Department of Energy
Washington, DC 20585

March 2, 2015

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Deputy Director
Mail Stop: T8F5
Washington, DC 20555-0001

Subject: Lakeview, Oregon, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I Disposal Site's West Side Slope Rock Degradation Assessment

To Whom It May Concern:

This letter provides follow-up information to the U.S. Nuclear Regulatory Commission (NRC) letter dated November 12, 2014, which requested information about rock riprap monitoring on the west-facing side slope of the Lakeview, Oregon, UMTRCA Title I disposal cell. This letter also summarizes the U.S. Department of Energy's (DOE's) assessment of the 18 years of rock monitoring and establishes why DOE proposes to replace the annual gradation and durability rock monitoring with a more effective method for addressing any potential vulnerability of erosion on the cell's west side slope.

Response to NRC's November 12, 2014, Letter Item 3:

DOE sent NRC a partial response to Item 3 in a letter dated December 19, 2014, which transmitted the 2014 rock monitoring data and results. DOE has compiled the requested historical monitoring data and results for 1997 through 2014 and is including the available information as attachments to this letter.

- Attachment 1 provides summary data results and information, including (1) a graph plotting values for the mean diameter (D_{50}) results of the annual gradation monitoring conducted over the past 18 years; (2) tables identifying the various rock types, with descriptions, and durability classes/codes of rock present on the side slope; (3) a table summarizing the 6 years of rock durability monitoring results by durability class; and (4) a map showing the local reference to which the monitoring sample location coordinates apply.
- Available rock gradation monitoring data and results are provided by year for 1997 (Attachment 2) through 2014 (Attachment 19). Gradation monitoring in 1997 was performed by weight instead of rock count because it predated the gradation monitoring procedure established in the 1998 update to DOE's *Long-Term Surveillance Plan for the Collins Ranch Disposal Site, Lakeview, Oregon* (August 1994; LTSP).
- Durability monitoring data and results, including the field data logs, are provided for the 6-year period of 2009 (Attachment 14) through 2014 (Attachment 19) when durability monitoring was performed.

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Response to NRC's November 12, 2014, Letter Item 4:

The use of Global Positioning System (GPS) to retain sample locations was not included in the LTSP gradation monitoring procedure, and the requested GPS data are therefore not available. However, sample location coordinates using a local site reference (see Attachment 1) have been compiled for each year and are included in Attachments 2 through 19 when available. Some locating precision may have been lost during the field locating of these randomly generated sample locations.

Response to NRC's November 12, 2014, Letter Items 1 and 2:

The Type B size side-slope riprap used to construct the cell met the original computed D_{50} design size range of 2.7 to 3.9 inches. However, all parties involved at the time of construction (1987 and 1988) acknowledged that weathering would likely accelerate degradation of the available rock.

DOE has performed gradation monitoring in accordance with the procedure (a surrogate gradation analysis method) since 1998. The objectives of the monitoring were to provide a method for generally quantifying rock degradation over time. It was acknowledged when the rock gradation monitoring procedure was developed that the procedure had inherent limitations, including:

- The surrogate monitoring procedure method identified D_{50} by rock count, not by weight, which is the standard method for determining D_{50} in the laboratory.
- Only surface rocks were included in the monitoring instead of the entire riprap thickness profile. The more-exposed surface rocks may be more susceptible to accelerated weathering, thus conservatively skewing the data (i.e., provides a smaller D_{50} result).
- The method conservatively measures the minimum rock dimension for sieve sizing, thus also conservatively skewing the data (i.e., provides a smaller D_{50} result).

DOE has made field observations of the erosion protectiveness of the side-slope rock since completion of the disposal cell in 1989 and has performed rock gradation monitoring since 1997, including 6 years of rock durability monitoring. Relevant conclusions about the rock degradation include:

- The D_{50} measurements obtained since 1997 (see graph in Attachment 1) indicate that degradation of the Type B size riprap is inconsistent but that it has occurred.
- Gradation monitoring results shown on the graph in Attachment 1 for the years 1997 to 2014 indicate variability in the D_{50} measurement. Some of this variability is natural randomness, and some could result from different personnel performing the procedure. However, a rate of rock degradation cannot be determined.
- The annual gradation monitoring results shown on the graph in Attachment 1 indicate that the average D_{50} value for the 18-year monitoring period is 2.55 inches. Without the 1997 value, which was atypically performed by weight instead of rock count, the 17-year average D_{50} value is 2.53 inches. This is less than 0.2 inches below the calculated size range lower

limit of 2.7 inches, and represents a less than 6.5 percent size decrease. These values represent D_{50} based on rock count instead of weight, which is the standard method for determining D_{50} in the laboratory.

- Other layers of conservatism associated with the calculated D_{50} size range of 2.7 to 3.9 inches include:
  - — The vegetation present on the cell cover top slope provides flow resistant properties during storms and reduces the potential for erosion. This was not factored into the calculated D_{50} value; if it had been factored in, the required size range would be smaller.
  - — More geographically precise weather data (Hydrometeorological Report 581[1]) have become available since the original D_{50} value was calculated.
  - — New methods for calculating the D_{50} value (Apt-Johnson[2]) became available after construction of the Lakeview disposal cell.
- Observations made at the site during the past 6 years since rock durability monitoring began indicate that the various classifications of durable rock and rock types are randomly distributed over the cell's west side slope (see Attachment 1 for general durability information and Attachments 14 through 19 for specific monitoring year information).
- Of the rocks monitored each year during the 6-year durability monitoring period, the sum of all Class A (highly durable) and Class B (durable) rocks, ranged from 56.4 percent to 71.8 percent (see the Summary of 2009 through 2014 Rock Durability Monitoring Results by Durability Class table in Attachment 1).
- Field observations indicate that large rocks are present throughout the riprap profile and are present at depth.
- Multiple visits to the two rock source quarries (Pepperling and Sheer's quarries) over the years have helped DOE understand the rock weathering mechanisms that have occurred at the disposal site and have provided evidence that the rock placed on the disposal cell will undergo similar weathering processes.
- Augur Hill, located immediately north of the disposal site, represents a good analog site for the disposal cell's west side slope because it is of similar slope and aspect and has historically undergone the same local weather conditions. This analog slope can be useful for predicting how the cell's west side slope will respond to storm events. Pleistocene-age glacial deposits identified on the top of Augur Hill indicate that the hilltop has remained in place without erosional compromise for thousands of years.

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[1] U.S. Department of Commerce, 1998. *Hydrometeorological Report No. 58, Probable Maximum Precipitation Estimates for California*, October.

[2] Abt, S.R., T.L. Johnson, C.I. Thornton, and S.C. Trabant, 1998. "Riprap Sizing at the Toe of Embankment Slopes," *Journal of Hydraulic Engineering* 124(7): 672–677. This method is also published in NUREG-1623.

- The Lakeview disposal cell continues to meet the criteria in Title 40 *Code of Federal Regulations* Part 192, specifically Subpart A, which requires the cell to manage radon flux and remain protective for at least 200 years. This determination is based on the following:
  - — Observations made during the 2014 annual inspection indicated that the cell's erosion protection is currently intact and functioning properly.
  - — The 2010 Geoprobe technical borehole investigation demonstrated that water infiltration is not an issue, as identified in DOE's letter to NRC dated August 25, 2010. DOE initiated the investigation to assess potential saturated conditions within the cell.
  - — Annual inspections have identified no changes in the cell cover to suggest that radon flux from the cell would exceed the design specifications.

Engineering principles suggest that, if erosion of the side slope occurs, it would originate near the top-slope/side-slope interface[3, 4]. Any rilling on the top slope near this interface could channelize water flow. However, two conditions on the disposal cell would restrict the size of rills formed on the top slope, thus limiting any potential extent of water channelization: (1) the limited quantity of soil available to form a rill (4-inch-thick layer at the time of construction), and (2) the riprap rock cover is continuous beneath the top-slope soil cover, the slope crests, and the side slopes.

To verify continued protectiveness of the erosion control on the west side slope, DOE proposes to augment the current inspection plan by modifying the inspection checklist. Modifications would include adding a more rigorous, focused inspection of all rills that may form along the interface between the vegetated soil/rock top-slope cover and the rock-covered west side slope. The more focused inspection would include photographing any erosion rills annually, mapping locations of the features, inspecting the condition of erosion protection rock immediately downslope of a rill, and making repairs, as warranted, in accordance with the LTSP. Focusing on these areas will enable DOE to more proactively assess and mitigate potential failure points of the side-slope erosion protection. Because this augmented inspection approach more directly focuses on the potential development of vulnerabilities on the side slope, DOE will discontinue the annual rock gradation and durability monitoring.

In response to Item 1 of NRC's November 12, 2014, letter, which suggested that DOE consider plotting the monitoring data to draw conclusions about potential side-slope vulnerabilities, DOE believes that the original gradation and durability monitoring data were not intended to be used in this way, and such use could result in magnifying the data limitations identified in this letter.

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[3]Horton, R.E., 1945. "Erosional development of streams and their drainage basins; hydrophysical approach to quantitative morphology," *Bulletin of the Geological Society of America* 56: 275–370.

[4] Mosley, M.P., 1974. "Experimental study of rill erosion," *Transactions of the American Society of Agricultural Engineers* 17(5): 909–916.

Additionally, isolated areas of rock degradation have less significance because, as indicated previously, erosion of the side slope would likely originate near the top-slope/side-slope interface.

DOE acknowledges that all rock will naturally degrade, that the rock on the Lakeview cell west side slope is degrading, and that the future effects of natural weather events and performance of the rock erosion protection at the site will always have inherent uncertainties. However, these uncertainties are partly why the LTSP requires both annual inspections and corrective actions. DOE believes that adding the proposed rill monitoring during annual inspections is the most effective method for addressing any potential vulnerability of erosion on the side slope. This added inspection element would obviate the need for continued rock gradation and durability monitoring.

Upon NRC's acceptance of this proposed change, DOE will update the site's LTSP.

Please call me at (970) 248-6016, or Terry Petrosky at (970) 248-6041, if you have any questions. Please send any correspondence to:

U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Sincerely,

Jalena Daywalt
Site Manager

Enclosure

cc w/enclosure:
Z. Cruz, NRC
D. Engstrom, OR Dept. of Energy
G. Smith, GeoSmith Engineering (e)
T. Petrosky, DOE-LM (e)
C. Goodknight, SN3 (e)
A. Houska, SN3 (e)
File: LKD 0535.10 (rc grand junction)

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ATTACHMENT 1

Summary Data

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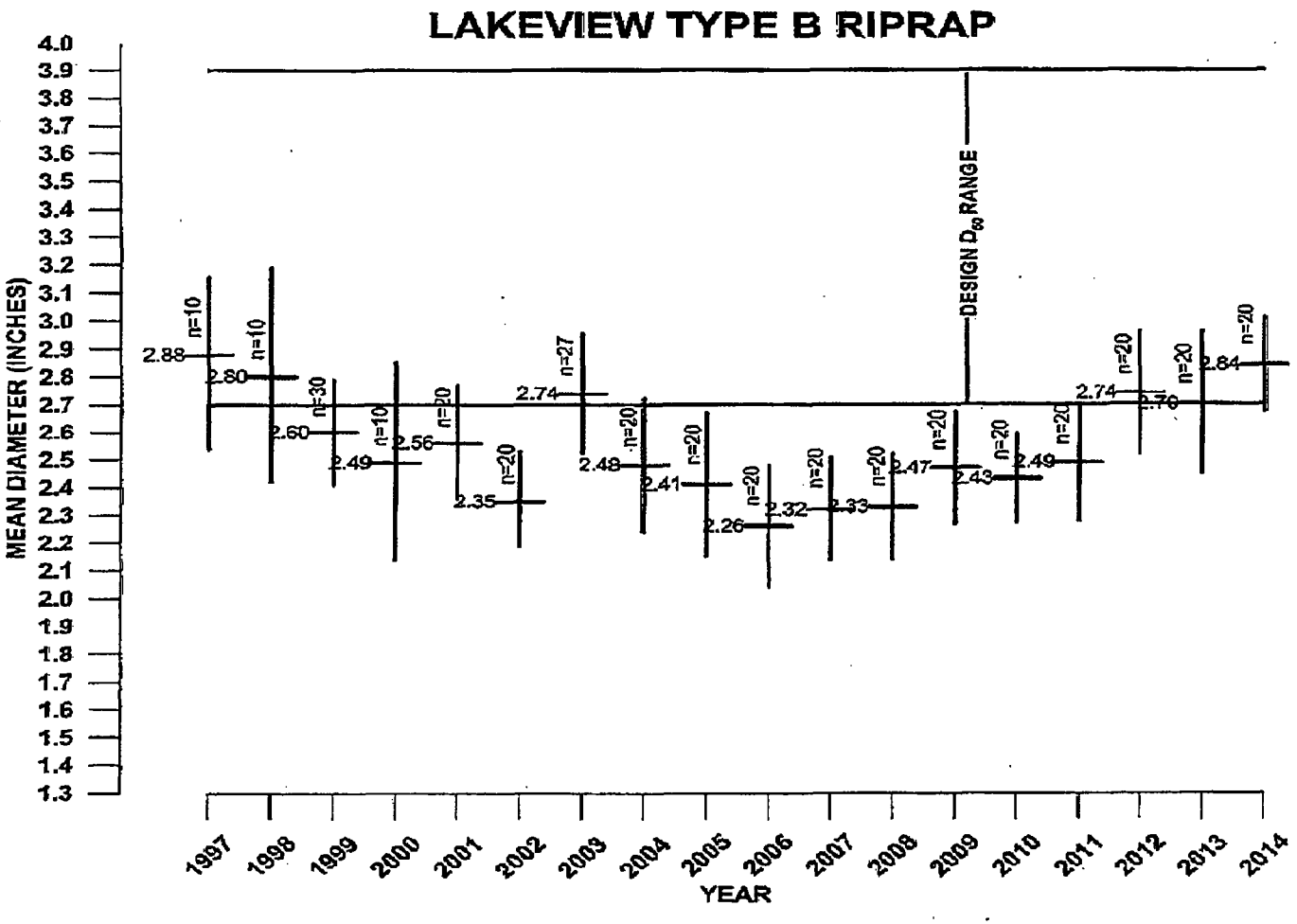


Riprap Gradation Monitoring

< Used in 2009 Only >

Rock Type and Durability Class

Rock Type Identification Number	Rock Type Description	Durability Class	Durability Class Code
1	Dense, hard, very fine-grained, dark gray basalt with no joints, white deposits, or alteration. Some hairline fractures and a few grayish brown, case-hardened surfaces may be present.	Highly Durable	A
2	Dense, hard, dark gray to grayish brown, olivine basalt. No joints or white deposits; olivine phenocrysts have altered to amber and brown material representing various minerals such as iddingsite, antigorite, chlorite, and nontronite. On some exposed surfaces, altered olivine phenocrysts have weathered out to give a vesicular appearance.	Durable	B
3a	Dense, fine-grained, grayish brown to brown basalt with hairline fractures. Basalt is slightly altered and fractured outer surfaces have a brown, limonite-like coating.	Moderately Durable	Ca
3b	Greenish gray to green, dense basalt with hairline fractures. Some fractures may have white or light brown coatings. Deuteric and hydrothermal alteration have imparted a distinctive greenish cast to the basalt resulting from alteration of calcic plagioclase to the more sodic plagioclase, albite-oligoclase.	Moderately Durable	Cb
4a	Fine-grained, highly fractured gray to greenish gray basalt. Hairline to open fractures are mostly coated with white to pink calcite and commonly with the zeolite mineral, analcime.	Susceptible to Near-Term Degradation	Da
4b	Greenish gray to grayish brown olivine basalt that is highly fractured. Olivine phenocrysts have altered to brown material, possibly nontronite.	Susceptible to Near-Term Degradation	Db
5	Fine- to medium-grained, soft, grayish green, highly altered basalt. Rock has a granular appearance, has relatively low specific gravity, is probably highly chloritized, and it has commonly disintegrated (rubblized) into pieces smaller than 1 inch in diameter.	Nondurable - Crumbled/ Rubblized	E
6	Non-basaltic rocks such as sandstone or quartzite	Highly Durable to Nondurable	A through E

July 22, 2009

(Used in 2010, 2011, 2012, 2013, and 2014)

Rock Types and Durability Classes and Subclasses

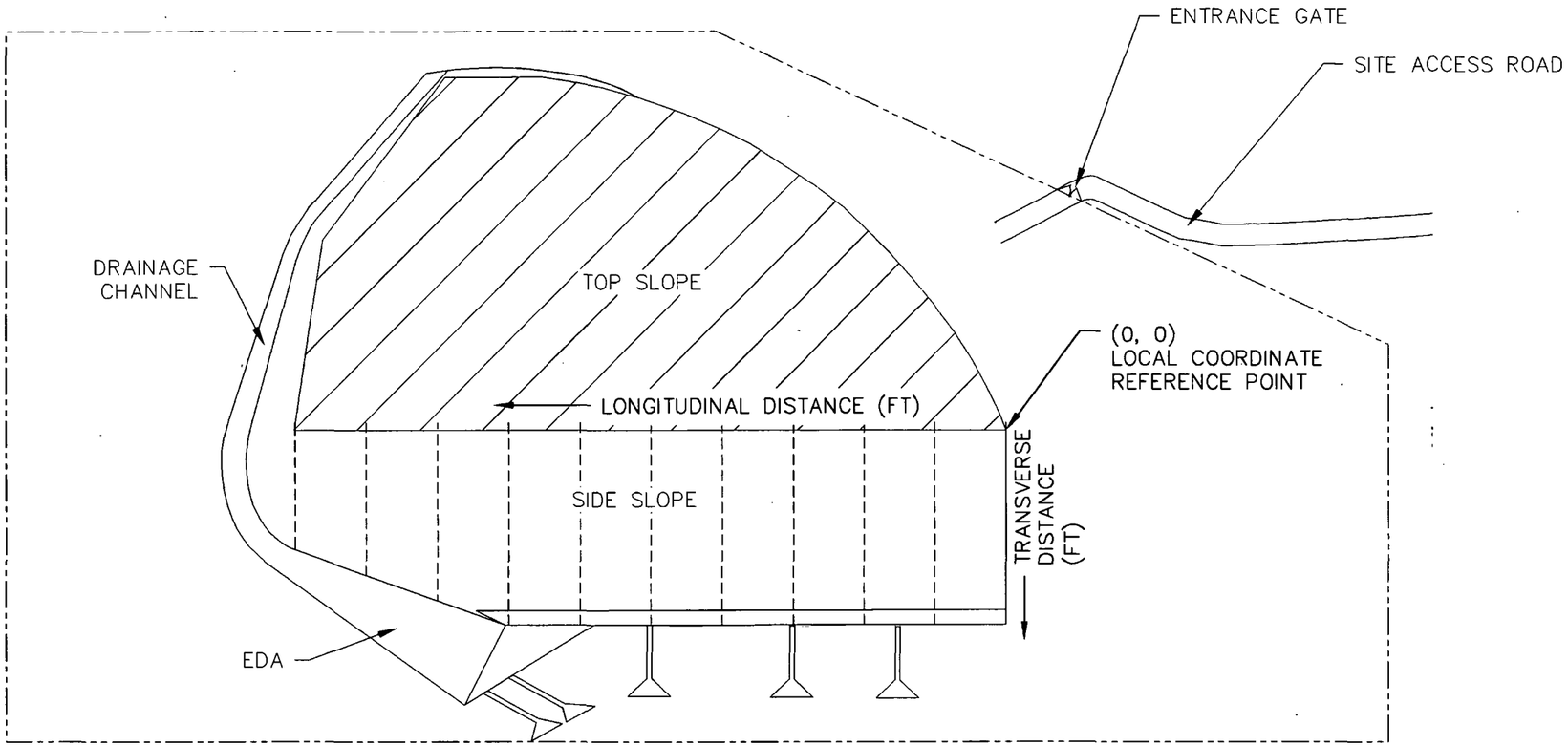
Rock Type Identification Number	Rock Type Description	Durability Class	Durability Class Code	Durability Subclass Code
1	Dense, hard, very fine-grained, dark gray basalt with no joints, fractures, white deposits, or alteration.	Highly Durable	A	Au
	As above in Au, except with tight, hairline fracture(s). Asterisk indicates the number of tight, hairline fractures.		A	Ah*
	As above in Au, except with open fracture(s). Asterisk indicates the number of open fractures in the rock that are ready to split.		A	Ao*
	As above in Au, except that the rock has split along fractures since placement on the cover, but the rocks are still in place.[1]		A	As
2	Dense, hard, dark gray to grayish brown, olivine basalt. No joints or white deposits; olivine phenocrysts have altered to amber and brown material representing various minerals such as iddingsite, antigorite, chlorite, and nontronite. On some exposed surfaces, altered olivine phenocrysts have weathered out to give a vesicular appearance.	Durable	B	----
3a	Dense, fine-grained, grayish brown to brown basalt with hairline fractures. Basalt is slightly altered and fractured outer surfaces have a brown, limonite-like coating.	Moderately Durable	Ca	----
3b	Greenish gray to green, dense basalt with hairline fractures. Some fractures may have white or light brown coatings. Deuteric and hydrothermal alteration have imparted a distinctive greenish cast to the basalt resulting from alteration of calcic plagioclase to the more sodic plagioclase, albite-oligoclase.	Moderately Durable	Cb	----
4a	Fine-grained, highly fractured gray to greenish gray basalt. Hairline to open fractures are mostly coated with white to pink calcite and commonly with the zeolite mineral, analcime.	Susceptible to Near-Term Degradation	Da	----
4b	Greenish gray to grayish brown olivine basalt that is highly fractured. Olivine phenocrysts have altered to brown material, possibly nontronite.	Susceptible to Near-Term Degradation	Db	----
5	Fine- to medium-grained, soft, grayish green, highly altered basalt. Rock has a granular appearance, has relatively low specific gravity, is probably highly chloritized, and it has commonly disintegrated (rubblized) into pieces smaller than 1 inch in diameter.	Nondurable - Crumbled/ Rubblized	E	----
6	Non-basaltic rocks such as sandstone or quartzite.	Highly Durable to Nondurable	F	----

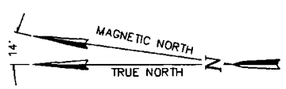
[1] "As" must be determined while the rocks are still in place on the side slope before the rocks are picked up for gradation monitoring. The size of the monitored rock reflects the size of the selected/marked split piece, not the size of the pre-split rock.

