Geotechnical Investigation Report
Materials Recycling Facility
Grand Junction, Colorado

Prepared for:

City of Grand Junction
244 North 7th Street
Grand Junction, Colorado

Attention: Jerod Timothy
General Services Manager

Prepared by:

RockSol Consulting Group, Inc.

566 W Crete Circle, #2
Grand Junction, Colorado 81505

RockSol Project No. 803.64
February 4, 2026

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COLORADO REGISTERED PROFESSIONAL ENGINEER
DONALD GORDON HUNT
35249
2-5-26

Reviewed by:

Alex Walt, E.I.T.
Staff Engineer

Alec Moens, P.E.
Geotechnical Engineer

Donald G. Hunt, P.E.
Senior Engineer

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ATTACHMENTS

1.0 PROJECT PURPOSE AND DESCRIPTION

This report documents the geotechnical engineering investigation performed by RockSol Consulting Group, Inc. (RockSol) to assist with design of the proposed City of Grand Junction Materials Recycling Facility (MRF). The project will re-purpose an existing building located at 365 32 Road in Grand Junction, Colorado. A site vicinity map is presented in Image 1. Proposed construction includes removal of select portions of existing interior walls, installation of industrial equipment, addition of a steel framed mezzanine, and a new exterior truck circulation road pavement. The purpose of this report is to identify existing soil conditions to be used for analysis of foundation design and structural modifications to interior load-bearing walls of the building. A site layout plan for the MRF provided by the design team is included in Appendix A.

