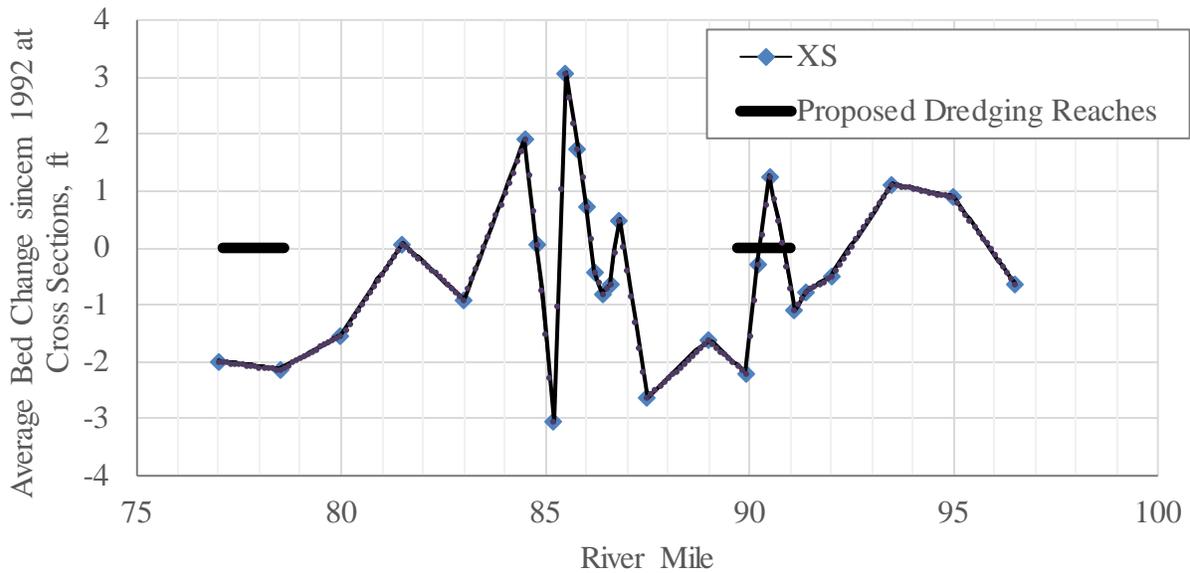
3 Encls



ERIC D. SHUMATE, P.E.  
Chief, Hydrologic Engineering Branch  
Engineering Division



Enclosure 1. Change in Average Bed Elevation at Individual Cross-Sections from 1992 to 2015/2016 survey (Kansas City to Lawrence)



Enclosure 2. Change in Average Bed Elevation at Individual Cross-Sections from 1992 to 2015/2016 survey (near Topeka)