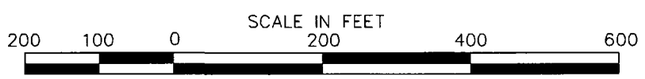
Summary of 2009 through 2014 Rock Durability Monitoring Results By Durability Class

Rock Durability Class/Subclass Code	2009 Percent	2010 Percent	2011 Percent	2012 Percent	2013 Percent	2014 Percent	Durability Class	Comments
Au	NA[1]	27.7	11.2	9.7	18.0	14.2	Highly Durable	
Ah	NA[1]	13.8	11.5	15.9	12.0	20.5	Highly Durable	Sum of all Ah*
Ao	NA[1]	4.8	4.3	5.2	3.9	4.4	Highly Durable	Sum of all Ao*
As	NA[1]	0.8	1.4	1.3	0.8	1.5	Highly Durable	
Total A Class	37.5	47.2	28.5	32.1	34.7	40.6	Highly Durable	Sum of Au, Ah, Ao, and As
B	25.9	20.2	27.9	27.3	28.9	31.2	Durable	
Ca	21.4	14.4	16.7	18.3	13.6	8.6	Moderately Durable	
Cb	6.9	1.0	13.6	2.3	3,9	1.9	Moderately Durable	
Da	4.5	8.3	7.9	12.8	9.7	10.1	Susceptible to Near-Term Degradation	
Db	1.6	5.9	3.7	5.7	7.6	5.9	Susceptible to Near-Term Degradation	
E	2.2	3.0	1.7	1.5	1.5	1.9	Nondurable - Crumbled/ Rubblized	
F	. 0	0	0.2	0.4	0	0	Varied	
Total A Class + B Class	63.4	67.4	56.4	59.4	63.6	71.8	Highly Durable and Durable	Sum of all A and B rocks

[1] NA = Not applicable. Only the category of Rock Durability Class Code A was monitored in 2009; subclass data was not included until the 2010 durability monitoring.







EXPLANATION

——·—— SITE PROPERTY BOUNDARY

EDA ENERGY DISSIPATION AREA

Local Coordinate Reference Point For Rock Gradation and Durability Monitoring Locations, Lakeview Disposal Site

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ATTACHMENT 2

1997 Rock Gradation Monitoring Data

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Sample Year 1997	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	99	149
2	148	24
3	256	151
4	326	27
5	421	102
6	544	210
7	642	211
8	786	17
9	818	123
10	930	11

U.S. Department of Energy
Grand Junction Office
2597 B 3/4 Road
Grand Junction, CO 81503

JAN 05 1998

Mr. Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
Mail Stop T7J9
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Lakeview Rock Gradation Testing

Dear Mr. Holonich:

Design specification for diameter of basalt riprap, D_{50}, used for erosion protection on the side slope of the Lakeview Disposal Cell is 2.7 to 3.9 inches. Gradation testing of the riprap was performed in 1997 to compare the current condition of the rock to the design specification.

When first tested, in May and July 1997 (May-July test), the rock was subjected to a single hammer blow before it was sized and weighed. The more highly weathered rock readily broke. The hammer test was, in effect, an accelerated weathering test. When the rock was tested this way, the mean size of the rock, D_{50}, was 2.2 inches.

Gradation tests were repeated in August 1997 without the hammer test. Results of the second tests showed that the mean size of the rock, as placed on the side slope of the disposal cell, is within the design specification, D_{50}, of 2.8 inches. (In a previous letter, this value was given, in error, as 2.4 inches. Source of the error was a change from a 2 inch. screen used in May to a 2.5 inch screen in July and August. This change in screens was not taken into account in the earlier calculation.)

A D_{50} of 2.8 inches is at the lower end of the 2.7 to 3.9 inch size range considered sufficient to resist the Probable Maximum Precipitation (PMP) event deemed appropriate for the Lakeview Site. Therefore, DOE concludes that the current size of the riprap does not present a risk to human health, safety, or the environment at the present time. The riprap will be monitored annually, using the procedure developed by DOE, a procedure that DOE considers statistically valid. The procedure is based on the rock-size distribution obtained from this year's tests. A copy of this procedure will be sent to NRC separately.

As explained above, two separate gradation tests were performed this year on the side slope riprap. The first test included a hammer blow to approximate accelerated physical weathering.

The second test omitted this step. Except for this difference, the procedure was the same on both occasions.

Large Gibson sieves with 4-inch and 2½-inch openings (a sieve with 2 inch openings in May) were used to determine the mean particle size, D_{50}, of the riprap. Statistically random locations on the side slope were used for each test (see enclosed map).

Sieving Procedure:

(1) A tripod and scale for weighing, and sieves for sizing the rock, were placed uphill from each randomly determined sampling location. The scale was tared, and the tare included the empty weighing bucket.

(2) A 2-by-2 foot square was laid on the surface of the west-facing, riprapped slope. The southeast corner of the square was placed at the randomly selected sampling point. The 2-by-2 foot square was aligned along the fall line of the side slope. All riprap within the 2-by-2 foot square, down to the radon and infiltration barrier, a thickness of about 18 inches, was measured and weighed to produce a representative sample of minimum of size. Total weight of all rock in a typical square was about 600 pounds. Statistical sampling was based on American Society of Testing Materials Procedure No. D 1140.

(3) A point intercept grid, made of 4-by-4 inch field fence, was placed on the wooden template. Rock directly beneath each intersection point on the grid was marked with white paint.

(4a) <u>In situ rock gradation test (no hammer test)</u>

Painted rocks were removed one at a time and placed in a 5-gallon bucket. Care was taken to avoid breaking rocks while each was placed in the bucket.

or

(4b) <u>Accelerated weathering gradation test (with hammer test)</u>

Painted rocks were removed, one at a time, and struck with a single blow from a standard geologist's hammer. The number of pieces that resulted were counted, and all pieces were placed in a 5-gallon bucket. The more densely crystalline basalt tended to survive the hammer blow; the more visibly altered basalt did not. Rock that broke after one hammer blow was assumed to have already degraded.

(5) The 5-gallon bucket and rocks (or rock pieces) were weighed and the weight recorded. The sample was then sieved using the large Gibson sieves. The weight retained on each size of sieve was recorded.

(6) The remainder of the riprap sample within the 2-by-2 foot square was removed one rock at a time, down to the radon and infiltration barrier. Then each rock was struck with the hammer (May-July test) or not (August test), weighed, and sieved. The weights retained on each sieve were recorded. Riprap was removed from the test square one layer at a time, down to the bedding layer, to see if size of the riprap varied with depth. The depth of the rock sampled was measured and recorded.

At each of the 10 sampling locations for each test (May-July and August), the total weight of the rock sieved and the total weight of rock retained on each size of sieve were measured and recorded. From this information, the percentage passing each size of sieve was determined. The mean particle size, D_{50}, was computed from the data on the weight of rock passing each size of sieve. Results are presented in the following table:

Lakeview Riprap Baseline Gradation Data

August 1997
In Situ Test
(No Hammer Blow Applied)

Sample Location	D_{50} (inches)
SP1	2.5*
SP2	2.6*
SP3	2.5*
SP4	2.7
SP5	2.7
SP6	3.2
SP7	2.7
SP8	3.4
SP9	2.5*
SP10	2.9
Mean	2.8
Standard Dev.	0.3
Standard Error	0.1

May-July 1997
Accelerated Aging Test
(Each Rock Struck With a Hammer)

Sample Location	D_{50} (inches)
P1	1.6*
P2	2.7
P3	1.9*
P4	2.5*
P5	2.4*
P6	2.1*
P7	3.0
P8	2.4*
P9	0.9*
P10	2.3*
Mean	2.2
Standard Dev.	0.55
Standard Error	0.18

*Fails the design D_{50} design specification for this site.

Based on these results, mean diameter of the riprap from the accelerated weathering (hammer) test is 2.2 inches and therefore insufficient to protect the cell from runoff associated with the

specified design PMP storm event. Without the hammer test, the mean diameter, 2.8 inches, is sufficient to provide the requisite protection, although it is at the lower end of acceptable diameters, 2.7 to 3.9 inches.

Comparison of the results of the two tests (with and without the hammer test) shows that much of the rock in the riprap cover is significantly weakened by weathering. The original rock, as placed, had a D_{50} between 2.7 and 3.9 inches. It has been exposed to weathering on the side slope for eight years. The hammer test is not that severe a test. The rock is held in one hand and hit with a hammer in the other. The rock breaks easily along visible and hairline cracks. In addition, the rock is altered. Most specimens are discolored and have a dusty or earthy appearance from growth of clay minerals. The clay minerals are alteration products that result from the chemical weathering of the original glassy and crystalline components of the basalt. Expansion of the crystal lattices that accompanies clay-mineral formation causes or allows small cracks to develop. Continued gradation monitoring will indicate whether disintegration of the riprap is a gradual (and continuing) weathering process or the result of rapid weathering that occurred just after the rock was placed and exposed to the elements. If the latter, further size reduction may not occur or may occur only very gradually.

Biointrusion Study

As a part of the monitoring of the Lakeview site, a test of the effects of root intrusion on the saturated hydraulic conductivity of the radon/infiltration barrier was also begun. The barrier, a compacted soil layer (CSL), was designed to limit the escape of radon and to limit infiltration of water into underlying tailings. Test results will be used to evaluate the need for long-term control or management of vegetation growing on the cover.

The top slope cover design for the Lakeview Disposal Cell has created conditions that favor the growth of deep-rooted plants rather than relatively shallow-rooted grasses because of the low water storage capacity of the topsoil. Many mature rabbitbrush plants and a few mature sagebrush plants now grow on the top of the disposal cell, and shrub density is expected to increase until it approaches or exceeds population levels (density) observed in native plant communities adjacent to the site.

The effects of root growth on the saturated hydraulic conductivity of the CSL was measured by using air-entry permeameters (AEPs). The AEP, based on a design by Bouwer (1966), consists of a round, 30-cm deep permeameter ring, air-tight cover, stand pipe graduated water reservoir, and vacuum gauge. Paired AEP measurements, one through the root crown of a rabbitbrush or sagebrush, and the other in an adjacent area with sparse or no vegetation were performed.

The three-stage tests consisted of: (1) measuring the rate of water-level drop in the reservoir, (2) measuring the pressure (tension) with the vacuum gauge after shutting off the water supply and allowing water to redistribute for a period of time (the vacuum gauge measurement was used to calculate the air-entry or bubbling pressure of the soil), and then (3) excavating the roots of selected plants to observe dye in preferred flow paths. Results presented in the following table suggest that the rabbitbrush and sagebrush plants may have had a subtle effect on the saturated

hydraulic conductivity (K_{sat}) of the radon/infiltration barrier. In both paired tests, K_{sat} was slightly greater where plant roots penetrated the radon/infiltration barrier.

Paired Test Location	K_{sat} (cm/s)
1 - Rabbitbrush	6.5×10^{-5}
1 - Bare Site	6.0×10^{-5}
2 - Sagebrush	1.3×10^{-4}
2 - Bare Site	1.1×10^{-4}

The as-built K_{sat}, for the radon barrier in 1988, according to the Completion Report, was between 1.0×10^{-8} and 1.0×10^{-9} cm/s. The mean K_{sat}, of the radon barrier in July 1997, as indicated by these preliminary results, is 9.01×10^{-5} cm/s, or between 4 and 5 orders of magnitude greater than it was in 1988. Additional saturated hydraulic conductivity testing of the cell cover is planned for the spring of 1998 to gain greater spatial coverage.

I would like to discuss these results and our monitoring plans with you on a conference call once you have had a chance to evaluate the information in this letter.

Sincerely,

Russel Edge

Russel W. Edge
Project Site Manager

Enclosure

cc w/o enclosure:
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File LTSM21.4.3.1 (Record: O. Beyer)

l:\wellkv-rock.r3

November 14, 1997

Lakeview Riprap Gradation Test Results, FY 1997

Mean diameter, defined as the diameter such that 50 percent of the stones by weight are smaller, of in-place riprap on the side slope of the Lakeview, Oregon, Title I disposal cell was determined by a sieving and weighing procedure. Each sample consists of all the rock in a test square, the entire thickness, down to the radon-infiltration barrier. Each test square was randomly located. In-place mean diameters were determined in order to compare them to the design mean diameter of 2.7 - 3.9 inches. Sieve sizes of 2.5-inches and 4.0-inches that closely match the specified design mean diameter were used in the determination.

Data supplied herewith are the baseline data for the LKV riprap. Samples labeled P1 to P10 are from the "accelerated weathering" test during which each stone was hit with a hammer to approximate accelerated physical weathering. These samples represent, at least approximately, w worst case. Samples P1, P4, and P7 were tested with a 2-inch sieve. The remaining seven samples were tested with the 2.5-inch sieve.

Samples labeled SP1 to SP10 are "in-place" samples. In-place samples were not subjected to the hammer test but were handle carefully to prevent breakage. In-place samples represent the current size and weight of the rock, the best case.

In the data tables, the depth or total thickness of the riprap is reported on the same line as the sample label. As stones were removed from the test square, they were place in a bucket. Six to 12 individual buckets of rock were removed from each 2-ft by 2-ft test square. For each bucket of rock, the total weight of the rock in the bucket and the weight of rock retained on each of the two sieves recorded. From this information, the percentage of the stones, by weight, passing each sieve was computed.

By knowing the percentage of rocks that pass through sieves that closely match the design mean diameter, 2.7-in. to 3.9-in., the current size of the rocks can be compared to the size of the rocks, as placed when the site was constructed. If 50 percent or more of the sample is retained on the smallest, 2.7 in. sieve, the riprap is still within design specification.

The attached sheets indicate the total weight of the stones collected in each bucket, and the

weight retained on each sieve. Each bucket full of rocks is a subset of the total sample in the test square. The percentage or rock retained on the smallest size and the percentage passing through are computed for each bucket subset sample. Total weight of the sample is obtained by summing the pre-sieved subset weights, and again summed for the weight retained on each sieve. These cumulative weights are used to compute the mean diameter for the sample. Since the stones were obtained from the excavation one roughly horizontal layer at a time, computation of the mean size for individual subset samples provides insight into how the mean size varies with depth.

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (MAY-JLY, 1997); design d50 2.7" - 3.9 "
hammer blow applied, accelerated aging test

P1 inches deep = 10

sample weight	weight retained (kg) 4"	2"	< 2"	% retained 4"	2"	< 2"	% passing 4"	2"
12.8	4.4	7.0	1.4	34	55	11	66	11
18.2	1.8	12.6	3.8	10	69	21	90	21
9.8	0.0	4.6	5.2	0	47	53	100	53
14.8	2.4	4.4	8.0	16	30	54	84	54
16.0	0.0	4.2	11.8	0	26	74	100	74
14.6	0.0	2.6	12.0	0	18	82	100	82
15.0	3.4	8.0	3.6	23	53	24	77	24
17.6	0.0	4.0	13.6	0	23	77	100	77
17.2	0.0	3.0	14.2	0	17	83	100	83
16.4	0.0	4.2	12.2	0	26	74	100	74
152.4	12.0	54.6	85.8	8	36	56	92	56

P2 inches deep = 10

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
22.2	3.0	15.2	4.0	14	68	18	86	18
22.8	2.0	11.6	9.2	9	51	40	91	40
22.6	2.0	10.2	10.4	9	45	46	91	46
22.8	1.6	9.8	11.4	7	43	50	93	50
22.4	4.0	7.6	10.8	18	34	48	82	48
12.8	0.0	5.0	7.8	0	39	61	100	61
125.6	12.6	59.4	53.6	10	47	43	90	43

P3 inches deep = 14

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
18.4	2.0	13.2	3.2	11	72	17	89	17
21.2	3.4	7.8	10.0	16	37	47	84	47
19.2	0.0	6.0	13.2	0	31	69	100	69
21.0	0.0	4.2	16.8	0	20	80	100	80
22.2	0.0	7.0	15.2	0	32	68	100	68
20.6	0.0	9.4	11.2	0	46	54	100	54
21.8	0.0	5.6	16.2	0	26	74	100	74
19.4	0.0	5.8	13.6	0	30	70	100	70
14.0	0.0	1.0	13.0	0	7	93	100	93
177.8	5.4	60.0	112.4	3	34	63	97	63

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (MAY-JLY, 1997); design d50 2.7" - 3.9"
hammer blow applied, accelerated aging test

P4 Inches deep = 13.5

sample weight	weight retained (kg) 4"	2"	< 2"	% retained 4"	2"	< 2"	% passing 4"	2"
16.0	4.4	11.2	0.4	28	70	3	73	3
11.8	0.0	9.4	2.4	0	80	20	100	20
17.4	3.6	9.0	4.8	21	52	28	79	28
17.4	0.0	11.6	5.8	0	67	33	100	33
18.4	4.0	6.8	7.6	22	37	41	78	41
17.6	1.2	10.6	5.8	7	60	33	93	33
18.4	3.0	11.4	4.0	16	62	22	84	22
16.0	0.0	8.8	7.2	0	55	45	100	45
18.8	1.8	6.6	10.4	10	35	55	90	55
17.8	3.8	4.8	9.2	21	27	52	79	52
18.0	3.0	7.4	7.6	17	41	42	83	42
14.4	1.4	2.4	10.5	10	17	73	79	52
202.0	26.2	100.0	75.7	13	50	37	87	38

P5 Inches deep = 12

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
12.4	0.0	7.6	4.8	0	61	39	100	39
20.4	4.8	9.0	6.6	24	44	32	76	32
18.0	0.0	9.2	8.8	0	51	49	100	49
18.6	0.0	8.0	10.6	0	43	57	100	57
23.4	1.8	8.6	13.0	8	37	56	92	56
22.6	2.2	8.4	12.0	10	37	53	90	53
22.6	4.2	6.6	11.8	19	29	52	81	52
21.6	0.0	6.2	15.4	0	29	71	100	71
27.0	0.0	9.8	17.2	0	36	64	100	64
186.6	13.0	73.4	100.2	7	39	54	93	54

P6 Inches deep = 14

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
12.6	2.0	7.4	3.2	16	59	25	84	25
20.6	0.0	7.8	12.8	0	38	62	100	62
22.0	2.8	8.6	10.6	13	39	48	87	48
21.0	0.0	8.4	12.6	0	40	60	100	60
21.2	0.0	9.0	12.2	0	42	58	100	58
19.8	1.6	4.8	13.4	8	24	68	92	68
22.4	8.8	7.0	6.6	39	31	29	61	29
18.8	2.0	1.6	15.2	11	9	81	89	81
19.2	0.0	4.4	14.8	0	23	77	100	77
4.6	0.0	0.0	4.6	0	0	100	100	100
182.2	17.2	59.0	106.0	9	32	58	91	58

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (MAY-JLY, 1997); design d50 2.7" - 3.9 "
hammer blow applied, accelerated aging test