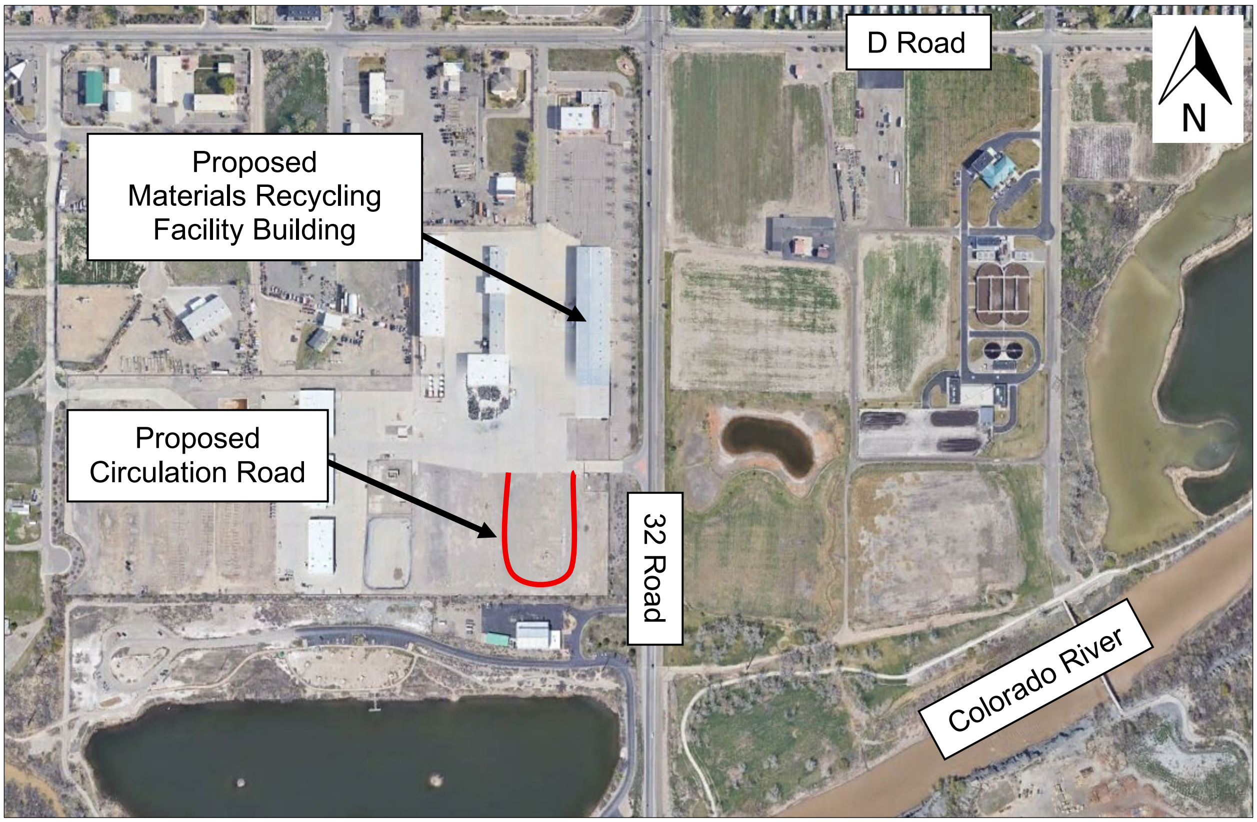


Image 1 – Site Vicinity Map

The scope of work for this geotechnical investigation included:

- Preparing a drilling program to perform a subsurface investigation and implementing the program to collect soil samples for laboratory testing.
- Preparing a geotechnical report presenting the field and laboratory data obtained, geological conditions, and recommendations for foundation design or modifications,
- Performing pavement design for the proposed circulation road (added in a scope addendum).

Surface and groundwater hydrology, hydraulic engineering, and environmental evaluation of site soils and groundwater for possible contaminant characterization were not included in RockSol's geotechnical scope of work.

Unless otherwise specified in this report, all recommendations presented in this report are based on the Colorado Department of Transportation (CDOT) 2025 Standard Specifications for Road and Bridge Construction; the City of Grand Junction Standard Specifications for Road and Bridge Construction; and the City of Grand Junction Transportation Engineering Design Standards.

2.0 PROPOSED BUILDING MODIFICATIONS

The existing building will undergo significant modifications to accommodate recycling facility equipment. Renovations include removal of portions of existing interior wall systems. New foundations to support loading from modifications to the interior load bearing walls and the new equipment are being considered. On the south end of the MRF, it is anticipated that the floor slab will undergo vehicle loading from placing recycling material and loading it into the recycling system. The center portion of the facility will experience static loading from new recycling equipment and dynamic loading while vibratory equipment is in operation. The north end of the facility will experience loading from recycled material bale storage. A 3-dimensional schematic showing the preliminary proposed equipment layout in the renovated MRF prepared by Bulk Handling Systems (BHS) is shown in Image 2 and also in Appendix B.