5-mile reaches	5-mile average bed change, ft	5-mile reaches	5-mile average bed change, ft	5-mile reaches	5-mile average bed change, ft	5-mile reaches	5-mile average bed change, ft
9.4 - 14.4	-0.84	14.1 - 19.1	1.45	18.8 - 23.8	0.20	23.5 - 28.5	-1.54
9.5 - 14.5	-0.70	14.2 - 19.2	1.63	18.9 - 23.9	0.06	23.6 - 28.6	-1.56
9.6 - 14.6	-0.54	14.3 - 19.3	1.78	19.0 - 24.0	-0.11	23.7 - 28.7	-1.58
9.7 - 14.7	-0.37	14.4 - 19.4	1.88	19.1 - 24.1	-0.30	23.8 - 28.8	-1.60
9.8 - 14.8	-0.23	14.5 - 19.5	1.94	19.2 - 24.2	-0.47	23.9 - 28.9	-1.62
9.9 - 14.9	-0.11	14.6 - 19.6	2.02	19.3 - 24.3	-0.63	24.0 - 29.0	-1.65
10.0 - 15.0	-0.02	14.7 - 19.7	2.14	19.4 - 24.4	-0.78	24.1 - 29.1	-1.67
10.1 - 15.1	0.06	14.8 - 19.8	2.16	19.5 - 24.5	-0.90	24.2 - 29.2	-1.70
10.2 - 15.2	0.12	14.9 - 19.9	2.12	19.6 - 24.6	-1.01	24.3 - 29.3	-1.74
10.3 - 15.3	0.15	15.0 - 20.0	2.05	19.7 - 24.7	-1.16	24.4 - 29.4	-1.76
10.4 - 15.4	0.17	15.1 - 20.1	1.98	19.8 - 24.8	-1.36	24.5 - 29.5	-1.77
10.5 - 15.5	0.18	15.2 - 20.2	1.93	19.9 - 24.9	-1.49	24.6 - 29.6	-1.77
10.6 - 15.6	0.18	15.3 - 20.3	1.91	20.0 - 25.0	-1.55	24.7 - 29.7	-1.77
10.7 - 15.7	0.17	15.4 - 20.4	1.93	20.1 - 25.1	-1.57	24.8 - 29.8	-1.77
10.8 - 15.8	0.16	15.5 - 20.5	1.95	20.2 - 25.2	-1.58	24.9 - 29.9	-1.77
10.9 - 15.9	0.15	15.6 - 20.6	1.98	20.3 - 25.3	-1.59	25.0 - 30.0	-1.75
11.0 - 16.0	0.13	15.7 - 20.7	2.00	20.4 - 25.4	-1.62	25.1 - 30.1	-1.70
11.1 - 16.1	0.11	15.8 - 20.8	2.03	20.5 - 25.5	-1.68	25.2 - 30.2	-1.63
11.2 - 16.2	0.08	15.9 - 20.9	2.05	20.6 - 25.6	-1.72	25.3 - 30.3	-1.56
11.3 - 16.3	0.06	16.0 - 21.0	2.06	20.7 - 25.7	-1.75	25.4 - 30.4	-1.50
11.4 - 16.4	0.03	16.1 - 21.1	2.06	20.8 - 25.8	-1.76	25.5 - 30.5	-1.44
11.5 - 16.5	0.05	16.2 - 21.2	2.06	20.9 - 25.9	-1.76	25.6 - 30.6	-1.40
11.6 - 16.6	0.11	16.3 - 21.3	2.07	21.0 - 26.0	-1.75	25.7 - 30.7	-1.37
11.7 - 16.7	0.22	16.4 - 21.4	2.07	21.1 - 26.1	-1.73	25.8 - 30.8	-1.34
11.8 - 16.8	0.33	16.5 - 21.5	2.08	21.2 - 26.2	-1.70	25.9 - 30.9	-1.32
11.9 - 16.9	0.41	16.6 - 21.6	2.03	21.3 - 26.3	-1.67	26.0 - 31.0	-1.32
12.0 - 17.0	0.46	16.7 - 21.7	1.93	21.4 - 26.4	-1.65	26.1 - 31.1	-1.32
12.1 - 17.1	0.48	16.8 - 21.8	1.77	21.5 - 26.5	-1.64	26.2 - 31.2	-1.34
12.2 - 17.2	0.49	16.9 - 21.9	1.60	21.6 - 26.6	-1.64	26.3 - 31.3	-1.38
12.3 - 17.3	0.50	17.0 - 22.0	1.46	21.7 - 26.7	-1.66	26.4 - 31.4	-1.44
12.4 - 17.4	0.52	17.1 - 22.1	1.34	21.8 - 26.8	-1.64	26.5 - 31.5	-1.50
12.5 - 17.5	0.56	17.2 - 22.2	1.24	21.9 - 26.9	-1.59	26.6 - 31.6	-1.54
12.6 - 17.6	0.59	17.3 - 22.3	1.14	22.0 - 27.0	-1.50	26.7 - 31.7	-1.56
12.7 - 17.7	0.64	17.4 - 22.4	1.04	22.1 - 27.1	-1.42	26.8 - 31.8	-1.57
12.8 - 17.8	0.68	17.5 - 22.5	0.95	22.2 - 27.2	-1.37	26.9 - 31.9	-1.64
12.9 - 17.9	0.70	17.6 - 22.6	0.86	22.3 - 27.3	-1.35	27.0 - 32.0	-1.71
13.0 - 18.0	0.70	17.7 - 22.7	0.78	22.4 - 27.4	-1.37	27.1 - 32.1	-1.82
13.1 - 18.1	0.66	17.8 - 22.8	0.70	22.5 - 27.5	-1.39	27.2 - 32.2	-1.92
13.2 - 18.2	0.64	17.9 - 22.9	0.63	22.6 - 27.6	-1.40	27.3 - 32.3	-2.00
13.3 - 18.3	0.61	18.0 - 23.0	0.57	22.7 - 27.7	-1.42	27.4 - 32.4	-2.04
13.4 - 18.4	0.60	18.1 - 23.1	0.51	22.8 - 27.8	-1.43	27.5 - 32.5	-2.04
13.5 - 18.5	0.59	18.2 - 23.2	0.47	22.9 - 27.9	-1.44	27.6 - 32.6	-2.05
13.6 - 18.6	0.59	18.3 - 23.3	0.44	23.0 - 28.0	-1.45	27.7 - 32.7	-2.06
13.7 - 18.7	0.66	18.4 - 23.4	0.42	23.1 - 28.1	-1.47	27.8 - 32.8	-2.08
13.8 - 18.8	0.81	18.5 - 23.5	0.42	23.2 - 28.2	-1.48	27.9 - 32.9	-2.10
13.9 - 18.9	1.03	18.6 - 23.6	0.38	23.3 - 28.3	-1.50		
14.0 - 19.0	1.25	18.7 - 23.7	0.31	23.4 - 28.4	-1.52		