P7 inches deep = 16

sample weight	weight retained (kg) 4"	2"	< 2"	% retained 4"	2"	< 2"	% passing 4"	2"
22.2	6.2	15.0	1.0	28	68	5	72	5
14.0	1.6	10.4	2.0	11	74	14	89	14
15.2	3.6	9.4	2.2	24	62	14	76	14
17.6	1.6	11.8	4.2	9	67	24	91	24
18.6	6.4	11.0	1.2	34	59	6	66	6
18.0	2.8	10.4	4.8	16	58	27	84	27
20.6	0.0	15.8	4.8	0	77	23	100	23
20.2	6.8	11.8	1.6	34	58	8	66	8
18.6	2.4	10.2	6.0	13	55	32	87	32
19.6	4.6	13.2	1.8	23	67	9	77	9
19.4	0.0	7.8	11.6	0	40	60	100	60
204.0	36.0	126.8	41.2	18	62	20	82	20

P8 inches deep = 15

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
18.8	3.4	12.2	3.2	18	65	17	82	17
16.8	1.4	10.8	4.6	8	64	27	92	27
20.6	1.4	7.2	12.0	7	35	58	93	58
20.8	0.0	7.6	13.2	0	37	63	100	63
18.6	0.0	2.4	16.2	0	13	87	100	87
20.2	3.4	13.6	3.2	17	67	16	83	16
24.2	2.6	11.4	10.2	11	47	42	89	42
25.6	2.4	6.8	16.4	9	27	64	91	64
21.4	2.2	6.2	13.0	10	29	61	90	61
15.6	0.0	1.2	14.4	0	8	92	100	92
202.6	16.8	79.4	106.4	8	39	53	92	53

P9 inches deep = 12

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
16.2	7.0	2.6	6.6	43	16	41	57	41
20.6	1.6	6.4	12.6	8	31	61	92	61
20.2	0.0	3.8	16.4	0	19	81	100	81
22.4	0.0	3.2	19.2	0	14	86	100	86
23.4	7.2	5.2	11.0	31	22	47	69	47
22.0	0.0	5.2	16.8	0	24	76	100	76
17.6	0.0	0.8	16.8	0	5	95	100	95
142.4	15.8	27.2	99.4	11	19	70	89	70

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (MAY-JLY, 1997); design d50 2.7" - 3.9 "
hammer blow applied, accelerated aging test

P10 Inches deep = 17

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
11.9	2.4	6.8	2.6	20	57	22	80	23
19.0	3.2	8.0	7.8	17	42	41	83	41
22.0	1.4	8.2	12.4	6	37	56	94	56
21.4	0.0	5.6	15.8	0	26	74	100	74
21.8	0.0	9.2	12.6	0	42	58	100	58
17.8	3.8	6.6	7.4	21	37	42	79	42
22.0	4.8	12.4	4.8	22	56	22	78	22
25.4	7.6	7.8	10.0	30	31	39	70	39
22.0	0.0	6.2	15.8	0	28	72	100	72
18.6	2.6	9.8	6.2	14	53	33	86	33
23.0	1.4	4.4	17.2	6	19	75	94	75
19.0	0.0	0.8	18.2	0	4	96	100	96
243.9	27.2	85.8	130.8	11	35	54	89	54

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (AUG., 1997); design d50 2.7" - 3.9 "
no hammer blow applied, in situ test

SP1 inches deep = not recorded

sample	weight retained (kg)			% retained			% passing	
weight	4"	2.5"	< 2.5"	4"	2.5"	< 2.5"	4"	2.5"
18.4	2.0	13.8	2.6	11	75	14	89	14
24.4	1.8	15.0	7.6	7	61	31	93	31
26.0	2.0	8.2	15.8	8	32	61	92	61
29.2	3.4	13.6	12.2	12	47	42	88	42
29.6	4.6	6.2	18.8	16	21	64	84	64
25.6	0.0	10.8	14.8	0	42	58	100	58
29.8	0.0	12.2	17.6	0	41	59	100	59
183.0	13.8	79.8	89.4	8	44	49	92	49

SP2 inches deep = 12

sample	weight retained (kg)			% retained			% passing	
weight	4"	2.5"	< 2.5"	4"	2.5"	< 2.5"	4"	2.5"
12.4	0.0	9.6	2.8	0	77	23	100	23
23.0	2.4	12.4	8.2	10	54	36	90	36
17.6	0.0	4.2	13.4	0	24	76	100	76
27.6	0.0	10.4	17.2	0	38	62	100	62
30.0	6.0	12.2	11.8	20	41	39	80	39
23.4	1.6	7.6	14.2	7	32	61	93	61
21.6	1.4	10.2	10.0	6	47	46	94	46
31.6	6.8	16.2	8.6	22	51	27	78	27
32.6	1.8	17.0	13.8	6	52	42	94	42
26.0	0.0	9.2	16.8	0	35	65	100	65
245.8	20.0	109.0	116.8	8	44	48	92	48

SP3 inches deep = 14

sample	weight retained (kg)			% retained			% passing	
weight	4"	2.5"	< 2.5"	4"	2.5"	< 2.5"	4"	2.5"
16.0	5.4	8.6	2.0	34	54	13	66	12
19.2	0.0	10.6	8.6	0	55	45	100	45
27.8	3.8	10.6	13.4	14	38	48	86	48
31.6	6.4	12.6	12.6	20	40	40	80	40
34.0	7.2	16.0	10.8	21	47	32	79	32
25.8	0.0	8.2	17.6	0	32	68	100	68
27.4	0.0	9.0	18.4	0	33	67	100	67
29.8	0.0	14.0	15.8	0	47	53	100	53
32.8	0.0	9.2	23.6	0	28	72	100	72
244.4	22.8	98.8	122.8	9	40	50	91	50

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (AUG., 1997); design d50 2.7" - 3.9 "
no hammer blow applied, in situ test

SP4 inches deep = 14

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
15.4	2.4	10.8	2.2	16	70	14	84	14
22.0	0.0	13.6	8.4	0	62	38	100	38
25.8	1.8	10.2	13.8	7	40	53	93	53
27.6	0.0	13.8	13.8	0	50	50	100	50
21.8	0.0	11.0	10.8	0	50	50	100	50
34.4	8.2	19.3	6.9	24	56	20	76	20
25.8	2.0	11.6	12.2	8	45	47	92	47
28.4	4.2	10.6	13.6	15	37	48	85	48
26.2	0.0	10.2	16.0	0	39	61	100	61
31.2	7.6	15.0	8.6	24	48	28	76	28
19.6	4.2	3.6	11.8	21	18	60	79	60
278.2	30.4	129.7	118.1	11	47	42	89	42

SP5 inches deep = 15.5

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
13.2	4.8	6.2	2.2	36	47	17	64	17
18.8	0.0	9.2	9.6	0	49	51	100	51
26.6	0.0	13.2	13.4	0	50	50	100	50
21.4	2.0	7.4	12.0	9	35	56	91	56
31.6	2.4	19.6	9.6	8	62	30	92	30
28.4	0.0	12.6	15.8	0	44	56	100	56
30.2	5.2	15.8	9.2	17	52	30	83	30
27.2	3.6	9.6	14.0	13	35	51	87	51
31.6	1.6	16.8	13.2	5	53	42	95	42
20.0	0.0	8.6	11.4	0	43	57	100	57
249.0	19.6	119.0	110.4	8	48	44	92	44

SP6 inches deep = 15

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
26.6	4.6	20.2	1.8	17	76	7	83	7
23.2	0.0	18.4	4.8	0	79	21	100	21
27.0	6.2	15.6	5.2	23	58	19	77	19
20.6	1.8	14.2	4.6	9	69	22	91	22
29.0	1.6	18.2	9.2	6	63	32	94	32
28.4	5.4	16.0	7.0	19	56	25	81	25
28.0	7.6	12.8	7.6	27	46	27	73	27
182.8	27.2	115.4	40.2	15	63	22	85	22

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (AUG., 1997); design d50 2.7" - 3.9 "
no hammer blow applied, in situ test

SP7 inches deep = 11

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
11.4	1.8	6.0	3.6	16	53	32	84	32
20.8	0.0	8.2	12.6	0	39	61	100	61
22.6	1.2	10.8	10.6	5	48	47	95	47
22.0	1.2	8.6	12.2	5	39	55	95	55
28.2	7.4	15.0	5.8	26	53	21	74	21
27.0	5.2	9.6	12.2	19	36	45	81	45
27.0	0.0	15.8	11.2	0	59	41	100	41
28.2	2.0	15.4	10.8	7	55	38	93	38
26.6	6.4	8.2	12.0	24	31	45	76	45
23.6	1.6	5.2	16.8	7	22	71	93	71
237.4	26.8	102.8	107.8	11	43	45	89	45

SP8 inches deep = 15

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
43.5	22.6	21.0	-0.1	52	48	-0	48	-0
27.0	9.4	16.2	1.4	35	60	5	65	5
25.0	0.0	24.2	0.8	0	97	3	100	3
23.8	2.0	20.4	1.4	8	86	6	92	6
26.0	9.8	9.2	7.0	38	35	27	62	27
24.8	2.0	14.2	8.6	8	57	35	92	35
170.1	45.8	105.2	19.1	27	62	11	73	11

SP9 inches deep = 10

sample weight	weight retained (kg) 4"	2.5"	< 2.5"	% retained 4"	2.5"	< 2.5"	% passing 4"	2.5"
23.0	9.0	13.4	0.6	39	58	3	61	3
16.0	0.0	13.6	2.4	0	85	15	100	15
15.6	0.0	6.4	9.2	0	41	59	100	59
22.0	2.6	5.8	13.6	12	26	62	88	62
20.4	0.0	7.4	13.0	0	36	64	100	64
25.2	0.0	6.8	18.4	0	27	73	100	73
12.2	0.0	3.6	8.6	0	30	70	100	70
134.4	11.6	57.0	65.8	9	42	49	91	49

LAKEVIEW RIPRAP GRADATION TEST RESULTS
BASELINE (AUG., 1997); design d50 2.7" - 3.9 "
no hammer blow applied, in situ test

SP10 Inches deep = 11

sample	weight retained (kg)			% retained			% passing	
weight	4"	2.5"	< 2.5"	4"	2.5"	< 2.5"	4"	2.5"
19.6	5.8	12.2	1.6	30	62	8	70	8
17.6	1.8	14.0	1.8	10	80	10	90	10
14.4	0.0	6.6	7.8	0	46	54	100	54
20.4	2.2	12.8	5.4	11	63	26	89	26
23.8	0.0	15.0	8.8	0	63	37	100	37
21.0	2.0	13.6	5.4	10	65	26	90	26
22.0	3.4	9.2	9.4	15	42	43	85	43
25.4	2.0	10.8	12.6	8	43	50	92	50
29.2	2.4	7.2	19.6	8	25	67	92	67
193.4	19.6	101.4	72.4	10	52	37	90	37

ATTACHMENT 3

1998 Rock Gradation Monitoring Data

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Sample Year 1998	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	98	41
2	171	208
3	298	111
4	304	132
5	410	259
6	590	235
7	641	135
8	739	230
9	865	41
10	912	124

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ATTACHMENT 4

1999 Rock Gradation Monitoring Data

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Sample Year 1999	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	68	218
2	185	177
3	231	167
4	306	209
5	413	29
6	572	118
7	634	50
8	724	242
9	823	12
10	937	130
11	7	208
12	156	169
13	232	65
14	314	204
15	445	32
16	565	236
17	627	18
18	791	213
19	847	154
20	920	34
21	71	35
22	107	269
23	207	122
24	368	113
25	491	157
26	562	227
27	660	270
28	719	56
29	851	80
30	948	125

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1999 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained				cumulative number passing				cumulative percent passing				D_{50}	
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	(inch)	P/F
WP 1	25	1	5	6	12	24	19	13	1	96	76	52	4	2.46	F
WP 2	24	0	4	3	16	24	20	17	1	100	83	71	4	2.19	F
WP 3	24	0	13	2	8	24	11	9	1	100	46	38	4	3.08	P
WP 4	24	2	11	4	6	22	11	7	1	92	46	29	4	3.09	P
WP 5	24	0	2	3	9	24	22	19	10	100	92	79	42	1.72	F
WP 6	24	0	11	5	5	24	13	8	3	100	54	33	13	2.90	P
WP 7	25	0	4	3	11	25	21	18	7	100	84	72	28	2.00	F
WP 8	25	1	4	2	11	24	20	18	7	96	80	72	28	2.00	F
WP 9	23	5	9	7	1	18	9	2	1	78	39	9	4	3.28	P
WP 10	24	4	12	3	5	20	8	5	0	83	33	21	0	3.33	P
CP 1	25	1	12	4	6	24	12	8	2	96	48	32	8	3.04	P
CP 2	22	1	10	2	7	21	11	9	2	95	50	41	9	3.00	P
CP 3	25	1	6	3	13	24	18	15	2	96	72	60	8	2.31	F
CP 4	24	1	2	8	10	23	21	13	3	96	88	54	13	2.40	F
CP 5	24	4	1	4	7	20	19	15	8	83	79	63	33	2.07	F
CP 6	25	0	5	6	11	25	20	14	3	100	80	56	12	2.36	F
CP 7	25	2	4	1	9	23	19	18	9	92	76	72	36	1.89	F
CP 8	25	2	7	4	12	23	16	12	0	92	64	48	0	2.56	F
CP 9	22	6	8	4	3	16	8	4	1	73	36	18	5	3.38	P
CP 10	20	1	12	2	3	19	7	5	2	95	35	25	10	3.25	P
CP 11	25	0	4	5	9	25	21	16	7	100	84	64	28	2.11	F
CP 12	24	1	9	5	7	23	14	9	2	96	58	38	8	2.80	P
CP 13	25	0	4	1	15	25	21	20	5	100	84	80	20	2.00	F
CP 14	24	1	6	3	10	23	17	14	4	96	71	58	17	2.30	F
CP 15	24	1	4	3	8	23	19	16	8	96	79	67	33	2.00	F
CP 16	24	6	11	5	1	18	7	2	1	75	29	8	4	3.45	P
CP 17	25	0	4	5	9	25	21	16	7	100	84	64	28	2.11	F
CP 18	22	7	8	3	3	15	7	4	1	68	32	18	5	3.50	P
CP 19	25	2	11	7	3	23	12	5	2	92	48	20	8	3.05	P
CP 20	24	0	3	5	8	24	21	16	8	100	88	67	33	2.00	F
CP 21	24	6	7	7	3	18	11	4	1	75	46	17	4	3.14	P
CP 22	24	4	11	7	2	20	9	2	0	83	38	8	0	3.27	P
CP 23	25	0	8	4	11	25	17	13	2	100	68	52	8	2.45	F
CP 24	25	0	5	5	14	25	20	15	1	100	80	60	4	2.32	F
CP 25	25	1	8	1	9	24	16	15	6	96	64	60	24	2.22	F
CP 26	24	3	7	11	3	21	14	3	0	88	58	13	0	2.91	P
CP 27	23	2	10	10	1	21	11	1	0	91	48	4	0	3.05	P
CP 28	25	2	6	3	6	23	17	14	8	92	68	56	32	2.25	F
CP 29	25	0	1	0	17	25	24	24	7	100	96	96	28	1.82	F
CP 30	25	1	11	5	5	24	13	8	3	96	52	32	12	2.95	P

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Count data analysis w/ 4 sieves	
Mean	2.60
Standard Error	0.085
Median	2.46
Mode	2.00
Standard Deviation	0.53
Sample Variance	0.29
Range	1.78
Minimum	1.72
Maximum	3.50
Sum	104.03
Count	40.00
Confidence Level(95.0%)	0.17

Count data analysis w/ 3 sieves	
Mean	2.60
Standard Error	0.09
Median	2.46
Mode	2.00
Standard Deviation	0.54
Sample Variance	0.29
Range	1.73
Minimum	1.72
Maximum	3.45
Sum	103.90
Count	40.00
Confidence Level(95.0%)	0.17

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ATTACHMENT 5

2000 Rock Gradation Monitoring Data

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Sample Year 2000	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	2	73
2	139	124
3	280	108
4	329	127
5	478	86
6	558	251
7	682	19
8	747	82
9	865	144
10	901	78

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05/16/00 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained 4 - inch	3 - inch	2.5 - inch	1.5 - inch	cumulative number passing 4 - inch	3 - inch	2.5 - inch	1.5 - inch	cumulative percent passing 4 - inch	3 - inch	2.5 - inch	1.5 - inch	D_{50} (inch)	P/F
CP 1	25	3	6	4	8	22	16	12	4	88	64	48	16	2.56	F
CP 2	25	3	6	6	8	22	16	10	2	88	64	40	8	2.71	P
CP 3	25	1	5	5	8	24	19	14	6	96	76	56	24	2.31	F
CP 4	24	1	1	3	12	23	22	19	7	96	92	79	29	1.92	F
CP 5	25	2	6	3	6	23	17	14	8	92	68	56	32	2.25	F
CP 6	23	3	4	4	6	20	16	12	6	87	70	52	26	2.42	F
CP 7	25	2	3	0	7	23	20	20	13	92	80	80	52	1.43	F
CP 8	25	4	8	5	6	21	13	8	2	84	52	32	8	2.95	P
CP 9	24	6	10	5	3	18	8	3	0	75	33	13	0	3.40	P
CP 10	24	2	10	3	8	22	12	9	1	92	50	38	4	3.00	P
	245					218	159	121	49	89	65	49	20	2.52	F

May-00	
Mean	2.49
Standard Error	0.18
Median	2.49
Standard Deviation	0.568
Sample Variance	0.322
Range	2.0
Minimum	1.4
Maximum	3.4
Count	10

computed S.E. = 0.180

95% confidence interval 2.85
2.14

n req'd (within 0.1")	α (%)
40	5
28	10
17	20

n req'd (within 0.2")	α (%)
10	5
7	10
4	20

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ATTACHMENT 6

2001 Rock Gradation Monitoring Data

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Sample Year 2001	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	42	213
2	175	140
3	221	38
4	388	159
5	486	227
6	569	103
7	602	243
8	782	94
9	828	146
10	915	10
11	29	11
12	131	24
13	295	186
14	357	184
15	440	200
16	532	181
17	654	197
18	743	28
19	861	54
20	913	105

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06/01/01 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained 4 - inch	3 - inch	2.5 - inch	1.5 - inch	cumulative number passing 4 - inch	3 - inch	2.5 - inch	1.5 - inch	cumulative percent passing 4 - inch	3 - inch	2.5 - inch	1.5 - inch	D_{50} (inch)	P/F
CP 1	25	0	4	12	8	25	21	9	1	100	84	36	4	2.65	F
CP 2	24	0	5	7	11	24	19	12	1	100	79	50	4	2.50	F
CP 3	25	3	6	6	8	22	16	10	2	88	64	40	8	2.71	P
CP 4	24	2	4	9	9	22	18	9	0	92	75	38	0	2.67	F
CP 5	24	2	7	3	9	22	15	12	3	92	63	50	13	2.50	F
CP 6	25	1	4	1	12	24	20	19	7	96	80	76	28	1.96	F
CP 7	24	1	12	3	4	23	11	8	4	96	46	33	17	3.08	P
CP 8	25	2	8	2	12	23	15	13	1	92	60	52	4	2.46	F
CP 9	24	2	8	5	7	22	14	9	2	92	58	38	8	2.80	P
CP 10	23	4	13	2	1	19	6	4	3	83	26	17	13	3.42	P
CP 11	23	1	10	8	2	22	12	4	2	96	52	17	9	2.97	P
CP 12	23	0	15	5	3	23	8	3	0	100	35	13	0	3.23	P
CP 13	25	0	4	3	9	25	21	18	9	100	84	72	36	1.89	F
CP 14	25	1	1	5	16	24	23	18	2	96	92	72	8	2.16	F
CP 15	25	0	7	5	12	25	18	13	1	100	72	52	4	2.46	F
CP 16	25	2	10	3	5	23	13	10	5	92	52	40	20	3.00	P
CP 17	25	0	3	0	12	25	22	22	10	100	88	88	40	1.71	F
CP 18	24	2	9	4	9	22	13	9	0	92	54	38	0	2.88	P
CP 19	25	2	4	4	5	23	19	15	10	92	76	60	40	2.00	F
CP 20	24	0	4	6	8	24	20	14	6	100	83	58	25	2.25	F
	487					462	324	231	69	95	67	47	14	2.57	F