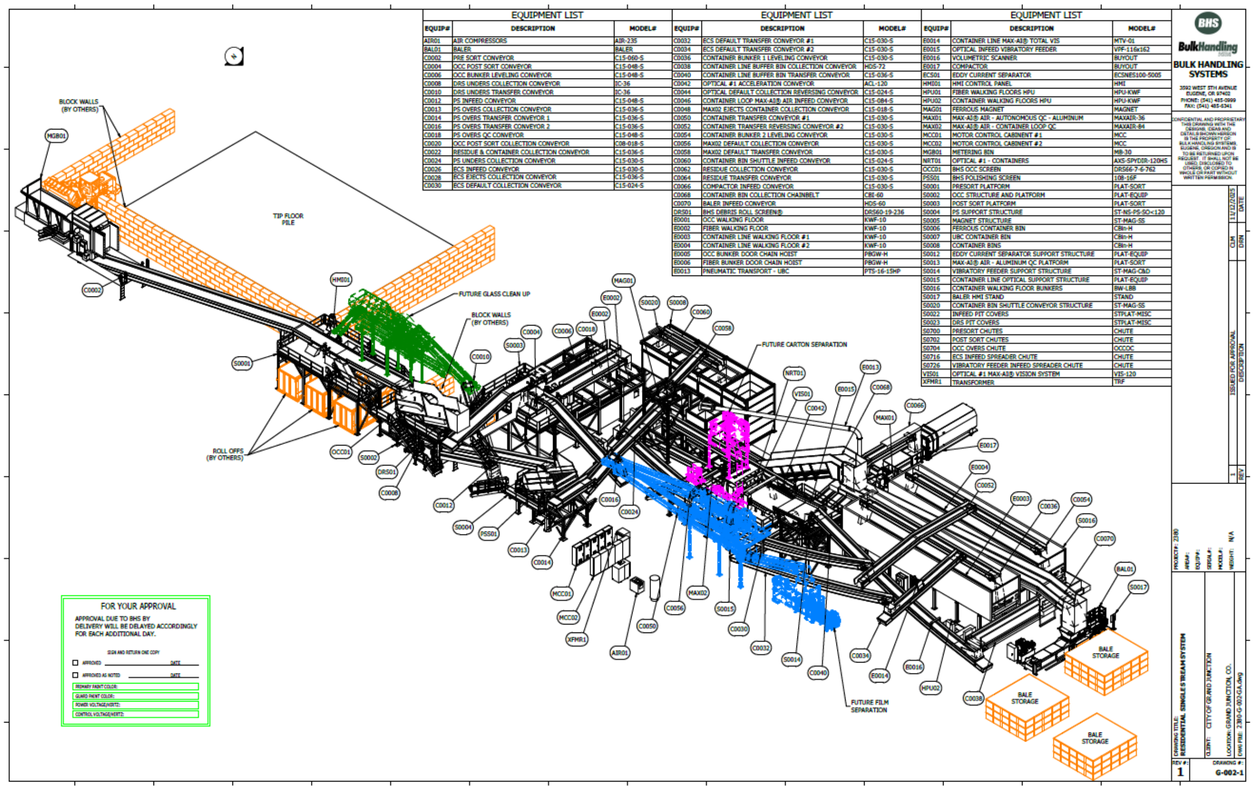


Image 2 – Preliminary Recycling Facility Equipment Schematic Layout (BHS)

The existing floor slab will be removed in select areas, and the floor will be lowered by 6-feet to provide vertical space for certain specialized equipment. Based on conditions exposed at two locations within the building, the existing load bearing walls and interior columns appear to be founded on shallow footings. Photographs of the exposed existing foundation systems are shown in Appendix C.

The building has a gridline delineation with Gridline 1 at the south side of the building and going to Gridline 24 at the north side of the building. The west side of the building is designated as Gridline A and the east side of the building is designated as Gridline C.

3.0 SUBSURFACE EXPLORATION SUMMARY

On November 10 and 11, 2025, RockSol completed six geotechnical boreholes to evaluate subsurface conditions at the project site. Four boreholes were completed within the existing building and are identified as B-1 through B-4. Two boreholes were completed outside of the building for the purpose of pavement design for a proposed circulation road and are identified as P-1 and P-2. Borehole locations are presented in Figures 1A and 1B.

A truck mounted Simco 2800 drill rig was used for drilling and sampling of all boreholes. The boreholes were advanced using 4-inch outside diameter solid stem augers to maximum depths ranging from approximately 10.5 feet to 36 feet below existing grades. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater, if encountered, noted at the time of drilling. All boreholes were backfilled with pea gravel upon completion of drilling and groundwater level readings.

Subsurface materials were sampled and resistance of the soil to penetration of the sampler was performed using modified California barrel and standard split spoon samplers. The modified California barrel sampler has an outside diameter of approximately 2.5 inches and an inside diameter of 2 inches. The standard split spoon sampler used has an outside diameter of 2 inches and an inside diameter of 1⅜-inches. Brass tube liners were used with the modified California barrel sampler. Brass tube liners are not used with the standard split spoon sampler. Soils were logged in the field using visual-manual methods as described in ASTM D2488.

Penetration Tests were performed at selected intervals using an automatic hammer lift system. The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586. Penetration Tests were also performed using the modified California barrel sampler with a standard hammer weighing 140 pounds falling 30 inches per ASTM D3550. The modified California Barrel sampling method is similar to the SPT test with the difference being the sampler dimensions and the number of 6-inch intervals driven with the hammer. It is RockSol's experience that blow counts obtained with the modified California sampler tend to be slightly greater than a standard split spoon sampler. Penetration resistance values (blow counts) were recorded for each sampling event. Blow counts, when properly evaluated, indicate the relative density or consistency of the soil.