5-mile reaches	5-mile average bed change, ft	5-mile reaches	5-mile average bed change, ft	5-mile reaches	5-mile average bed change, ft
77.0 - 82.0	-1.38	82.1 - 87.1	0.11	87.4 - 92.4	-1.21
77.1 - 82.1	-1.35	82.2 - 87.2	0.09	87.5 - 92.5	-1.16
77.2 - 82.2	-1.32	82.3 - 87.3	0.06	87.6 - 92.6	-1.11
77.3 - 82.3	-1.29	82.4 - 87.4	0.03	87.7 - 92.7	-1.05
77.4 - 82.4	-1.26	82.5 - 87.5	-0.01	87.8 - 92.8	-1.00
77.5 - 82.5	-1.23	82.6 - 87.6	-0.05	87.9 - 92.9	-0.94
77.6 - 82.6	-1.20	82.7 - 87.7	-0.09	88.0 - 93.0	-0.88
77.7 - 82.7	-1.17	82.8 - 87.8	-0.12	88.1 - 93.1	-0.83
77.8 - 82.8	-1.15	82.9 - 87.9	-0.15	88.2 - 93.2	-0.77
77.9 - 82.9	-1.13	83.0 - 88.0	-0.18	88.3 - 93.3	-0.71
78.0 - 83.0	-1.10	83.1 - 88.1	-0.21	88.4 - 93.4	-0.65
78.1 - 83.1	-1.08	83.2 - 88.2	-0.24	88.5 - 93.5	-0.58
78.2 - 83.2	-1.04	83.3 - 88.3	-0.27	88.6 - 93.6	-0.52
78.3 - 83.3	-1.01	83.4 - 88.4	-0.30	88.7 - 93.7	-0.47
78.4 - 83.4	-0.97	83.5 - 88.5	-0.34	88.8 - 93.8	-0.41
78.5 - 83.5	-0.93	83.6 - 88.6	-0.37	88.9 - 93.9	-0.35
78.6 - 83.6	-0.88	83.7 - 88.7	-0.41	89.0 - 94.0	-0.30
78.7 - 83.7	-0.83	83.8 - 88.8	-0.46	89.1 - 94.1	-0.25
78.8 - 83.8	-0.78	83.9 - 88.9	-0.50	89.2 - 94.2	-0.20
78.9 - 83.9	-0.73	84.0 - 89.0	-0.55	89.3 - 94.3	-0.14
79.0 - 84.0	-0.67	84.1 - 89.1	-0.60	89.4 - 94.4	-0.09
79.1 - 84.1	-0.67	84.2 - 89.2	-0.72	89.5 - 94.5	-0.03
79.2 - 84.2	-0.61	84.3 - 89.3	-0.78	89.6 - 94.6	0.03
79.3 - 84.3	-0.55	84.4 - 89.4	-0.86	89.7 - 94.7	0.08
79.4 - 84.4	-0.48	84.5 - 89.5	-0.93	89.8 - 94.8	0.14
79.5 - 84.5	-0.41	84.6 - 89.6	-1.00	89.9 - 94.9	0.20
79.6 - 84.6	-0.34	84.7 - 89.7	-1.05	90.0 - 95.0	0.26
79.7 - 84.7	-0.28	84.8 - 89.8	-1.10	90.1 - 95.1	0.31
79.8 - 84.8	-0.23	84.9 - 89.9	-1.11	90.2 - 95.2	0.34
79.9 - 84.9	-0.20	85.0 - 90.0	-1.10	90.3 - 95.3	0.36
80.0 - 85.0	-0.18	85.1 - 90.1	-1.06	90.4 - 95.4	0.36
80.1 - 85.1	-0.18	85.2 - 90.2	-1.00	90.5 - 95.5	0.35
80.2 - 85.2	-0.20	85.3 - 90.3	-0.96	90.6 - 95.6	0.33
80.3 - 85.3	-0.23	85.4 - 90.4	-0.96	90.7 - 95.7	0.32
80.4 - 85.4	-0.22	85.5 - 90.5	-1.00	90.8 - 95.8	0.31
80.5 - 85.5	-0.18	85.6 - 90.6	-1.04	90.9 - 95.9	0.31
80.6 - 85.6	-0.10	85.7 - 90.7	-1.09	91.0 - 96.0	0.31
80.7 - 85.7	-0.03	85.8 - 90.8	-1.13	91.1 - 96.1	0.32
80.8 - 85.8	0.03	85.9 - 90.9	-1.16	91.2 - 96.2	0.34
80.9 - 85.9	0.08	86.0 - 91.0	-1.20	91.3 - 96.3	0.35
81.0 - 86.0	0.12	86.1 - 91.1	-1.22	91.4 - 96.4	0.36
81.1 - 86.1	0.15	86.2 - 91.2	-1.23	91.5 - 96.5	0.36
81.2 - 86.2	0.16	86.3 - 91.3	-1.24		
81.3 - 86.3	0.16	86.4 - 91.4	-1.23		
81.4 - 86.4	0.15	86.5 - 91.5	-1.23		
81.5 - 86.5	0.14	86.6 - 91.6	-1.23		
81.6 - 86.6	0.12	86.7 - 91.7	-1.24		
81.7 - 86.7	0.11	86.8 - 91.8	-1.26		
81.8 - 86.8	0.11	86.9 - 91.9	-1.27		
81.9 - 86.9	0.12	87.0 - 92.0	-1.27		
82.0 - 87.0	0.12	87.1 - 92.1	-1.26		
82.1 - 87.1	0.12	87.2 - 92.2	-1.24		