1-Jun-01	
Mean	2.56
Standard Error	0.10
Median	2.57
Mode	2.50
Standard Deviation	0.468
Sample Variance	0.219
Range	1.71
Minimum	1.71
Maximum	3.42
Count	20
Confidence Level(95.0%)	0.219

computed S.E. = 0.1047

95% confidence interval 2.77
2.36

n req'd (within 0.1")	α (%)
84	5
59	10
36	20

n req'd (within 0.2")	α (%)
21	5
15	10
9	20

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ATTACHMENT 7

2002 Rock Gradation Monitoring Data

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Sample Year 2002	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	31	205
2	179	184
3	291	162
4	366	257
5	482	197
6	569	76
7	607	230
8	724	10
9	867	28
10	927	65
11	7	19
12	137	46
13	299	11
14	314	240
15	468	132
16	554	192
17	634	186
18	769	48
19	842	52
20	910	40

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05/22/02 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained				cumulative number passing				cumulative percent passing				D_{50}	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	(inch)	
CP 1	24	1	9	3	8	23	14	11	3	96	58	46	13	2.67	F
CP 2	25	1	7	8	7	24	17	9	2	96	68	36	8	2.72	P
CP 3	25	2	4	5	9	23	19	14	5	92	76	56	20	2.33	F
CP 4	19	4	7	5	1	15	8	3	2	79	42	16	11	3.21	P
CP 5	25	1	3	6	8	24	21	15	7	96	84	60	28	2.19	F
CP 6	25	2	3	3	11	23	20	17	6	92	80	68	24	2.09	F
CP 7	25	2	5	4	10	23	18	14	4	92	72	56	16	2.35	F
CP 8	24	2	3	3	13	22	19	16	3	92	79	67	13	2.19	F
CP 9	24	1	7	3	8	23	16	13	5	96	67	54	21	2.38	F
CP 10	25	1	3	1	13	24	21	20	7	96	84	80	28	1.92	F
CP 11	24	1	8	5	8	23	15	10	2	96	63	42	8	2.70	P
CP 12	25	0	5	9	4	25	20	11	7	100	80	44	28	2.58	F
CP 13	24	1	7	4	11	23	16	12	1	96	67	50	4	2.50	F
CP 14	23	1	8	8	5	22	14	6	1	96	61	26	4	2.84	P
CP 15	25	0	3	2	8	25	22	20	12	100	88	80	48	1.56	F
CP 16	25	1	6	8	9	24	18	10	1	96	72	40	4	2.66	F
CP 17	25	1	4	1	11	24	20	19	8	96	80	76	32	1.91	F
CP 18	25	0	4	0	13	25	21	21	8	100	84	84	32	1.85	F
CP 19	25	2	6	2	7	23	17	15	8	92	68	60	32	2.14	F
CP 20	24	2	5	4	8	22	17	13	5	92	71	54	21	2.38	F
	486					460	353	269	97	95	73	55	20	2.35	

5/22/2002	
Mean	2.36
Standard Error	0.088
Median	2.36
Mode	2.38
Standard Deviation	0.393
Sample Variance	0.154
Minimum	1.56
Maximum	3.21
Count	20
Confidence Level(95.0%)	0.183861

computed S.E. = 0.0878

95% confidence interval 2.53
2.19

n req'd (within 0.1")	α (%)
9	5
6	10
4	20

n req'd (within 0.2")	α (%)
2	5
2	10
1	20

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ATTACHMENT 8

2003 Rock Gradation Monitoring Data

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Sample Year 2003	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	77	159
2	140	11
3	299	230
4	361	108
5	491	32
6	567	68
7	696	16
8	776	145
9	812	9
10	901	121
11	10	19
12	190	235
13	274	59
14	342	265
15	433	132
16	515	139
17	614	49
18	794	133
19	881	178
20	902	61
21	50	90
22	150	90
23	250	240
24	350	60
25	550	30
26	650	90
27	750	180

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6/24-25/2003 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained				cumulative number passing				cumulative percent passing				D_{50}	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	(inch)	
CP 1	25	2	6	6	5	23	17	11	6	92	68	44	24	2.63	F
CP 2	22	2	6	5	7	20	14	9	2	91	64	41	9	2.70	P
CP 3	24	2	11	6	4	22	11	5	1	92	46	21	4	3.09	P
CP 4	24	0	2	2	15	24	22	20	5	100	92	83	21	1.97	F
CP 5	24	6	7	0	6	18	11	11	5	75	46	46	21	3.14	P
CP 6	25	0	2	1	11	25	23	22	11	100	92	88	44	1.64	F
CP 7	24	3	9	5	5	21	12	7	2	88	50	29	8	3.00	P
CP 8	24	1	11	5	4	23	12	7	3	96	50	29	13	3.00	P
CP 9	23	3	12	1	5	20	8	7	2	87	35	30	9	3.29	P
CP 10	25	2	6	7	8	23	17	10	2	92	68	40	8	2.68	F
CP 11	21	8	9	0	2	13	4	4	2	62	19	19	10	3.72	P
CP 12	25	1	13	5	2	24	11	6	4	96	44	24	16	3.12	P
CP 13	25	1	2	7	11	24	22	15	4	96	88	60	16	2.27	F
CP 14	23	7	11	4	1	16	5	1	0	70	22	4	0	3.59	P
CP 15	25	1	4	7	11	24	20	13	2	96	80	52	8	2.45	F
CP 16	23	4	7	4	5	19	12	8	3	83	52	35	13	2.94	P
CP 17	22	4	4	6	5	18	14	8	3	82	64	36	14	2.75	P
CP 18	23	3	3	6	5	20	17	11	6	87	74	48	26	2.54	F
CP 19	21	6	6	3	4	15	9	6	2	71	43	29	10	3.25	P
CP 20	25	2	1	3	13	23	22	19	6	92	88	76	24	2.00	F
CP 21	25	0	3	6	12	25	22	16	4	100	88	64	16	2.21	F
CP 22	24	2	5	4	11	22	17	13	2	92	71	54	8	2.41	F
CP 23	23	6	9	3	3	17	8	5	2	74	35	22	9	3.39	P
CP 24	25	1	2	2	12	24	22	20	8	96	88	80	32	1.88	F
CP 25	25	4	8	3	4	21	13	10	6	84	52	40	24	2.92	P
CP 26	25	0	4	3	9	25	21	18	9	100	84	72	36	1.89	F
CP 27	22	5	12	3	2	17	5	2	0	77	23	9	0	3.50	P
	642					566	391	284	102	88	61	44	16	2.67	

random + fill-in points

6/23-24/2003	
Mean	2.74
Standard Error	0.110
Median	2.75
Mode	3.00
Standard Deviation	0.571
Sample Variance	0.326
Minimum	1.64
Maximum	3.72
Count	27

computed S.E. = 0.1098

95% conf. int. 2.95
2.52

n req'd (within 0.1")	α (%)
125	5
88	10
54	20

n req'd (within 0.2")	α (%)
31	5
22	10
13	20

random points

6/23-24/2003	
Mean	2.79
Standard Error	0.121
Median	2.84
Mode	3.00
Standard Deviation	0.539
Sample Variance	0.291
Minimum	1.64
Maximum	3.72
Count	20

computed S.E. = 0.1206

95% conf. int. 3.02
2.55

n req'd (within 0.1")	α (%)
112	5
79	10
48	20

n req'd (within 0.2")	α (%)
28	5
20	10
12	20

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ATTACHMENT 9

2004 Rock Gradation Monitoring Data

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Sample Year 2004	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	69	49
2	179	262
3	220	8
4	334	30
5	478	22
6	527	19
7	665	62
8	768	230
9	823	123
10	949	86
11	99	162
12	115	213
13	249	135
14	309	165
15	466	173
16	555	170
17	661	246
18	785	207
19	835	60
20	944	103

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7/13-14/2004 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained				cumulative number passing				cumulative percent passing				D_{50} (inch)	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch		
CP 1	25	2	2	5	13	23	21	16	3	92	84	64	12	2.23	F
CP 2	24	6	6	6	4	18	12	6	2	75	50	25	8	3.00	P
CP 3	25	2	6	3	10	23	17	14	4	92	68	56	16	2.35	F
CP 4	25	1	4	2	10	24	20	18	8	96	80	72	32	1.95	F
CP 5	25	2	3	2	8	23	20	18	10	92	80	72	40	1.81	F
CP 6	25	1	2	3	8	24	22	19	11	96	88	76	44	1.69	F
CP 7	24	3	3	4	8	21	18	14	6	88	75	58	25	2.25	F
CP 8	25	9	5	1	2	16	11	10	8	64	44	40	32	3.30	P
CP 9	24	5	8	1	7	19	11	10	3	79	46	42	13	3.13	P
CP 10	24	4	5	5	6	20	15	10	4	83	63	42	17	2.70	P
CP 11	25	1	1	11	7	24	23	12	5	96	92	48	20	2.52	F
CP 12	25	2	11	5	4	23	12	7	3	92	48	28	12	3.05	P
CP 13	25	1	6	4	11	24	18	14	3	96	72	56	12	2.36	F
CP 14	25	0	1	4	12	25	24	20	8	100	96	80	32	1.88	F
CP 15	25	4	9	4	5	21	12	8	3	84	48	32	12	3.06	P
CP 16	25	3	3	1	7	22	19	18	11	88	76	72	44	1.71	F
CP 17	24	4	11	5	4	20	9	4	0	83	38	17	0	3.27	P
CP 18	24	2	5	3	10	22	17	14	4	92	71	58	17	2.30	F
CP 19	25	1	2	4	11	24	22	18	7	96	88	72	28	2.00	F
CP 20	24	2	11	6	2	22	11	5	3	92	46	21	13	3.09	P

7/13-7/14/2004

Mean	2.48
Standard Error	0.123
Median	2.36
Standard Deviation	0.551
Sample Variance	0.304
Range	1.61
Minimum	1.69
Maximum	3.30
Sum	49.65
Count	20
Confidence Level(95.0%)	0.258

computed S.E. = 0.1233

95% conf. int. 2.72
2.24

n req'd (within 0.1")	α (%)
36	5
25	10
15	20

n req'd (within 0.2")	α (%)
9	5
6	10
4	20

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ATTACHMENT 10

2005 Rock Gradation Monitoring Data

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Sample Year 2005	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	61	81
2	116	113
3	239	165
4	340	19
5	478	92
6	574	14
7	619	149
8	738	242
9	847	6
10	942	68
11	5	78
12	177	159
13	253	86
14	311	259
15	420	162
16	519	65
17	614	57
18	799	224
19	828	110
20	948	83

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07/13/05 LAKEVIEW

D_{50} by size - 4 selves

sample	total	number retained				cumulative number passing				cumulative percent passing				D_{50}	
number	painted	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	(inch)	P/F
CP 1	25	3	6	3	9	22	16	13	4	88	64	52	16	2.44	F
CP 2	25	0	3	2	12	25	22	20	8	100	88	80	32	1.88	F
CP 3	25	1	4	1	10	24	20	19	9	96	80	76	36	1.85	F
CP 4	24	3	7	7	5	21	14	7	2	88	58	29	8	2.66	P
CP 5	24	2	5	2	5	22	17	15	10	92	71	63	42	1.90	F
CP 6	25	2	7	6	8	23	16	10	2	92	64	40	8	2.71	P
CP 7	25	0	2	1	11	25	23	22	11	100	92	88	44	1.64	F
CP 8	25	2	10	8	3	23	13	5	2	92	52	20	8	2.97	P
CP 9	25	3	13	4	3	22	9	5	2	88	36	20	8	3.27	P
CP 10	24	1	7	7	7	23	16	9	2	96	67	38	8	2.71	P
CP 11	24	3	8	5	5	21	13	8	3	88	54	33	13	2.90	P
CP 12	24	0	7	3	9	24	17	14	5	100	71	58	21	2.28	F
CP 13	24	1	0	3	9	23	23	20	11	96	96	83	46	1.61	F
CP 14	25	4	8	5	5	21	13	8	3	84	52	32	12	2.95	P
CP 15	25	2	9	4	8	23	14	10	2	92	56	40	8	2.81	P
CP 16	25	1	5	3	9	24	19	16	7	96	76	64	28	2.11	F
CP 17	25	1	6	3	9	24	18	15	6	96	72	60	24	2.22	F
CP 18	24	5	11	3	5	19	8	5	0	79	33	21	0	3.36	P
CP 19	25	1	0	4	6	24	24	20	14	96	96	80	56	1.25	F
CP 20	25	0	8	5	6	25	17	12	6	100	68	48	24	2.55	F

7/13/2005	
Mean	2.41
Standard Error	0.132
Median	2.50
Mode	#N/A
Standard Deviation	0.591
Sample Variance	0.349
Range	2.114
Minimum	1.25
Maximum	3.36
Sum	48.27
Count	20
Confidence Level(95.0%)	0.277

computed S.E. =	0.132
95% conf. Int.	2.67
	2.15

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ATTACHMENT 11

2006 Rock Gradation Monitoring Data

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Sample Year 2006	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	Data Records were not retained.	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

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07/19/06 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained				cumulative number passing				cumulative percent passing				D_{50} (inch)	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch		
CP 1	25	2	5	4	7	23	18	14	7	92	72	56	28	2.29	F
CP 2	25	0	1	4	10	25	24	20	10	100	96	80	40	1.75	F
CP 3	25	0	1	2	13	25	24	22	9	100	96	88	36	1.77	F
CP 4	25	0	2	3	14	25	23	20	6	100	92	80	24	1.96	F
CP 5	25	0	4	4	9	25	21	17	8	100	84	68	32	2.00	F
CP 6	25	5	6	3	9	20	14	11	2	80	56	44	8	2.75	P
CP 7	25	1	3	1	11	24	21	20	9	96	84	80	36	1.82	F
CP 8	24	7	8	5	2	17	9	4	2	71	38	17	8	3.38	P
CP 9	23	3	4	3	6	20	16	13	7	87	70	57	30	2.25	F
CP 10	25	0	2	3	17	25	23	20	3	100	92	80	12	2.06	F
CP 11	25	1	3	1	8	24	21	20	12	96	84	80	48	1.56	F
CP 12	25	0	4	6	10	25	21	15	5	100	84	60	20	2.25	F
CP 13	25	0	4	7	9	25	21	14	5	100	84	56	20	2.33	F
CP 14	25	1	3	2	16	24	21	19	3	96	84	76	12	2.09	F
CP 15	25	2	1	2	9	23	22	20	11	92	88	80	44	1.67	F
CP 16	24	6	7	5	4	18	11	6	2	75	46	25	8	3.14	P
CP 17	25	1	3	5	14	24	21	16	2	96	84	64	8	2.25	F
CP 18	25	2	5	4	5	23	18	14	9	92	72	56	36	2.20	F
CP 19	23	5	7	7	2	18	11	4	2	78	48	17	9	3.07	P
CP 20	23	1	5	6	6	22	17	11	5	96	74	48	22	2.54	F
	492	37	78	77	181	455	377	300	119	92	77	61	24	2.20	

7/19/2006	
Mean	2.26
Standard Error	0.112
Median	2.23
Mode	2.25
Standard Deviation	0.501
Sample Variance	0.251
Range	1.81
Minimum	1.56
Maximum	3.38
Sum	45.13
Count	20
Confidence Level(95.0%)	0.234

computed S.E. = 0.112

95% conf. int. 2.48
2.04

n req'd (within 0.1")	α (%)
24	5
17	10
10	20

n req'd (within 0.2")	α (%)
6	5
4	10
3	20

n req'd (within 0.15")	α (%)
11	5
8	10
5	20

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ATTACHMENT 12

2007 Rock Gradation Monitoring Data

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Sample Year 2007	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	Data Records were not retained.	
2		
3		
4		
5		
6		
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9		
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11		
12		
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14		
15		
16		
17		
18		
19		
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LAKEVIEW
7/10/2007

number retained				cumulative number passing				cumulative percent passing				D50	
4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	(inch)	P/F
3	4	4	7	21	17	13	6	88	71	54	25	2.36	F
1	4	6	10	24	20	14	4	96	80	56	16	2.35	F
1	7	7	8	24	17	10	2	96	68	40	8	2.68	F
0	7	5	8	25	18	13	5	100	72	52	20	2.44	F
2	5	5	7	23	18	13	6	92	72	52	24	2.43	F
2	3	3	7	22	19	16	9	92	79	67	38	1.93	F
0	1	3	12	25	24	21	9	100	96	84	36	1.79	F
0	6	0	13	25	19	19	6	100	76	76	24	2.00	F
2	0	0	14	23	23	23	9	92	92	92	36	1.75	F
2	5	3	9	23	18	15	6	92	72	60	24	2.22	F
6	7	5	3	17	10	5	2	74	43	22	9	3.21	P
1	6	3	11	24	18	15	4	96	72	60	16	2.27	F
0	3	11	8	25	22	11	3	100	88	44	12	2.57	F
4	8	2	6	19	11	9	3	83	48	39	13	3.06	P
0	1	2	11	25	24	22	11	100	96	88	44	1.64	F
2	3	0	13	23	20	20	7	92	80	80	28	1.92	F
4	7	2	8	21	14	12	4	84	56	48	16	2.63	F
4	4	7	7	19	15	8	1	83	65	35	4	2.75	P
1	5	3	9	23	18	15	6	96	75	63	25	2.17	F
0	4	7	8	25	21	14	6	100	84	56	24	2.31	F
												15% passing	
35	90	78	179	456	366	288	109	93	75	59	22	2.26	F

07/10/07	
Mean	2.32
Standard Error	0.094
Median	2.33
Mode	#N/A
Standard Deviation	0.421
Sample Variance	0.177
Range	1.58
Minimum	1.64
Maximum	3.21
Sum	46.48
Count	20
Confidence Level(95.0%)	0.197

computed S.E. =	0.094
95% conf. int.	2.51
	2.14

n req'd (within 0.1")	α (%)
12	5
8	10
5	20

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ATTACHMENT 13

2008 Rock Gradation Monitoring Data

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Sample Year 2008	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	10	200
2	187	76
3	226	251
4	352	119
5	445	111
6	531	113
7	671	113
8	726	15
9	832	181
10	965	101
11	32	95
12	136	30
13	256	92
14	351	3
15	408	14
16	567	108
17	657	262
18	722	125
19	870	32
20	928	118

06/24/08 **LAKEVIEW**

D_{50} by size - 4 seives

sample number	total painted	number retained				cumulative number passing				cumulative percent passing				D_{50} (inch)	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch		
CP 1	25	2	5	5	10	23	18	13	3	92	72	52	12	2.45	F
CP 11	24	5	7	5	5	19	12	7	2	79	50	29	8	3.00	P
CP 2	25	1	4	4	12	24	20	16	4	96	80	64	16	2.21	F
CP 12	25	1	4	3	12	24	20	17	5	96	80	68	20	2.13	F
CP 3	25	2	8	3	10	23	15	12	2	92	60	48	8	2.58	F
CP 13	24	1	3	2	14	23	20	18	4	96	83	75	17	2.07	F
CP 4	25	1	1	5	12	24	23	18	6	96	92	72	24	2.04	F
CP 14	25	0	5	6	12	25	20	14	2	100	80	56	8	2.38	F
CP 5	25	2	6	7	7	23	17	10	3	92	68	40	12	2.68	F
CP 15	25	3	6	3	7	22	16	13	6	88	64	52	24	2.43	F
CP 6	25	0	4	3	10	25	21	18	8	100	84	72	32	1.95	F
CP 16	25	3	4	3	10	22	18	15	5	88	72	60	20	2.25	F
CP 7	25	0	2	1	7	25	23	22	15	100	92	88	60	1.14	F
CP 17	25	1	1	5	15	25	24	19	4	100	96	76	16	2.07	F
CP 8	25	2	5	2	10	23	18	16	6	92	72	64	24	2.15	F
CP 18	25	6	6	6	3	19	13	7	4	76	52	28	16	2.96	P
CP 9	25	4	10	5	5	21	11	6	1	84	44	24	4	3.15	P
CP 19	25	1	4	5	9	24	20	15	6	96	80	60	24	2.22	F
CP 10	25	1	6	4	7	24	18	14	7	96	72	56	28	2.29	F
CP 20	25	0	5	7	12	25	20	13	1	100	80	52	4	2.46	F

06/24/08

Mean	2.33
Standard Error	0.098
Median	2.27
Mode	#N/A
Standard Deviation	0.437
Sample Variance	0.191
Range	2.01
Minimum	1.14
Maximum	3.15
Sum	46.60
Count	20
Confidence Level (95.0%)	0.204
computed S.E. =	0.098
95% conf. int.	2.52
	2.14