Depths at which the samples were taken, the type of sampler used, and the blow counts that were obtained are shown on the Boring Logs for each borehole. Borehole locations were not surveyed as part of this project. For the purposes of this evaluation, we have noted a generic borehole elevation of 100 feet and will reference all subgrade materials per depth below existing grade. Individual Borehole Logs are included in Appendix D.

4.0 GEOLOGICAL SETTING

Based on information presented in the United States Geological Survey (USGS) Geologic Map (See Image 3, *Site Geology Map*) of the Clifton Quadrangle, Mesa County, Colorado, by P.E. Carrara, dated 2001, the project site is predominantly underlain by alluvium and colluvium (Holocene and late Pleistocene) (Qac). The Qac alluvium generally consists of silt, sand, and gravel and the Qac colluvium generally consists of sandy silt, silty to clayey sand, and sandy clay. Alluvium deposited by the Colorado River (Qalc1) is mapped at the ground surface at the south end of the project site. Mancos Shale bedrock (Km) is mapped at or near the surface to the south of the project site and generally consists of sandy gravel and gravelly sand. The materials identified by the USGS mapping were consistent with native soils and bedrock encountered during our geotechnical investigation. In our borehole logs we describe the Mancos Shale as "Shale."

Of particular note is the project site is underlain by both the Qac and Qalc1 soil deposits with the Qalc1 more prominent in the southern portion of the site.

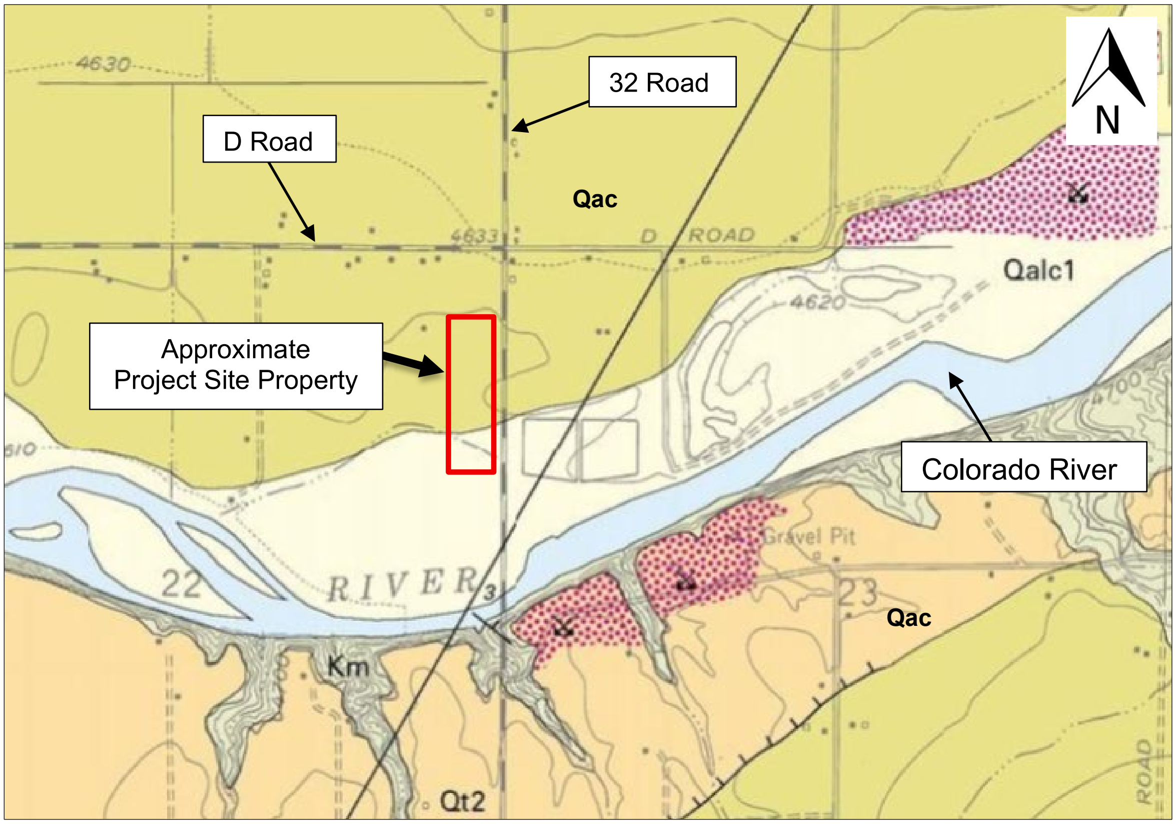


Image 3 – Site Geology Map (USGS)