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ATTACHMENT 14

2009 Rock Gradation and Durability Monitoring Data

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Sample Year 2009	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	9	92
2	102	84
3	246	146
4	392	130
5	454	246
6	578	143
7	679	192
8	796	48
9	828	211
10	931	122
11	33	254
12	103	157
13	251	73
14	322	92
15	424	213
16	503	49
17	681	103
18	761	110
19	809	37
20	903	40

07/15/09 LAKEVIEW

D_{30} by size - 5 sieves

sample number	total painted	number retained					cumulative number passing					cumulative percent passing					D_{30} (inch)	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	1 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch		
CP 1	25	0	9	8	6	0	25	16	8	2	2	100	64	32	8	8	2.78	P
CP 11	25	1	7	5	8	3	24	17	12	4	1	96	68	48	16	4	2.55	F
CP 2	24	0	4	6	10	2	24	20	14	4	2	100	83	58	17	8	2.30	F
CP 12	23	3	6	3	5	4	20	14	11	6	2	87	61	48	26	9	2.58	F
CP 3	24	1	11	5	5	1	23	12	7	1	0	96	50	29	4	0	3.00	P
CP 13	25	0	2	3	16	3	25	23	20	4	1	100	92	80	16	4	2.03	F
CP 4	25	0	6	6	12	0	25	19	13	1	1	100	76	52	4	4	2.48	F
CP 14	25	1	6	2	12	4	24	18	16	4	0	96	72	64	16	0	2.21	F
CP 5	22	3	10	2	5	2	19	9	7	2	0	86	41	32	9	0	3.20	P
CP 15	25	1	11	2	8	1	24	13	11	3	2	96	52	44	12	8	2.88	P
CP 6	25	0	1	0	15	7	25	24	24	9	2	100	96	96	36	8	1.73	F
CP 16	25	1	5	5	11	3	24	19	14	3	0	96	76	56	12	0	2.36	F
CP 7	25	1	5	8	11	0	24	19	11	0	0	96	76	44	0	0	2.64	F
CP 17	25	1	2	2	10	9	24	22	20	10	1	96	88	80	40	4	1.75	F
CP 8	25	0	3	4	14	3	25	22	18	4	1	100	88	72	16	4	2.11	F
CP 18	25	3	5	5	10	1	22	17	12	2	1	88	68	48	8	4	2.55	F
CP 9	24	2	15	3	3	0	22	7	4	1	1	92	29	17	4	4	3.33	P
CP 19	25	1	3	6	6	8	24	21	15	9	1	96	84	60	36	4	2.06	F
CP 10	24	4	9	6	3	1	20	11	5	2	1	83	46	21	8	4	3.11	P
CP 20	25	0	2	6	9	5	25	23	17	8	3	100	92	68	32	12	2.00	F
																	30% passing	
	491	23	122	87	180	57	468	346	259	79	22	95	70	53	16	4	2.43	F

7/15/2009	
Mean	2.47
Standard Error	0.104
Median	2.41
Mode	2.55
Standard Deviation	0.466
Sample Variance	0.217
Range	1.6
Minimum	1.73
Maximum	3.33
Sum	49.4
Count	20
Confidence Level(95.0%)	0.218

computed S.E. =	0.104
95% conf. int.	2.67
	2.26

n req'd (within 0.1")	α (%)
18	5
13	10
8	20

LAKEVIEW TYPE B RIPRAP
2009 DURABILITY SUMMARY TABLE
(NUMBER OF OCCURRANCES RETAINED ON SIEVE)

	SIEVE SIZE							
DURABILITY CLASS	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	< 1 - inch		total by durability class	% of total
class A	10	41	26	84	22	1		184	37.5
class B	11	52	30	26	7	1		127	25.9
class Ca	1	22	23	43	13	3		105	21.4
class Cb	0	2	6	16	8	2		34	6.9
class Da	1	3	1	7	8	4		22	4.5
class Db	0	2	1	4	1	0		8	1.6
class E	0	0	0	0	0	11		11	2.2
								491	
total by sieve size	23	122	87	180	57	22	491	total	
% of total	4.7	24.8	17.7	36.7	11.6	4.5			

PERCENTAGE BY SIEVE SIZE

DURABILITY CLASS	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	< 1 - inch
class A	43.5	33.6	29.9	46.7	38.6	4.5
class B	47.8	42.6	34.5	14.4	12.3	4.5
class Ca	4.3	18.0	26.4	23.9	22.8	13.6
class Cb	0.0	1.6	6.9	8.9	14.0	9.1
class Da	4.3	2.5	1.1	3.9	10.5	18.2
class Db	0.0	1.6	1.1	2.2	1.8	0.0
class E	0.0	0.0	0.0	0.0	0.0	50.0

PERCENTAGE BYDURABILITY CLASS

DURABILITY CLASS	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	< 1 - inch
class A	5.4	22.3	14.1	45.7	12.0	0.5
class B	8.7	40.9	23.6	20.5	5.5	0.8
class Ca	1.0	21.0	21.9	41.0	12.4	2.9
class Cb	0.0	5.9	17.6	47.1	23.5	5.9
class Da	4.5	13.6	4.5	31.8	27.3	18.2
class Db	0.0	25.0	12.5	50.0	12.5	0.0
class E	0.0	0.0	0.0	0.0	0.0	100.0

Lakeview Riprap Gradation Testing Date 7/15/09

Sample #	random numbers pairs (x,y)		multiplier		sample locations		number retained						
	longitudinal (x)	transverse (y)	longitudinal (ft)	transverse (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	<1
1	0.09	0.34	100x	270y	9	92	25		A B A B A A A B B (9)	Cb Ca B Ca Ca A Ca Ca (8)	Da Ca A B A Ca (6)	(0)	B Da A E
11	0.33	0.94	100x	270y	33	254	25	B (1)	Db B B Ca B A Ca (7)	Ca A Ca Ca Ca B (5)	A Da A Ca Ca A B B (8)	Db Ca Da (3)	E (1)
2	0.02	0.31	100x + 100	270y	102	84	~~25~~ 24		B B B B (4)	B A Ca A Ca Ca (6)	Ca Ca B Ca A A A A B A (10)	A B (2)	Cb A E
12	0.03	0.58	100x + 100	270y	103	157	23	A A B (3)	Ca A B B Ca B (6)	B. Ca A (3)	A Ca Ca Ca Ca (5)	Cb Da A Ca (4)	E E (2)
3			100x + 200	270y									
13			100x + 200	270y									
4			100x + 300	270y									
14			100x + 300	270y									
5			100x + 400	270y									
15			100x + 400	270y									

Lakeview Riprap Gradation Testing

Date 7/14/09

Sample #	random numbers pairs (x,y): longitudinal (x)	transverse (y)	multiplier: longitudinal (ft)	transverse (ft)	sample locations: longitudinal distance (ft)	transverse distance (ft)	# painted	number retained: 4"	3"	2½"	1½"	1"	
~~1~~	~~0.04~~	~~0.34~~	100x	270y	~~4~~	~~92~~	~~25~~		~~ABAAB CCC~~	~~AACCA CCACB~~	~~CCCAB~~	~~AA~~	
~~11~~	~~0.33~~ REDONE	~~0.94~~	100x	270y	~~33~~	~~254~~	~~25~~	~~CCC BB~~	~~ABBB A~~	~~AAA~~	~~ACAAA BBAAB~~	~~AA~~	
~~2~~	~~0.62~~ SEE XTRA SHEET*	~~0.84~~	100x + 100	270y	~~162~~	~~84~~	~~25~~	~~BA~~	~~ABAAA AA~~	~~BBBBA BB~~	~~BAAAA~~	~~AAA Cb~~	
~~12~~	~~0.63~~	~~0.58~~	100x + 100	270y	~~163~~	~~157~~	~~25~~		~~ABAAB~~	~~ABBA~~	~~ABBBB BBC~~	~~BBCC AAC~~	C
3	0.46	0.54	100x + 200	270y	246	146	~~25~~ 24	BA (1)	(4) AAAAA AACaCa	BBBB AAAA A (6)	BAAAA A (6)	AAACa Da (1)	
13	0.51	0.27	100x + 200	270y	251	73	25		Ca B (2)	BAB (3)	A Ca ADb Ca Cb A Ca A A Ca A Da AB (16)	AAA (3)	Da (1)
4	0.92	0.48	100x + 300	270y	392	130	25		A Db A Ca B A (6)	BBBAAB (6)	AA Ca Cb A AAAAA Ca Cb (12)		Ca (1)
14	0.22	0.34	100x ÷ 300	270y	322	92	25	B (1)	ABA Ca Ca B (6)	BB (2)	BAAAAA Ca A Ca ABA (12)	Ca Da Ca Cb (4)	
5	0.54	0.91	100x + 400	270y	454	246	22	AAB (3)	BBBBDaBB Cb DaCa (10)	B Cb (2)	AADaAA (5)	A Da (2)	
15	0.24	0.19	100x + 400	270y	424	213	25	B (1)	B Ca BBBA Da B Ca AB (11)	B Ca (2)	Db Ca Ca BBA AB (8)	B (1)	EE (2)

* Durability classification still under development & needed consistent observer.

2009

Sample #	random numbers pairs (x,y)		multiplier		sample locations		number retained						
	longitudinal (x)	transverse (y)	longitudinal (ft)	transverse (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4"	3"	2½"	1½"	1"	
6	C.78	C.53	100x ÷ 500	270y	578	143	25	B (1)			Ca A Cb AA B B Cb B Cb A Cb A Cb Cb (15)	Cb Ca A A Da A Cb (7)	E Cb Ca (2)
16	C.C3	C.18	100x ÷ 500	270y	503	49	~~25~~ ~~24~~ 23 B (1)		AA Cb Ca A (5)	A Ca A B Ca (5)	Cb B Ca B Cb A B Cb A A A (11)	A Cb Cb (3)	
7	C.79	C.71	100x ÷ 600	270y	679	192	25 A (1)		A B B B Ca (5)	Cb B Db Cb B Ca Ca A (8)	A Ca Cb Da B Cb Ca Ca A Da Ca (11)		
17	C.81	C.38	100x ÷ 600	270y	681	103	25 B (1)		B Ca (2)	B Ca (2)	AA Ca B A B A AA Ca (10)	AA Cb B AA Ca A Cb (9)	E (1)
8	C.76	C.19	100x + 700	255y	796	~~5~~ 148	25		Ca B A (3)	Cb A B B (4)	Ca AA Ca A Ca B A A A Cb A Ca Ca (14)	AAA (3)	E (1)
18	C.61	C.43	100x + 700	255y	761	~~116~~ 110	25	B Ca Da (3)	Ca B AAA (5)	AA B Ca B (5)	Cb Cb A Ca AA Ca Ca B B (10)	A (1)	Da (1)
9	C.2E	C.1E	100x + 800	215y	828	~~265~~ 211	~~25~~ ~~24~~ 23 BA (2)		B B A B B A A B A B Ca A A A B (15)	A B A (3)	B Db B (3)		E (1)
19	C.09	C.17	100x + 800	215y	809	37	25 B (1)		B Ca A (3)	B A B B B B (6)	AAA Ca A Ca (6)	A B Ca A B Ca Ca B (8)	Da (1)
10	C.62	C.44	50x + 900	130y	931	122	24 BAAA (4)		A B B A A A Ca B B (9)	Da Ca Ca Cb A B (6)	Db Ca Da (3)	Ca (1)	E (1)
20	C.07	C31	50x + 900	130y	903	40	25		BB (2)	A A A A Ca Ca (6)	Ca A A A A A Ca A A (9)	Ca Ca A B Ca (5)	Ca Ca E (3)

ATTACHMENT 15

2010 Rock Gradation and Durability Monitoring Data

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Sample Year 2010	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	36	11
2	147	51
3	229	65
4	337	205
5	448	211
6	543	224
7	628	219
8	720	23
9	837	22
10	939	56
11	63	59
12	137	189
13	285	173
14	356	46
15	490	186
16	503	116
17	646	157
18	748	56
19	877	155
20	942	8

August 30,31 2010 LAKEVIEW
D_{50} BY SIZE - 5 SIEVES
GRADATION MONITORING

sample number	total painted	number retained						cumulative number passing					cumulative percent passing					D_{50}	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	<1-inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	(inch)	
CP 1	24	2	2	3	8	7	2	22	20	17	9	2	92	83	71	38	8	1.88	F
CP 11	26	0	9	1	12	2	2	26	17	16	4	2	100	65	62	15	8	2.25	F
CP 2	25	2	4	6	10	2	1	23	19	13	3	1	92	76	52	12	4	2.45	F
CP 12	26	1	7	6	10	0	2	25	18	12	2	2	96	69	46	8	8	2.58	F
CP 3	23	2	4	7	9	1	0	21	17	10	1	0	91	74	43	4	0	2.61	F
CP 13	23	0	4	4	12	1	2	23	19	15	3	2	100	83	65	13	9	2.21	F
CP 4	24	1	8	4	7	1	3	23	15	11	4	3	96	63	46	17	13	2.63	F
CP 14	25	2	9	3	10	1	0	23	14	11	1	0	92	56	44	4	0	2.75	P
CP 5	24	1	11	10	2	0	0	23	12	2	0	0	96	50	8	0	0	3.00	P
CP 15	25	0	3	7	12	2	1	25	22	15	3	1	100	88	60	12	4	2.29	F
CP 6	26	2	6	9	6	0	2	23	17	8	2	2	92	68	32	8	8	2.75	P
CP 16	25	3	3	4	10	2	3	22	19	15	5	3	88	76	60	20	12	2.25	F
CP 7	25	0	5	4	12	2	2	25	20	16	4	2	100	80	64	16	8	2.21	F
CP 17	25	1	3	6	13	0	2	24	21	15	2	2	96	84	60	8	8	2.31	F
CP 8	25	0	2	8	13	2	0	25	23	15	2	0	100	92	60	8	0	2.31	F
CP 18	25	1	4	8	11	0	1	24	20	12	1	1	96	80	48	4	4	2.53	F
CP 9	24	2	12	7	3	0	0	22	10	3	0	0	92	42	13	0	0	3.17	P
CP 19	25	2	0	2	9	5	7	23	23	21	12	7	92	92	84	48	28	1.56	F
CP 10	24	1	6	4	7	3	3	23	17	13	6	3	96	71	54	25	13	2.36	F
CP 20	26	3	2	10	10	1	0	23	21	11	1	0	88	81	42	4	0	2.50	F
	494	26	104	113	186	32	33	468	364	251	65	33	95	74	51	13	7	2.48	F

8/31/2010

Mean	2.43
Standard Error	0.081
Median	2.4036
Mode	2.25
Standard Deviation	0.3624
Sample Variance	0.1313
Range	1.61
Minimum	1.56
Maximum	3.17
Sum	48.67
Count	20

computed S.E. = 0.081

95% conf. int. 2.59
2.27

n req'd (within 0.1")	α (%)
7	5
5	10
3	20

LAKEVIEW TYPE B RIPRAP
2010 DURABILITY SUMMARY TABLE
(NUMBER OF OCCURRENCES RETAINED ON SIEVE)

DURABILITY CLASS & SUBCLASS	SIEVE SIZE 4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	< 1 - inch		total by durability class	% of total		
class Au	1	18	28	65	18	7		137	27.7		
class As	0	0	0	4	0	0		4	0.8		
class Ao1	1	6	4	4	0	0		15	3.0		
class Ao2	0	3	2	2	0	0		7	1.4		
class Ao3	0	1	0	0	0	0		1	0.2		
class Ao5	0	1	0	0	0	0		1	0.2		
class Ah1	0	6	8	23	2	2		41	8.3		
class Ah2	3	9	7	3	1	0		23	4.7	total "A"	% of
class Ah3	0	3	0	0	0	0		3	0.6	durability	total
class Ah4	1	0	0	0	0	0		1	0.2	233	47.2
class B	17	33	32	13	3	2		100	20.2		
class Ca	1	13	16	33	3	5		71	14.4		
class Cb	0	0	1	3	1	0		5	1.0		
class Da	2	6	10	20	0	3		41	8.3		
class Db	0	5	5	13	4	2		29	5.9		
class E	0	0	0	3	0	12		15	3.0		
								494	100.0		
total by sieve size	26	104	113	186	32	33	494	total			
% of total	5.3	21.1	22.9	37.7	6.5	6.7	100.0				

PERCENTAGE BY SIEVE SIZE

DURABILITY CLASS & SUBCLASS	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	< 1 - inch
class Au	3.8	17.3	24.8	34.9	56.3	21.2
class As	0.0	0.0	0.0	2.2	0.0	0.0
class Ao1	3.8	5.8	3.5	2.2	0.0	0.0
class Ao2	0.0	2.9	1.8	1.1	0.0	0.0
class Ao3	0.0	1.0	0.0	0.0	0.0	0.0
class Ao5	0.0	1.0	0.0	0.0	0.0	0.0
class Ah1	0.0	5.8	7.1	12.4	6.3	6.1
class Ah2	11.5	8.7	6.2	1.6	3.1	0.0
class Ah3	0.0	2.9	0.0	0.0	0.0	0.0
class Ah4	3.8	0.0	0.0	0.0	0.0	0.0
class B	65.4	31.7	28.3	7.0	9.4	6.1
class Ca	3.8	12.5	14.2	17.7	9.4	15.2
class Cb	0.0	0.0	0.9	1.6	3.1	0.0
class Da	7.7	5.8	8.8	10.8	0.0	9.1
class Db	0.0	4.8	4.4	7.0	12.5	6.1
class E	0.0	0.0	0.0	1.6	0.0	36.4
	100	100	100	100	100	100

LAKEVIEW TYPE B RIPRAP TESTING
2010 GRADATION BY WEIGHT SUMMARY

sample	weight D_{50} (mm)	inch
RR-11	60	2.36
RR-12	60	2.36
RR-13	60	2.36
RR-14	67	2.64
RR-15	53	2.09
RR-16	69	2.72
RR-17	50	1.97
RR-18	68	2.68
RR-19	31	1.22
RR-20	51	2.01

2010 gradation samples by weight

Mean	2.24
Standard Error	0.142
Median	2.36
Mode	2.36
Standard Deviation	0.449
Sample Variance	0.201
Range	1.50
Minimum	1.22
Maximum	2.72
Sum	22.40
Count	10

computed SE	0.142
+ 1.96 SE	2.52
- 1.96 SE	1.96

n req'd (within 0.1")	α (%)
16	5
11	10
7	20

2010 Lakeview Riprap Gradation Testing, pg 2/2

Date 8/30,31/10

Thickness		random numbers pairs (x,y)		multiplier		sample locations		number retained							
		longitudinal (x)	transverse (y)	longitudinal (ft)	transverse (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
	6	0.43	0.83	100x + ~~500~~	270y	~~543~~ 543	224	25	B Da (2)	Da Da Ah3 Da B Ca (6)	Cb Da Ao1 Au Au Da Ah1 Db Ah2 (9)	E Db Da E Da Ca (6)	(0)	E Da (2)
9"	16*	0.03	0.43	100x + 500	270y	503	116	25	BBB (3)	Ca Cb B (3)	B B Da B (4)	Da Ca Da Ca Au Ca Au Ca Au Ca (10)	Au Au (2)	E E E E (3)
	7	0.28	0.81	100x + ~~100~~ 600	270y	628	219	25	(0)	B Ah2 B Au Da (5)	Ao2 Ah2 B Ao1 (4)	Ca Db Ca Ca Da Ah2 Ah1 Au Au Ca Ca Ca (12)	Db Cb (2)	E Db (2)
11"	17*	0.46	0.58	100x + ~~100~~ 600	270y	646	157	25	Ah2 (1)	Au Au Ah1 (3)	B Au Ca Ca Au Au (6)	Ah1 Au Au Au Au Ah1 Ao1 Au Au Ca Ca Au Au (13)	(0)	Au B (2)
	8	0.20	0.09	100x + ~~200~~ 700	~~270y~~ 255y	720	23	25	(0)	Ah2 Au (2)	Au Ca Ca B B Au Ao2 Au (8)	Db Au Ah1 Ah1 Db Ah1 Au Ah1 Ah1 Ca Au Ah1 Au (13)	Au Au (2)	(0)
12.5"	18*	0.48	0.22	100x + ~~200~~ 700	~~270y~~ 255y	748	56	25	Ah2 (1)	B B Au Ah2 (4)	B Au Au Au Db Ah1 Ca Ca (8)	Au Ah1 Au Au Au Ah1 Au Au B Ah2 Au (11)	(0)	Ca (1)
	9	0.37	0.10	100x + ~~300~~ 800	~~270y~~ 215y	837	22	24	BB. (2)	Ah2 B Ah2 B Ao2 Ca Ao5 Au Ah1 Ao1 Ca Ca (12)	Ao1 Ca B Au B B Au (7)	Ao2 Ao1 Da (3)	(0)	(0)
"Streak" 9"	19*	0.77	0.72	100x + ~~300~~ 800	~~270y~~ 215y	877	155	25	Da B (2)	(0)	B Au (2)	Ca Ca Au Au Da Ah1 Ah1 Au Ca (9)	Ca Ah2 Ah1 Au B (5)	Ah1 Au Au Au Ah1 B Au (7)
	10	0.78	0.43	~~50~~ 100x + ~~400~~ 200	~~270y~~ 130y	978 39	56	24	Ah2 (1)	B Ca Db Db Ah2 Ao1 (6)	Au B Ah1 B (4)	Au Au Ah1 Da Db Db Da (7)	Au Au Au (3)	Au Ca Ca (3)
10.5"	20*	0.84	0.06	~~50~~ 100x + ~~400~~ 900	~~270y~~ 130y	984 42	8	26	BBB (3)	BB (2)	Au Ah1 Ah2 Ah2 Ah2 Da Au Da Ca Ah2 (10)	Ca Au Au Ca Ah1 Au Ah1 Da Au Au (10)	Au (1)	(0)

largest particle at depth of 4-5"

* gradation by weigh

2010 Lakeview Riprap Gradation Testing, pg 1/2

Date Aug 30-31, 2010

Thickness

		random numbers pairs (x,y)		multiplier		sample locations		number retained						
		longitudinal (x)	transverse (y)	longitudinal (ft)	transverse (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
	1	0.36	0.04	100x	270y	36	11	24	B Ao1 (2)	B Ca (2)	Ca Ca Au (3)	Cb Ca Au Da Ab1 Ao1 Au Da (8)	B Au Db Ca Au B Au (9)	Ca Db (2)
12"	11*	0.63	0.22	100x	270y	63	59	26 25	(0)	Au Da Ah1 Au B B Au B B (9)	B (1)	Db Da As Au Au As B Cb Au Ca Da Cb (12)	Au Au (2)	Da Au (2)
	2	0.47	0.19	100x + 100	270y	147	51	25	B Ca (2)	Au Ao B B (4)	B Ca Ah1 B Au Ah1 (6)	Ca B Da Au Ah1 Ca Ao2 Ah1 Au Ca (10)	Ca Au (2)	Ca (1)
8"	12*	0.34	0.70	100x + 100	270y	137	189	25 2.6	B (1)	Ca Ah2 Ah1 Ao1 Db Ca Db (7)	Ca Ca Ca Au Ah1 Au (6)	B Da Ca Au Ah1 Db Ca As Au Au (10)	(0)	E E (2)
	3	0.29	0.24	100x + 200	270y	229	65	23	BB (2)	Da Ah2 Ca Ao3 (4)	Ah2 Au B Ah1 Au Au Ca (7)	B Au Ah1 Au Ca Da Au Ca Ca (9)	Au (1)	(0)
12"	13*	0.85	0.64	100x + 200	270y	285	173	23	(0)	B B B Au (4)	Da B B Da (4)	Da Da Db B Ah1 Ah1 Au B B Au Au Au (12)	Ah1 (1)	Da E (2)
	4	0.37	0.76	100x + 300	270y	337	205	24	Ah4 (1)	Au B Ao1 Ao1 Au B B Ao2 (8)	B Da B B (4)	Ca B E Au Ah2 Au Ao1 (9)	Db (1)	E E E (3)
11"	14*	0.56	0.17	100x + 300	270y	356	46	25	B Au (2)	Db Au B Au Ca Au B B Ah2 (9)	Au B B (3)	Au Ca Au Au Au B Au Au Au Ca (10)	Au (1)	(0)
	5	0.48	0.78	100x + 400	270y	448	211	24	B (1)	Ao1 B Ca B Ah1 B Ah3 B B Ah1 Ao2 (11)	B Au B Db Ao1 B Ca Au B B (10)	Da B (2)	(0)	(0)
11"	15*	0.90	0.69	100x + 400	270y	490	186	25	(0)	Au Ah3 B (3)	B Au Db Da Db B Da (7)	Au Au B Db B Au Au Db Db Au Au Db (12)	Au Db (2)	E (1)

* gradation by weigh

ATTACHMENT 16

2011 Rock Gradation and Durability Monitoring Data

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Sample Year 2011	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	17	180.9
2	198	121.5
3	212	118.8
4	345	102.6
5	445	175.5
6	599	62.1
7	667	99.9
8	794	132.6
9	884	199.95
10	934.5	20.8
11	99	132.3
12	196	37.8
13	282	234.9
14	394	226.8
15	425	45.9
16	528	164.7
17	684	86.4
18	730	175.95
19	894	131.15
20	948	26

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September 7 - 8, 2011 LAKEVIEW
D_{60} by size - 6 selves

sample number	total painted	number retained 4 - inch	3 - inch	2.5 - inch	1.5 - inch	1-inch	<1-inch	cumulative number passing 4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	cumulative percent passing 4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	D_{60} (inch)	P/F
CP 1	23	0	3	6	8	6	0	23	20	14	6	0	100	87	61	26	0	2.19	F
CP 11	24	2	8	4	8	1	1	22	14	10	2	1	92	58	42	8	4	2.76	P
CP 2	24	0	4	8	11	0	1	24	20	12	1	1	100	83	50	4	4	2.50	F
CP 12	25	2	8	3	6	4	2	23	15	12	6	2	92	60	48	24	8	2.58	F
CP 3	24	2	3	4	13	2	0	22	19	15	2	0	92	79	63	8	0	2.27	F
CP 13	25	1	12	4	5	1	2	24	12	8	3	2	96	48	32	12	8	3.04	P
CP 4	24	1	6	2	7	5	3	23	17	15	8	3	96	71	63	33	13	2.07	F
CP 14	26	3	11	9	2	1	0	23	12	3	1	0	88	46	12	4	0	3.09	P
CP 5	25	1	6	2	13	1	2	24	18	16	3	2	96	72	64	12	8	2.23	F
CP 15	24	2	5	6	10	1	0	22	17	11	1	0	92	71	46	4	0	2.58	F
CP 6	24	0	8	5	11	0	0	24	16	11	0	0	100	67	46	0	0	2.60	F
CP 16	24	1	7	0	5	6	5	23	16	16	11	5	96	67	67	46	21	1.70	F
CP 7	25	2	4	1	14	2	2	23	19	18	4	2	92	76	72	16	8	2.11	F
CP 17	24	1	2	1	13	4	3	23	21	20	7	3	96	88	83	29	13	1.88	F
CP 8	23	2	15	3	3	0	0	21	6	3	0	0	91	26	13	0	0	3.37	P
CP 18	24	0	2	3	15	2	2	24	22	19	4	2	100	92	79	17	8	2.03	F
CP 9	23	4	7	4	4	1	3	19	12	8	4	3	83	52	35	17	13	2.94	P
CP 19	25	2	7	4	9	2	1	23	16	12	3	1	92	64	48	12	4	2.56	F
CP 10	24	5	11	3	5	0	0	19	8	5	0	0	79	33	21	0	0	3.36	P
CP 20	24	3	4	1	7	9	0	21	17	16	9	0	88	71	67	38	0	1.93	F
total sum	484	34	133	73	169	48	27	460	317	244	75	27	93	65	50	15	6	2.49	F

Sept. 8, 2011	
Mean	2.49
Standard E	0.109
Median	2.53
Mode	2.58
Standard D	0.489
Sample Va	0.239
Range	1.67
Minimum	1.70
Maximum	3.37
Sum	49.79
Count	20

computed S.E. = 0.109

95% conf. Int. 2.70
2.28

n req'd (within 0.1")	α (%)
22	5
15	10
9	20

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2011 Durability Monitoring – Percent of Total Rock Count By Durability Class and Sieve Size

Durability Class & Subclass	Rock Count by Sieve Size (Retained on Sieve)						Total By Durability Class	Percent of Total
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch		
Class Au	2	9	5	23	14	1	54	11.2
Class As	0	1	2	3	0	1	7	1.4
Class Ao1	1	9	4	5	0	0	19	3.9
Class Ao2	0	1	0	0	0	0	1	0.2
Class Ao3	1	0	0	0	0	0	1	0.2
Class Ao4	0	0	0	0	0	0	0	0
Class Ao5	0	0	0	0	0	0	0	0
Class Ah1	0	14	11	10	1	1	37	7.6
Class Ah2	2	7	0	2	2	0	13	2.7
Class Ah3	1	4	1	0	0	0	6	1.2
Class Ah4	0	0	0	0	0	0	0	0
Total A Class	7	45	23	43	17	3	138	28.5
Class B	17	46	27	35	9	1	135	27.9
Class Ca	1	20	9	43	4	4	81	16.7
Class Cb	7	13	9	30	7	0	66	13.6
Class Da	1	6	1	10	9	11	38	7.9
Class Db	1	3	4	5	1	4	18	3.7
Class E	0	0	0	3	1	4	8	1.7
Class F	0	0	0	0	0	0	0	0
Total by Sieve Size	34	133	73	169	48	27	484	–
Percent of Total	7.0	27.5	15.1	34.9	9.9	5.6	100	–
Total by Durability Class	–	–	–	–	–	–	484	100

2011 Durability Monitoring – Percent Durability Class By Sieve Size

Durability Class & Subclass	Percent by Sieve Size (Retained on Sieve)					
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch
Class Au	5.9	6.8	6.8	13.6	29.2	3.7
Class As	0.0	0.8	2.7	1.8	0.0	3.7
Class Ao1	2.9	6.8	5.5	3.0	0.0	0.0
Class Ao2	0.0	0.8	0.0	0.0	0.0	0.0
Class Ao3	2.9	0.0	0.0	0.0	0.0	0.0
Class Ao4	0.0	0.0	0.0	0.0	0.0	0.0
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0
Class Ah1	0.0	10.5	15.1	5.9	2.1	3.7
Class Ah2	5.9	5.3	0.0	1.2	4.2	0.0
Class Ah3	2.9	3.0	1.4	0.0	0.0	0.0
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0
Total A Class	20.6	34.0	31.5	25.4	35.4	11.1
Class B	50.0	34.6	37.0	20.7	18.8	3.7
Class Ca	2.9	15.0	12.3	25.4	8.3	14.8
Class Cb	20.6	9.8	12.3	17.8	14.6	0.0
Class Da	2.9	4.5	1.4	5.9	18.8	40.7
Class Db	2.9	2.3	5.5	3.0	2.1	14.8
Class E	0.0	0.0	0.0	1.8	2.1	14.8
Class F	0.0	0.0	0.0	0.0	0.0	0.0
Total Percent	100	100	100	100	100	100

2011 Durability Monitoring – Percent Sieve Size By Durability Class

Durability Class & Subclass	Percent by Sieve Size (Retained on Sieve)						Total Percent
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch	
Class Au	3.7	16.7	9.3	42.6	25.9	1.9	100
Class As	0	14.3	28.6	42.9	0	14.3	100
Class Ao1	5.3	47.4	21.1	26.3	0	o	100
Class Ao2	0	100	0	0	0	0	100
Class Ao3	100	0	0	0	0	0	0
Class Ao4	0	0	0	0	0	0	NA[1]
Class Ao5	0	0	0	0	0	0	NA
Class Ah1	0	37.8	29.7	27.0	2.7	2.7	100
Class Ah2	15.4	53.9	0	15.4	15.4	0	100
Class Ah3	16.7	66.7	16.7	0	0	0	100
Class Ah4	0	0	0	0	0	0	NA
Class B	12.6	34.1	20.0	25.9	6.7	0.7	100
Class Ca	1.2	24.7	11.1	53.1	4.9	4.9	100
Class Cb	10.6	19.7	13.6	45.5	10.6	0	100
Class Da	2.6	15.8	2.6	26.3	23.7	29.0	100
Class Db	5.6	16.7	22.2	27.8	5.6	22.2	100
Class E	0	0	0	37.5	12.5	50.0	100
Class F	0	0	0	0	0	0	NA

1 NA = Not Applicable

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Conservative-turning rock to find smallest dimension.

2011 Lakeview Riprap Gradation and Durability Monitoring

	random numbers pairs (x,y)		multiplier		sample locations		number retained							
	longitudinal (x)	transverse (y)	longitudinal (ft)	transverse (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"	
1	0..17	0.67	100x	270y	17	180.9	23		Au, B, Da	Da, Ah1, Ao1, Ca, B, Ca	Ah1, Cb, Cb, Ca, Au, Au, Au, Ca	B, B, Da, Ah2 Au, B.		24 23 bots for Degraded Rock.
11	0.99	0.49	100x	270y	99	132.3	24	Au, B	Ah3, B, Au B, Db, Ao1 B, B	B, Cb, Db Db	B, Au, Ca, Cb, Au, Cb Au Cb	Da,	Ca	24
2	0.98	0.45	100x + 100	270y	198	121.5	24		As, Da, B Ca	As, Ca, Ao Ah, Cb, Ao, Cb B, Cb	B, Ah1 Da Cb, Da, B Ah1, Cb, B, Ca Ah2		Db	24
12	0.96	0.14	100x + 100	270y	196	37.8	25	B, Ao4,	B, Ah2, Ao1 Ca, Ah2, Ao2 B, Ah1	Ca, Cb, B,	Ca, B, Ah1, Ca Ca, Ca	Da, Au, B, Da	Da, E	25
3	0.12	0.44	100x + 200	270y	212	118.8	24	Db, Ca	Cb, B, B	Ah1, B, Db Db	Cb, Da, Au, Cb Cb, Db, Da, B Cb, Da, Ca Ca, Ca	Da Ca Ca	E	exceed up 23 1 2 splits
13	0.82	0.87	100x + 200	270y	282	234.9	24 25	B	B, Ah1, Ah3, B B, B, Da, Ca Ca, B, B, B	Cb, Au, B, B Ca	Da, Db, B, Ca Ca	Cb	Db, E	25
4	0.45	0.38	100x + 300	270y	345	102.6	24	Ah2	B, B, Ah2, Ca Ah1, B,	Au, B	B, Ca, Cb, Cb Ca, B, Ca	Au, B, Au, Au Cb,	As, Db, Da	24
14	0.94	0.84	100x + 300	270y	394	226.8	26	Cb, Cb, B	Ca, Cb, Cb Db, Ca, Ah2 B, Cb, B, Db B	As, B, Ca, B Ah1, Ah1, B B, Ah1	B, Cb, Ca	Au		25
5	0.45	0.65	100x + 400	270y	445	175.5	25	B	Ah3, Ah1, Au Ah1, Ao1, Ca	B, Ah1,	Ca, Au, Cb B, Ca, B, Au E, B, Ca, B, B B	Da	Da, Ca	25
15	0.25	0.17	100x + 400	270y	425	45.9	24	Cb, Ah3	Ao1, Cb, Ao1, Ca B, ~~Ah~~	Ah1, B, B, B B, Au	Au, Ah1, Ca Ca, Ah1, B, B Ao1, Au, Db	Db		24

September 2, 2011

Sample location stakes placed 9/6/11
Monitoring field work Date 9/7-9/8/11.
Dan Nordeen - gradation
Kyle Turley - durability / rock type

2011 Lakeview Riprap Gradation Testing, pg 2/2

Date 9/7-8/11

	random numbers pairs (*x,y*)		multiplier		sample locations		number retained							
	longitudinal (*x*)	transverse (*y*)	longitudinal (ft)	transverse (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4"	3"	2½"	1½"	1"	<1"	
6	0.99	0.23	100*x*+500	270*y*	599	62.1	24		Ah2, Ah1, B B, Cb, Cb, Ah1 B	Ca, Ca, Cb, Ca AO1,	B, Ca, Ca, Au AO1, As, As, B Cb, Cb, Db			24 ~~25~~
16	0.28	0.61	100*x*+500	270*y*	528	164.7	~~22~~ 24	B	B, Ca, B, AO1 Au, Ca, Ca		Ca, Ca, Au, Au, Db	Ca, Ah2, Ah1 B, Au, Au	Da, Da, Au Da, Ca	24
7	0.67	0.37	100*x* + 600	270*y*	667	99.9	25	B, Ah2	B, Da, Ca. Ah1,	B	Ah1, cb, Ca, AO1 Au, Cb, Da, Cb Cb, Ca, B, Da Da, Cb	Da, Cb	E, Db	25
17	0.84	0.32	100*x* + 600	270*y*	684	86.4	24	Au	Ca, B	Ah1,	Ah1, Ah1, Au, Ca, Cb, Ca, Cb Au, Ca, Ca, Ah1 B, B	Au, B, Ca, Au	Da, Ca, Ah1	24
8	0.94	0.52	100*x* + 700	255*y*	794	132.6	23	Cb, Cb	Ca, Ah1, Ah1 B, B, B, Ah1 Au, Ah2, B, Cb B, B, Au, Cb	Au, Cb, B	B, Da, Ca			23 ~~24~~
18	0.30	0.69	100*x* + 700	255*y*	730	175.95	24		Ah1, Db, Cb	B, Ah1, Ah1	B, Ca, B, Au Cb, Au, Ca, Au Au, B, E, AO1 Ah2, Ca, Ad1	Da, Cb	E, Ca	25
9	0.84	0.93	100*x* + 800	215*y*	884	199.95	23	B, B, B, AO1	Ah3, Au, B Ah1, Ca, Ah2 Cb	B, B, Cb, B	Cb, Cb, Cb, Au	Da	Da, Da, Da	23
19	0.94	0.61	100*x* + 800	215*y*	891	131.15	25	B, B	B, Ca, Da, Ca Ah1, B, B	B, B, Au, B	B, Ca, Ca, B, B B, AS, B, B	Cb, B	B	25
10	0.69	0.16	50*x* + 900	130*y*	934.5	20.8	24	Cb, B, B, B, B	AO1, Au, B Cb, B3, Cb, Da AO1, Ca, B, Au	Ah3, B, Cb	B, B, Ca, Cb Ca			24 ~~25~~
20	0.96	0.20	50*x* + 900	130*y*	948	26	24	Cb, B, Da	B, Ca, B, AO1	B	Ca, Cb, Au, Ca ~~Cb~~ E, Ca, Ca	F, Cb, Au, B Au, Cb, Au, Au Ca,		24

ATTACHMENT 17

2012 Rock Gradation and Durability Monitoring Data

Sample Year 2012	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	13	18.8
2	152	62.1
3	246	189
4	378	243
5	407	234.9
6	599	194.4
7	693	203
8	776	66.3
9	838	199.95
10	936	96.2
11	58	256.5
12	171	221.4
13	276	162
14	305	143.1
15	435	83.7
16	588	64.8
17	685	8.1
18	745	71.4
19	809	21.5
20	933	110.5

2012 Type B Riprap Durability Monitoring Summary Table – Number of Occurrences Retained on Sieve

Durability Class & Subclass	Sieve Size						Total By Durability Class	Percent of Total
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	<1 Inch		
Class Au	1	6	11	23	5	0	46	9.7
Class As	1	3	0	1	1	0	6	1.3
Class Ao1	2	4	2	6	0	0	14	2.9
Class Ao2	2	4	1	1	0	0	8	1.7
Class Ao3	0	1	1	0	0	0	2	0.4
Class Ao4	0	0	0	0	0	0	0	0.0
Class Ao5	0	1	0	0	0	0	1	0.2
Class Ah1	3	19	10	19	2	0	53	11.1
Class Ah2	2	10	4	6	0	0	22	4.6
Class Ah3	0	0	0	1	0	0	1	0.2
Class Ah4	0	0	0	0	0	0	0	0.0
Total A Class	11	48	29	57	8	0	153	32.1
Class B	19	58	39	12	2	0	130	27.3
Class Ca	4	17	22	37	6	1	87	18.3
Class Cb	0	1	3	5	2	0	11	2.3
Class Da	3	8	9	23	6	12	61	12.8
Class Db	1	6	7	9	2	2	27	5.7
Class E	0	0	0	4	3	0	7	1.5
Class F	0	0	0	0	0	2	2	0.4
Total by Sieve Size	38	138	109	147	29	15	476	–
Percent of Total	8.0	29.0	22.9	30.9	6.1	3.2	100	–
Total by Durability Class	–	–	–	–	–	–	476	100

2012 Type B Riprap Durability Monitoring Summary Table – Percentage Passing By Sieve Size

Durability Class & Subclass	Sieve Size					
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch
Class Au	2.6	4.3	10.1	15.6	17.2	0.0
Class As	2.6	2.2	0.0	0.7	3.4	0.0
Class Ao1	5.3	2.9	1.8	4.1	0.0	0.0
Class Ao2	5.3	2.9	0.9	0.7	0.0	0.0
Class Ao3	0.0	0.7	0.9	0.0	0.0	0.0
Class Ao4	0.0	0.0	0.0	0.0	0.0	0.0
Class Ao5	0.0	0.7	0.0	0.0	0.0	0.0
Class Ah1	7.9	13.8	9.2	12.9	6.9	0.0
Class Ah2	5.3	7.2	3.7	4.1	0.0	0.0
Class Ah3	0.0	0.0	0.0	0.7	0.0	0.0
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0
Class B	50.0	42.0	35.8	8.2	6.9	0.0
Class Ca	10.5	12.3	20.2	25.2	20.7	6.7
Class Cb	0.0	0.7	2.8	3.4	6.9	0.0
Class Da	7.9	5.8	8.3	15.6	20.7	80.0
Class Db	2.6	4.3	6.4	6.1	6.9	13.3
Class E	0.0	0.0	0.0	2.7	10.3	0.0
Class F	0.0	0.0	0.0	0.0	0.0	13.3
Total Percent	100	100	100	100	100	100

2012 Type B Riprap Durability Monitoring Summary Table – Percentage Passing By Durability Class

Durability Class & Subclass	Sieve Size						Total Percent
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch	
Class Au	2.2	13.0	23.9	50.0	10.9	0.0	100
Class As	16.7	50.0	0.0	16.7	16.7	0.0	100
Class Ao1	14.3	28.6	14.3	42.9	0.0	0.0	100
Class Ao2	25.0	50.0	12.5	12.5	0.0	0.0	100
Class Ao3	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ao4	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ah1	5.7	35.8	18.9	35.8	3.8	0.0	100
Class Ah2	9.1	45.5	18.2	27.3	0.0	0.0	100
Class Ah3	0.0	0.0	0.0	100.0	0.0	0.0	100
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0	0
Class B	14.6	44.6	30.0	9.2	1.5	0.0	100
Class Ca	4.6	19.5	25.3	42.5	6.9	1.1	100
Class Cb	0.0	9.1	27.3	45.5	18.2	0.0	100
Class Da	4.9	13.1	14.8	37.7	9.8	19.7	100
Class Db	3.7	22.2	25.9	33.3	7.4	7.4	100
Class E	0.0	0.0	0.0	57.1	42.9	0.0	100
Class F	0.0	0.0	0.0	0.0	0.0	100.0	100

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08/29/12 **LAKEVIEW**

D_{60} by size - 5 seives

sample number	total painted	number retained						cumulative number passing					cumulative percent passing					D_{50}	P/F
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0-inch	<1-inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	(inch)	
CP 1	25	6	7	6	5	0	1	19	12	6	1	1	76	48	24	4	4	3.07	F P
CP 11	25	1	8	8	6	2	0	24	16	8	2	0	96	64	32	8	0	2.78	P
CP 2	24	0	9	6	4	3	2	24	15	9	5	2	100	63	38	21	8	2.75	P
CP 12	23	2	7	5	7	2	0	21	14	9	2	0	91	61	39	9	0	2.75	P
CP 3	25	2	8	7	8	0	0	23	15	8	0	0	92	60	32	0	0	2.82	P
CP 13	24	1	10	5	7	1	0	23	13	8	1	0	96	54	33	4	0	2.90	P
CP 4	23	5	14	2	2	0	0	18	4	2	0	0	78	17	9	0	0	3.54	F P
CP 14	24	1	6	4	12	1	0	23	17	13	1	0	96	71	54	4	0	2.42	F
CP 5	23	9	11	1	1	1	0	14	3	2	1	0	61	13	9	4	0	3.77	P
CP 15	25	1	2	8	13	1	0	24	22	14	1	0	96	88	56	4	0	2.38	F
CP 6	22	1	11	4	4	1	1	21	10	6	2	1	95	45	27	9	5	3.09	P
CP 16	25	0	4	5	13	2	1	25	21	16	3	1	100	84	64	12	4	2.23	F
CP 7	21	4	13	2	2	0	0	17	4	2	0	0	81	19	10	0	0	3.50	P
CP 17	25	0	2	1	13	5	4	25	23	22	9	4	100	92	88	36	16	1.77	F
CP 8	25	0	3	6	8	3	5	25	22	16	8	5	100	88	64	32	20	2.06	F
CP 18	25	0	5	11	9	0	0	25	20	9	0	0	100	80	36	0	0	2.66	F
CP 9	22	1	2	6	9	4	0	21	19	13	4	0	95	86	59	18	0	2.28	F
CP 19	25	2	6	5	9	0	3	23	17	12	3	3	105	77	55	14	14	2.40	F
CP 10	23	1	9	6	5	2	0	22	13	7	2	0	88	52	28	8	0	2.96	P
CP 20	24	1	1	11	10	1	0	23	22	11	1	0	100	96	48	4	0	2.52	F
total sum	478	38	138	109	147	29	17	440	302	193	46	17	92	63	40	10	4	2.71	P

08/29/12	
Mean	2.74
Standard E	0.111
Median	2.75
Mode	2.75
Standard D	0.497
Sample Va	0.247
Range	2.00
Minimum	1.77
Maximum	3.77
Sum	54.83
Count	20

computed S.E. = 0.111

95% conf. int. 2.96
2.52

n req'd (within 0.1")	α (%)
23	5
16	10
10	20

2012 Lakeview Riprap Gradation and Durability Monitoring

	random numbers pairs (*x*, *y*)		multiplier		sample locations N W/E		number retained						
	longitudinal (*x*)	transverse (*y*)	Longitudinal[1] (ft)	Transverse[2] (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
1	0.13	0.44	100*x*	270*y*	13	118.8	25 ✓	B, B, As, B, B, B	B, Ah1, B, B, Ah1 Da, Ah1	Ah2, B, Ca, B B, Ah1	E, Ca, Ca, Da Db		Db
11	0.58	0.95	100*x*	270*y*	58	256.5	25 ✓	B	B, Da, As, Au Ca, Ao2, B, B	B, B, B, Au, Ca Ca, Ca, B	Ca, As, B, Ca B, Ca	Da, E	
2	0.52	0.23	100*x* + 100	270*y*	152	62.1	24 ✓		B, Ah2, Da, B Da, B, Ca, B, Ah2	Da, B, Au, Ao3 Cb, Ah2	Da, Cb, B, Ao1	E, Da, Da	Da, Da
12	0.71	0.82	100*x* + 100	270*y*	171 ~~171~~ amH	221.4	23 ✓	B, Ca	B, Ca, B, Ah2 Ca, B, B	Ah2, Au, B, B Db,	B, Ca, Ca, Db Ah2, Au, Ca	E, Db	
3	0.46	0.70	100*x* + 200	270*y*	246	189	25 ✓	B, Au,	B, B, Ao5, B, Db, Ca, Ca, Ah1	Au, Ca, Ca, B, Ca, Ah1, B	Ah1, E Ah2 Au, Ca, Db Ca, Ca		
13	0.76	0.60	100*x* + 200	270*y*	276	162	24 ✓	Ca,	Ao2, B, Ah1 B, Ah1, Ah2 Da, Ah2, Ah1 B	Db, Ca, B, B Au	Ah2, Ah1, B, Db, Ah2, Ah2 Au	Au	
4	0.78	0.90	100*x* + 300	270*y*	378	243	23 ✓	B, Da, Ao1 Ah2, Ao2	Ah2, B, Ao2 Au, Ca, B Ao1, Au, Ao3	Ah1, Da,	B, Au,		
14	0.05	0.53	100*x* + 300	270*y*	305	143.1	24 ✓	B,	B, Ca, B, Ah1, B Ah2, Ah2, Ao2 Ah1, B, B,	Da, Ca, Ao1, Ca	Ah1, Ah1, Ah1 Ah3, Ah1, E E, Ca, Au, Au Da, Ca	Ca	
5	0.07	0.87	100*x* + 400	270*y*	407	234.9	23 ✓	Ao2, B, B, B, Ca, B Ao1, B, B	Ao1, B, Db, B, B, Ca B, B, As, Ao1, Da	Ao2	Ah1,	Da,	
15	0.35	0.31	100*x* + 400	270*y*	435	83.7	25 ✓	B	Au, B,	B, ~~Ah1~~ amH B, B Au, Db, B, B Ah1	Au, Ah1, Ao1 Ah1, Cb, Au, B, Ah1, Ao1, Au Ao1, Ca, Ah1,	Au amH 5	~~25~~ 25 ✓

amH = Ann M. Houska

only Monitoring Dates: amH 8/29/12 ~~8/29/12~~ Monitoring Team: Craig Goodknight Kyle Turley

2012 Lakeview Riprap Gradation and Durability Monitoring, pg 2/2 N W **Date**

	random numbers pairs (*x*, *y*)		multiplier		sample locations		number retained						
	longitudinal (*x*)	transverse (*y*)	longitudinal[1] (ft)	Transverse[2] (ft)	longitudinal distance (ft)	transverse distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
6	0.99	0.72	100*x* + 500	270*y*	599	194.4	22	Ah1	Ca, B, B, B, B B, B, Au, B, B Ca,	Ca, Ca, Ca, B	Ca, Au, B, Au	Da	Da
16	0.88	0.24	100*x* + 500	270*y*	588	64.8	25		Ah1, Db, Ah1, B	B, Ah1, Au, Ca B	Da, Da, Da, Da Da, Db, Ah1, Au Da, Da, Ca, Au B	B, Au	Da
7	0.93	0.75	100*x* + 600	270*y*	693	203 3	21	B, Ah1, Da, Ah2,	B, Ah1, Ah1, Db B, Ca, Ah2, B, Ca, B, Da, Da A01	Ah1, Ca	Au, Da		
17	0.85	0.03	100*x* + 600	270*y*	685	8.1	25		Ah2, B	B,	Au, A02 Ca, Da, Db, Da Ca, Db, Ah1, Au Ah1, Au, A01	Au, Au, B, Ah1, Au	F, F, Db, Ca
8	0.76	0.26	100*x* + 700	255*y*	776	66.3	25		Db, Ah1, B	Db, Au, Ca Cb, Ca, B	Au, Ca, Da Ca, Ca, Ca, Da, Db,	Ca, Cb, Ca	Da, Da, Da Da, Da
18	0.45	0.28	100*x* + 700	255*y*	745	71.4	25		B, Au, B, Ah1 Ah1,	Db, B, Au, Cb Au, B, A01, Db Ca, Da, Ca	Db, Ca, B, Ah1 Da, Da, Au, Ah2 Ca		
9	0.38	0.93	100*x* + 800	215*y*	838	199.95	22	Ah1	Ca, B	Ca, B, B, B, B, B	B, Ca, Ah1, Au Au, Au, Ca Ca, A01	Ca, Cb, Da, Ca	
19	0.09	0.10	100*x* + 800	215*y*	809	21.5	25	Da, Db	B, B, Ca, B Ca, B	B, Ca, Da Da, Ah1	Da, Cb, Ca Cb, Au, Ca Cb, Da, Ca		Da, Da, Da
10	0.72	0.74	50*x* + 900	130*y*	936	96.2	23	Ca	Ah1, B, Ah1, B Ah1, Db, As, B Ca	B, B, Ah1, Db Ca, B	Ca, Ca, Ca, Da Da	Db, Ca	
20	0.66	0.85	50*x* + 900	130*y*	933	110.5	24	B	B	B, Ah1, B, Ah1, B Au, Da, Ah2, B Da, Da	B, Ca, Ca, Ah1 Da, Ca, Da, Ah1 Ah1, Ca	Ah1	

1 Measured along side slope/top slope break; measurements start from the south end of the west side slope.
2 Measured down slope from top of side slope.

Monitoring Dates: 8/29/12 Monitoring Team: Craig Goodknight, Kyle Turley

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ATTACHMENT 18

2013 Rock Gradation and Durability Monitoring Data

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Sample Year 2013	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	98	124.2
2	173	99.9
3	266	99.9
4	346	75.6
5	410	194.4
6	517	10.8
7	629	37.8
8	743	89.3
9	853	137.6
10	924	2.6
11	80	140.4
12	200	156.6
13	239	218.7
14	379	259.2
15	490	197.1
16	596	48.6
17	672	162
18	731	249.9
19	882	178.5
20	913	101.4

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08/27/13 **LAKEVIEW**

D_{50} by size - 5 seives

sample number	total painted	number retained						cumulative number passing				
		4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0-inch	<1-inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch
CP 1	25	4	6	7	7	1	0	21	15	8	1	0
CP 11	24	0	6	4	7	4	3	24	18	14	7	3
CP 2	23	2	8	3	9	1	2	21	13	10	1	0
CP 12	25	2	7	5	7	2	0	23	16	11	4	2
CP 3	25	0	10	7	6	1	1	25	15	8	2	1
CP 13	24	3	5	5	8	1	2	21	16	11	3	2
CP 4	23	0	6	2	9	4	2	23	17	15	6	2
CP 14	23	4	16	2	1	0	0	19	3	1	0	0
CP 5	24	3	12	3	4	0	2	21	9	6	2	2
CP 15	25	0	5	3	9	6	2	25	20	17	8	2
CP 6	25	1	8	4	10	1	1	24	16	12	2	1
CP 16	25	0	2	2	16	4	1	25	23	21	5	1
CP 7	25	1	3	3	7	10	1	24	21	18	11	1
CP 17	25	0	7	7	8	2	1	25	18	11	3	1
CP 8	24	4	10	7	2	1	0	20	10	3	1	0
CP 18	22	9	10	2	0	1	0	13	3	1	1	0
CP 9	23	4	13	4	0	0	2	19	6	2	2	2
CP 19	25	4	10	5	3	0	3	21	11	6	3	3
CP 10	24	1	10	5	6	0	2	23	13	8	2	2
CP 20	25	1	6	2	12	2	2	24	18	16	4	2
total sum	484	43	160	82	131	41	27	441	281	199	68	27

8|27|13

cumulative percent passing					D_{50}	
4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	(inch)	P/F
84	60	32	4	0	2.82	P
100	75	58	29	13	2.21	F
91	57	43	4	0	2.75	P
92	64	44	16	8	2.65	F
100	60	32	8	4	2.82	P
88	67	46	13	8	2.60	F
100	74	65	26	9	2.11	F
83	13	4	0	0	3.53	P
88	38	25	8	8	3.25	P
100	80	68	32	8	2.00	F
96	64	48	8	4	2.56	F
100	92	84	20	4	1.97	F
96	84	72	44	4	1.58	F
100	72	44	12	4	2.61	F
83	42	13	4	0	3.20	P
59	14	5	5	0	3.80	P
83	26	9	9	9	3.42	P
91	48	26	13	13	3.05	P
92	52	32	8	8	2.95	P
100	75	67	17	8	2.17	F
91	58	41	14	6	2.76	P

08/27/13	
Mean	2.70
Standard Error	0.129
Median	2.70
Mode	2.82
Standard Deviation	0.579
Sample Variance	0.335
Range	2.22
Minimum	1.58
Maximum	3.80
Sum	54.06
Count	20

computed S.E. =	0.129
95% conf. int.	2.96
	2.45

n req'd (within 0.1")	α (%)
43	5
30	10
18	20

2013 Durability Monitoring – Percent of Total Rock Count By Durability Class and Sieve Size

Durability Class & Subclass	Rock Count by Sieve Size (Retained on Sieve)						Total By Durability Class	Percent of Total
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch		
Class Au	3	27	15	32	9	1	87	18.0
Class As	0	3	0	1	0	0	4	0.8
Class Ao1	0	1	3	4	1	0	9	1.9
Class Ao2	1	3	0	0	0	0	4	0.8
Class Ao3	2	1	1	1	0	0	5	1.0
Class Ao4	0	1	0	0	0	0	1	0.2
Class Ao5	0	0	0	0	0	0	0	0
Class Ah1	1	20	11	8	2	1	43	8.9
Class Ah2	1	5	4	4	0	0	14	2.9
Class Ah3	1	0	0	0	0	0	1	0.2
Class Ah4	0	0	0	0	0	0	0	0
Total A Class	9	61	34	50	12	2	168	34.7
Class B	26	66	25	20	3	0	140	28.9
Class Ca	4	9	8	29	15	1	66	13.6
Class Cb	0	4	3	6	5	1	19	3.9
Class Da	1	8	6	18	3	11	47	9.7
Class Db	3	12	5	6	3	8	37	7.6
Class E	0	0	0	4	0	3	7	1.5
Class F	0	0	0	0	0	0	0	0
Total by Sieve Size	43	160	81	133	41	26	484	
Percent of Total	8.9	33.0	16.7	27.5	8.5	5.4	100	
Total by Durability Class	–	–	–	–	–	–	484	100

2013 Durability Monitoring – Percent Durability Class By Sieve Size

Durability Class & Subclass	Percent by Sieve Size (Retained on Sieve)					
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch
Class Au	7.0	16.9	18.5	24.1	22.0	3.8
Class As	0.0	1.9	0.0	0.8	0.0	0.0
Class Ao1	0.0	0.6	3.7	3.0	24	0.0
Class Ao2	2.3	1.9	0.0	0.0	0.0	0.0
Class Ao3	4.7	0.6	1.2	0.8	0.0	0.0
Class Ao4	0.0	0.6	0.0	0.0	0.0	0.0
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0
Class Ah1	2.3	12.5	13.6	6.0	4.9	3.8
Class Ah2	2.3	3.1	4.9	3.0	0.0	0.0
Class Ah3	2.3	0.0	0.0	0.0	0.0	0.0
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0
Total A Class	20.9	38.1	42.0	37.6	29.3	7.7
Class B	60.5	41.3	30.9	15.0	7.3	0.0
Class Ca	9.3	5.6	9.9	21.8	36.6	3.8
Class Cb	0.0	2.5	3.7	4.5	12.2	3.8
Class Da	2.3	5.0	7.4	13.5	7.3	42.3
Class Db	7.0	7.5	6.2	4.5	7.3	30.8
Class E	0.0	0.0	0.0	3.0	0.0	11.5
Class F	0.0	0.0	0.0	0.0	0.0	0.0
Total Percent	100	100	100	100	100	100

2013 Durability Monitoring – Percentage Sieve Size By Durability Class

Durability Class & Subclass	Percent By Sieve Size (Retained on Sieve)						Total Percent
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch	
Class Au	3.4	31.0	17.2	36.8	10.3	1.1	100
Class As	0.0	75.0	0.0	25.0	0.0	0.0	100
Class Ao1	0.0	11.1	33.3	44.4	11.1	0.0	100
Class Ao2	25.0	75.0	0.0	0.0	0.0	0.0	100
Class Ao3	40.0	20.0	20.0	20.0	0.0	0.0	100
Class Ao4	0.0	100.0	0.0	0.0	0.0	0.0	100
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ah1	2.3	46.5	25.6	18.6	4.7	2.3	100
Class Ah2	7.1	35.7	28.6	28.6	0.0	0.0	100
Class Ah3	100.0	0.0	0.0	0.0	0.0	0.0	100
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0	0
Total A Class	5.4	36.3	20.2	29.8	7.1	1.2	100
Class B	18.6	47.1	17.9	14.3	2.1	0.0	100
Class Ca	6.0	13.6	12.1	43.9	22.7	1.5	100
Class Cb	0.0	21.0	15.8	31.6	26.3	5.3	100
Class Da	2.1	17.0	12.8	38.3	6.4	23.4	100
Class Db	8.1	32.4	13.5	16.2	8.1	21.6	100
Class E	0.0	0.0	0.0	57.1	0.0	42.9	100
Class F	0.0	0.0	0.0	0.0	0.0	100.0	100

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2013 Lakeview Riprap Gradation and Durability Monitoring — All locations monitored 8/27/13.

	random numbers pairs (x,y)		multiplier		sample locations		number retained								
	long (x)	trans (y)	long (ft)	trans (ft)	long distance (ft)	trans distance (ft)	# painted	4 "	3½ "	3 "	2½ "	2 "	1½ "	1"	<1"
1	0.98	0.46	100*x*	270*y*	98.0	124.2	25	Ca; B; Au; B;	Au; B; B;	Ca; Db; B;	Ca; Da; Da; Db; B; Cb; B	Db; Cb; B;	Ca; Ca; Cb; Au	Cb;	Previously marked/ dotted rocks exist at this location.
11	0.80	0.52	100*x*	270*y*	80.0	140.4	24			B; B; CB; B; DA; DA;	Au; Ah1; Cb; B;	Au; Db; Au; Au; Da;	Ca; Cb;	Au; Ca; B; Cb;	Db; E; Da
2	0.73	0.37	100x+100	270*y*	173.0	99.9	23	Au; A02;	B; Au;	Ah2; Ah2; Au Db; Da; B	Ah1; Da; Ca;	Au; Au; B; Au;	Ah1; Au; Da; Ca; Da;	Db;	
12	1.00	0.58	100x+100	270*y*	200.0	156.6	25	B; Db;	B; B; Au;	Ca; Au; Ah1; Db;	B; Au; B; B;	Au; Au; Ca; A03; Au; B; B;	Au; Da;	Ca; Ca;	Db;
3	0.66	0.37	100*x*+200	270*y*	266.0	99.9	25			B; B; B; B; A01; B; Au; A02; B; B;	A03; Ah1; Au; B; Ah1; Db; Ah1	B; Ca; B; Da; B;	Ca;	Ca;	Da; Previously marked/ dotted rocks exist at this location
13	0.39	0.81	100*x*+200	270*y*	239.0	218.7	~~25~~ 24	Au; Ah3; B	Au;	B; B; Au; B;	Ah1; B; B; Da; B;	Db; Da; Da;	Da; E; E; Cb; B;	Ca;	Da; Db
4	0.46	0.28	100*x*+300	270*y*	346.0	75.6	23		B; B; Au	Db; Db; Au;	Au; B	Da; Ah2; Ah1;	Au; Ca; Au; B; Au; A01;	Ca; B; Ca; Au	Da; Da

Use of Sieves 3½" and 2" are not part of procedure. Calculation of D50 was not effected by their inclusion. Allowable

Rock Gradation Monitoring performed by Dan Nordeen; Durability monitoring performed by Craig Goodknight, S.M. Stoller.

2013 Lakeview Riprap Gradation and Durability Monitoring

	random numbers pairs (x,y)		multiplier		sample locations		number retained								
	long (x)	trans (y)	long (ft)	trans (ft)	long distance (ft)	trans distance (ft)	# painted	4 "	3½ "	3 "	2½ "	2 "	1½ "	1"	< 1"
14	0.79	0.96	100x +300	270y	379.0	259.2	23	B; B; Db; B;	Ah1; B; B; B; Db; As; As; Db;	B; Ah1; B; Ca; Ca; Ah1; Db; Ca;	Ah2; Ah2;	B;			
5	0.10	0.72	100x +400	270y	410.0	194.4	24	B; B; AO3;	A04; Ah1; Ah1; Db; Db;	Ah1; Au; Ah2; AO2; Ca; B; B;	Db; B; B;	Au; B; B;	Db;		E; Db;
15	0.90	0.73	100x +400	270y	490.0	197.1	25		B; B;	Cb; Au; B	B; Ah1; B	Ah2; Au; B; Au	Au; Ah1; Au; Da; B	Ca; Db; Au; B; Da; Au;	Da; Cb
6	0.17	0.04	100x +500	270y	517.0	10.8	25	AO3	AO2	Au; Au; Ah1; B; B; Da; Ah1	Db; Db; Au; Au;	Ca; Db; AO1; Da Au; Au; B	Au; Ca; Da	Au	Db
16	0.96	0.18	100x +500	270y	596.0	48.6	25		Ah2	B;	Da; B;	B; Au; Au Ca; Au; Ca; Ca; Ca	E; Au; Au; Ca; B; Ca; Ca; Au.	Au; Au; Ah1; Cb;	Db;
7	0.29	0.14	100x +600	270y	629.0	37.8	25	B;		B; Ah1; Db;	Ca; Au; Ca;	Ca; Ca; Ca;	Ah2; Ah1; Ah1; Ca;	Ca; Ca; Da; Cb; Ca; Au; Ca; Ca; Ca; Da	Ca;
17	0.72	0.60	100x +600	270y	672.0	162.0	25			B; Db; Au; B; B; B; Ah1	Da; AO1; Ah2; B; Ca; Ah1; B	Ah1; Cb; AO1 AO1; Db; Ah1	Au; Da;	AO1; Ah1;	Db

	random numbers pairs (x,y)		multiplier		sample locations		number retained								
	long (x)	trans (y)	long (ft)	trans (ft)	long distance (ft)	trans distance (ft)	# painted	4 "	3½"	3 "	2½ "	2 "	1½ "	1"	< 1"
8	0.43	0.35	100x+700	255y	743.0	89.3	24	B; Ah1; B; B;	B; B;	B; B; Da; Au; Au; Ah1; B; B;	Ca; B; Au; A01; Cb; B; Ca;	Ca;	Ca	Db	
18	0.31	0.98	100x+700	255y	731.0	249.9	22	B; Da; B; B; B; B; Ca; B; Db	Au; B; B; Au; B	Ah1; B; Da; B Ca	Ah1; Au;			Au	
9	0.53	0.64	100x+800	215y	853.0	137.6	23	B; B; Ca; B	B; B; B;	B; B; As; Ca; B; Ah1; Au; Au; B; Au	B; Au; Au; Ca				Da; Da;
19	0.82	0.83	100x+800	215y	882.0	178.5	25	B; Ca; B; B	B; A03; B	B; Ah1; Ah2 Da; Ah1; Au Au;	B; Ah2; Au; B; Ah1;	Cb; Da	As		Da; Da; Da
10	0.48	0.02	50x+900	130y	924.0	2.6	24	Ah2	Ah1; B; B	Ah1; Au; Ah1 B; Da; B; B	B; Au; B; A01 Ah1	Au; Ca; Au B	Ca; Ca;		Ah1; Au
20	0.26	0.78	50x+900	130y	913.0	101.4	25	Bi		Au; Ca; Au; Ah1; Cb; Cb	Au; Au;	Ca; B; Da; Da; Ah2;	Ca; E; Da; Ca; B; Da; Ah1;	Ca; Cb;	E; Db;

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ATTACHMENT 19

2014 Rock Gradation and Durability Monitoring Data

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Sample Year 2014	Sample Locations	
Sample Number	Longitudinal Distance (ft.)	Transverse Distance (ft.)
1	52	213.3
2	182	197.1
3	243	226.8
4	305	148.5
5	469	243
6	579	37.8
7	660	72.9
8	719	17.9
9	876	191.4
10	927.5	111.8
11	24	94.5
12	149	143
13	246	256.5
14	316	256.5
15	456	16.2
16	502	29.7
17	626	83.7
18	797	33.2
19	800	165.6
20	946.5	87.1

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09/16/14 **LAKEVIEW**

D_{50} by size - 5 seives

Note: D_{50} is the median rock size at a given location

sample	total	number retained						cumulative number passing					cumulative percent passing					D_{50}	
number	painted	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0-inch	<1-inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	4 - inch	3 - inch	2.5 - inch	1.5 - inch	1.0 - inch	(inch)	P/F
CP 1	24	0	6	8	9	1	0	24	18	10	1	0	100	75	42	4	0	2.63	F
CP 11	25	1	8	7	7	1	1	24	16	9	2	1	96	64	36	8	4	2.75	P
CP 2	24	2	8	6	7	1	0	22	14	8	1	0	92	58	33	4	0	2.83	P
CP 12	24	4	3	6	9	1	1	20	17	11	2	1	83	71	46	8	4	2.58	F
CP 3	25	2	15	6	2	0	0	23	8	2	0	0	92	32	8	0	0	3.30	P
CP 13	24	8	9	5	2	0	0	16	7	2	0	0	67	29	8	0	0	3.56	P
CP 4	24	0	5	7	9	0	3	24	19	12	3	3	100	79	50	13	13	2.50	F
CP 14	23	4	14	4	0	1	0	19	5	1	1	0	83	22	4	4	0	3.46	P
CP 5	23	4	10	6	3	0	0	19	9	3	0	0	83	39	13	0	0	3.25	P
CP 15	25	1	4	9	9	2	0	24	20	11	2	0	96	80	44	8	0	2.58	F
CP 6	24	2	7	3	3	6	3	22	15	12	9	3	92	63	50	38	13	2.50	F
CP 16	21	6	8	3	2	2	0	15	7	4	2	0	71	33	19	10	0	3.44	P
CP 7	25	0	4	7	13	0	1	25	21	14	1	1	100	84	56	4	4	2.38	F
CP 17	25	0	8	5	11	0	1	25	17	12	1	1	100	68	48	4	4	2.55	F
CP 8	22	3	3	6	8	1	1	19	16	10	2	1	86	73	45	9	5	2.58	F
CP 18	24	2	4	3	13	1	1	22	18	15	2	1	92	75	63	8	4	2.27	F
CP 9	25	3	8	3	5	3	3	22	14	11	6	3	88	56	44	24	12	2.75	P
CP 19	23	1	12	4	6	0	0	22	10	6	0	0	88	40	24	0	0	3.21	P
CP 10	25	0	7	9	6	1	2	25	18	9	3	2	109	78	39	13	9	2.64	F
CP 20	23	2	9	3	8	1	0	21	12	9	1	0	84	48	36	4	0	3.06	P
total sum	478	45	152	110	132	22	17	433	281	171	39	17	91	59	36	8	4	2.81	P

Note: D_{50} is the median rock size at a location

09/16/14

Statistics of the Median D_{50}'s

Mean	**2.84**
Standard Error	0.088
Median	2.69
Mode	2.58
Standard Deviation	0.395
Sample Variance	0.156
Range	1.29
Minimum	2.27
Maximum	3.56
Sum	56.82
Count	**20**
computed SE	0.088
95% conf. Int.	**3.01**
	2.67

n req'd (within 0.1")	α (%)
9	5
7	10
4	20

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2014 Durability Monitoring – Percent of Total Rock Count By Durability Class and Sieve Size

Durability Class & Subclass	Rock Count by Sieve Size (Retained on Sieve)						Total By Durability Class	Percent of Total
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch		
Class Au	3	16	14	28	7	0	68	14.2
Class As	0	2	1	4	0	0	7	1.5
Class Ao1	3	4	3	4	0	0	14	2.9
Class Ao2	1	5	0	1	0	0	7	1.5
Class Ao3	0	0	0	0	0	0	0	0
Class Ao4	0	0	0	0	0	0	0	0
Class Ao5	0	0	0	0	0	0	0	0
Class Ah1	2	24	20	25	1	0	72	15.1
Class Ah2	3	12	5	6	0	0	26	5.4
Class Ah3	0	0	0	0	0	0	0	0
Class Ah4	0	0	0	0	0	0	0	0
Total A Class	12	63	43	68	8	0	194	40.6
Class B	27	59	32	26	3	2	149	31.2
Class Ca	3	14	13	8	3	0	41	8.6
Class Cb	0	2	3	3	1	0	9	1.9
Class Da	2	6	13	17	5	5	48	10.1
Class Db	1	8	5	9	2	3	28	5.9
Class E	0	0	1	1	0	7	9	1.9
Class F	0	0	0	0	0	0	0	0
Total by Sieve Size	45	152	110	132	22	17	478	–
Percent of Total	9.4	31.8	23.0	27.6	4.6	3.6	100	–
Total by Durability Class	–	–	–	–	–	–	478	100

2014 Durability Monitoring – Percent Durability Class By Sieve Size

Durability Class & Subclass	Percent by Sieve Size (Retained on Sieve)					
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch
Class Au	6.7	10.5	12.7	21.2	31.8	0.0
Class As	0.0	1.3	0.9	3.0	0.0	0.0
Class Ao1	6.7	2.6	2.7	3.0	0.0	0.0
Class Ao2	2.2	3.3	0.0	0.8	0.0	0.0
Class Ao3	0.0	0.0	0.0	0.0	0.0	0.0
Class Ao4	0.0	0.0	0.0	0.0	0.0	0.0
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0
Class Ah1	4.4	15.8	18.2	18.9	4.5	0.0
Class Ah2	6.7	7.9	4.5	4.5	0.0	0.0
Class Ah3	0.0	0.0	0.0	0.0	0.0	0.0
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0
Total A Class	26.7	41.4	39.1	51.4	36.4	0.0
Class B	60.0	38.8	29.1	19.7	13.6	11.8
Class Ca	6.7	9.2	11.8	6.1	13.6	0.0
Class Cb	0.0	1.3	2.7	2.3	4.5	0.0
Class Da	4.4	3.9	11.8	12.9	22.7	29.4
Class Db	2.2	5.3	4.5	6.8	9.1	17.6
Class E	0.0	0.0	0.9	0.8	0.0	41.2
Class F	0.0	0.0	0.0	0.0	0.0	0.0
Total Percent	100	100	100	100	100	100

2014 Durability Monitoring – Percentage Sieve Size By Durability Class

Durability Class & Subclass	Percent By Sieve Size (Retained on Sieve)						Total Percent
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch	
Class Au	4.4	23.5	20.6	41.2	10.3	0.0	100
Class As	0.0	28.6	14.3	57.1	0.0	0.0	100
Class Ao1	21.4	28.6	21.4	28.6	0.0	0.0	100
Class Ao2	14.3	71.4	0.0	14.3	0.0	0.0	100
Class Ao3	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ao4	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ah1	2.8	33.3	27.8	34.8	1.4	0.0	100
Class Ah2	11.5	46.2	19.2	23.1	0.0	0.0	100
Class Ah3	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0	0
Total A Class	6.2	32.5	22.2	35.1	4.1	0.0	100
Class B	18.1	39.6	21.5	17.4	2.0	1.3	100
Class Ca	7.3	34.1	31.7	19.5	7.3	0.0	100
Class Cb	0.0	22.2	33.3	33.3	11.1	0.0	100
Class Da	4.2	12.5	27.1	35.4	10.4	10.4	100
Class Db	3.6	28.6	17.9	32.1	7.1	10.7	100
Class E	0.0	0.0	11.1	11.1	0.0	77.8	100
Class F	0.0	0.0	0.0	0.0	0.0	0.0	0

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2014 Durability Monitoring – Percentage Sieve Size By Durability Class

Durability Class & Subclass	Percent By Sieve Size (Retained on Sieve)						Total Percent
	4 Inch	3 Inch	2.5 Inch	1.5 Inch	1 Inch	< 1 Inch	
Class Au	4.4	23.5	20.6	41.2	10.3	0.0	100
Class As	0.0	28.6	14.3	57.1	0.0	0.0	100
Class Ao1	21.4	28.6	21.4	28.6	0.0	0.0	100
Class Ao2	14.3	71.4	0.0	14.3	0.0	0.0	100
Class Ao3	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ao4	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ao5	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ah1	2.8	33.3	27.8	34.8	1.4	0.0	100
Class Ah2	11.5	46.2	19.2	23.1	0.0	0.0	100
Class Ah3	0.0	0.0	0.0	0.0	0.0	0.0	0
Class Ah4	0.0	0.0	0.0	0.0	0.0	0.0	0
Total A Class	6.2	32.5	22.2	35.1	4.1	0.0	100
Class B	18.1	39.6	21.5	17.4	2.0	1.3	100
Class Ca	7.3	34.1	31.7	19.5	7.3	0.0	100
Class Cb	0.0	22.2	33.3	33.3	11.1	0.0	100
Class Da	4.2	12.5	27.1	35.4	10.4	10.4	100
Class Db	3.6	28.6	17.9	32.1	7.1	10.7	100
Class E	0.0	0.0	11.1	11.1	0.0	77.8	100
Class F	0.0	0.0	0.0	0.0	0.0	0.0	0

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9/11/2014

2014 Lakeview Riprap Gradation and Durability Monitoring

Date monitored Sept. 16, 2014
Kyle Turley Gradation monitoring
Craig Goodknight Durability monitoring

	random numbers pairs (x,y)		multiplier		sample locations			number retained					
	long (x)	trans (y)	long (ft)	trans (ft)	long distance (ft) Y	trans distance (ft) X	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
1	0.52	0.79	100x	270y	52.0	213.3	24		B Ah2 B B Db Au	Ah1 Da Au Ah1 B Db B Ca	Ah1 Ao1 Cb Db Da B Au B B	Cb	
11	0.24	0.35	100x	270y	24.0	94.5	25	B	Ah2 B Ca Ah2 Au Db B Ah1	Ah1, Ca, B Ah2 Ah1 Au Ah2	Db, Ca, B, E Au B B	Da,	E1
2	0.82	0.73	100x+100	270y	182.0	197.1	24	B Ah2	B Ao1 Ca Ca B B B B	B Ah2 Au Ca B Da	As Da Ah1 Ca Au Ca B	Au	
12	0.49	0.53	100x+100	270y	149.0	143.1	24	B B B B	Au Ah1 Ah2	Ca Au Au B ~~Ah2~~ Ca B	As B Au Au Ah1 Ah1 B Da Ah1	Au	B
3	0.43	0.84	100x+200	270y	243.0	226.8	25	Da Ca	B Da Ah1 B Au Au B Ah1 Ah1 B Db B Ah2 Ca Ah1	Ah1 Da Cb Da B Ca	Ca Da		
13	0.46	0.95	100x+200	270y	246.0	256.5	24	Ao2 B Au B Ao1 B B B	Ah1 B Db Ah1 Au Db Da B B	Ah1 Ca Ah1 Db Ah1	Ca Db		
4	0.05	0.55	100x+300	270y	305.0	148.5	24		B Au B Ca Ao2	B B Da B B Au B	Da Au Ah2 Ca Au Au Ao1 Ah1 Da		E Da Db

2014 Lakeview Riprap Gradation and Durability Monitoring

	random numbers pairs (x,y)		multiplier		sample locations			number retained					
	long (x)	trans (y)	long (ft)	trans (ft)	long distance (ft)	trans distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
14	0.16	0.95	100x+300	270y	316.0	256.5	23	Ah1 B B B	B Db Da B Ah1 Ah1 Ah1 Ca Ah1 B Ah1 Au B Ah2	Ah2 Da Db Ah1		Db	
5	0.69	0.90	100x+400	270y	469.0	243.0	23 ~~24~~	Au B B Db	B Au B B Ah1 Ah2 B B B B	B E B As Cb B	Da B Db		
15	0.56	0.06	100x+400	270y	456.0	16.2	15	B	B Ah1 B Ah1	B Ah1 Ca B Ah1 B Ah1 Ah1 B	Ah1 Da Da B Au Ca B Da B	Da Au	
6	0.79	0.14	100x+500	270y	579.0	37.8	24	B B	B E B Cb B B Ca	Ah2 Ca Da	B Ah1 Ah1	Au Da Da Ah1 Ca Au	Db E Da
16	0.02	0.11	100x+500	270y	502.0	29.7	21	Ca Ca Ao1 Ao1 B B	B B Ao1 Ah2 Ca Ah2 B Ah2	Au Da Ca	B E	Au Da	
7	0.60	0.27	100x+600	270y	660.0	72.9	25		Ah1 Db Ah2 B	Ca B Au Da Da B Da	Ah2 Au Ah2 Au Au Ah1 Ah1 Da B Ah1 Ah1 Ah1 Da		E
17	0.26	0.31	100x+600	270y	626.0	83.7	25		Ca Cb B B Au Ah1 Ca B	Ah1 Au Ca B B	Ag Da Db Au Ah1 Ah2 Da Cb B B Da		E

2014 Lakeview Riprap Gradation and Durability Monitoring

	random numbers pairs (x,y)		multiplier		sample locations			number retained					
	long (x)	trans (y)	long (ft)	trans (ft)	long distance (ft)	trans distance (ft)	# painted	4 "	3 "	2½ "	1½ "	1"	< 1"
8	0.19	0.07	100x+700	255y	719.0	17.9	22	~~Ah~~ B B Au	Da Ao2 B	Ah1 B B B Ao1	Da B Ah1 Au Au B Ao1 Au	Ca	Da
18	0.97	0.13	100x+700	255y	797.0	33.2	24	B Da	Ah1 B Au B	Ah1 B Db	Au B B Ah1 Ah1 Au Ah1 B Db Db Au Cb Ca	B	Da
9	0.76	0.89	100x+800	215y	876.0	191.4	25	B B Ah2	B Db Ao2 Ca Da Ao1 Au Ao2	B Au B	Ah1 Ah2 Au Ah1 Db	Db B B	E Da B
19	0.00	0.77	100x+800	215y	800.0	165.6	23	Ah1	B B Au B Ah1 As Ah1 Ca Ca B Au Au	Da Au Cb Ah1	B Ao2 Au B Au Au		
10	0.55	0.86	50x+900	130y	927.5	111.8	25		~~Da~~ B Au B Ao2 Da As	Ao1 Ah1 Au Da Db Ca Ao1 Ah1 Au	Ao1 Ah2 Au Au Da Au	Ca	E Db
20	0.93	0.67	50x+900	130y	946.5	87.1	23	B Ah2	B Ao1 Ah1 ~~As~~ B Ah1 B Ah2 B Ah1	Au Ah2 B	Ah1 As Ah1 Db Au Ah1 Au Ah1	Au	

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