5.0 LABORATORY TESTING

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. Selected samples were tested and classified according to the Unified Soil Classification System (USCS). The following laboratory tests were performed in accordance with the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and current local practices:

- Natural Moisture Content (ASTM D-2216)
- Percent Passing No. 200 Sieve (ASTM D-1140)
- Liquid and Plastic Limits (ASTM D-4318)
- Dry Density (ASTM D-2937)
- Soil Classification (ASTM D-2487 and AASHTO M145)
- Gradation (ASTM C136)
- Water Soluble Sulfate Content (CDOT CP-L 2103)
- Water Soluble Chloride Content (CDOT CP-L 2104)
- Standard Test Method for pH of Soils (ASTM D4972-01)
- Soil Resistivity (ASTM G57 - Soil Box)
- Swell Test (Denver Swell Test, modified from ASTM D-4546)
- Resistance Value (R-Value): (AASHTO T190)

Laboratory test results were used to characterize the engineering properties of the subsurface material. R-Value testing was performed by CMT Technical Services. All other laboratory tests were performed by RockSol. Laboratory test results are presented in Appendix E and are also summarized on the Borehole Logs presented in Appendix D.

6.0 INTERIOR FLOOR SLAB AND SITE SUBGRADE CHARACTERIZATION

6.1 Concrete Slab and Subsurface Materials (Building Location)

Subsurface conditions at Boreholes B-1 through B-4 generally consist of fill material and native soils overlying Mancos Shale sedimentary bedrock. Groundwater was encountered at approximate depths ranging from 10 feet to 13 feet below existing grades during drilling operations. See Table 1 for groundwater and bedrock depths, where encountered. Descriptions of the surface and subsurface conditions encountered in the boreholes are provided below and are also summarized on the Borehole Logs presented in Appendix D.

<u>Concrete Slab</u>

Each borehole within the building was drilled through the existing concrete slab. RockSol obtained concrete cores at 8 distinct locations within the existing concrete slab. A summary of concrete slab core locations and concrete cylinder compressive strength data is shown in Appendix F. The slab thickness measured from the recovered concrete cores ranged in thickness from 5.25 to 7.25 inches. At each borehole location the measured slab thickness ranged from 5 inches to 6.75 inches. The borehole slab thicknesses should be considered as approximate. Steel reinforcing rebar or wire mesh was not encountered in any of our concrete cores or at each borehole location. The existing slab was observed to have joints placed at an approximate spacing of 15 feet.

<u>Fill Material</u>

Fill material encountered generally consisted of medium dense silty to gravelly sand and dense gravel with cobbles, some of which ranged up to 6 inches in diameter. The fill material is likely associated with site grading during initial building construction.

<u>Native Soils</u>

Native soil encountered generally consists of medium dense to dense, silty to gravelly sand. A layer of loose clayey sand and sand was encountered in Borehole B-2 at a depth of 7 feet below the top of slab. A layer of loose clayey sand was also encountered in Borehole B-4 at 9 feet. Clay and sandy clay layers were encountered in Boreholes B-1 and B-3, respectively.

<u>Bedrock</u>

Mancos Shale sedimentary bedrock was encountered beneath the native soils at Boreholes B-2 through B-4. The bedrock generally consisted of hard to very hard Mancos Shale. The top of bedrock depths ranged from approximately 19 feet to 26 feet below grade. Borehole B-1 was terminated at a depth of approximately 15 feet and did not reach bedrock.

<u>Groundwater</u>

Groundwater was encountered in each of the “B” boreholes at depths ranging from approximately 10 feet to 13 feet below existing grades at the time of exploration. It should be noted that groundwater was encountered in each of the “P” boreholes at depths of 7 feet and 9 feet below existing grade at the time of exploration. All boreholes were backfilled after sampling was completed. Additional long-term groundwater monitoring would be required to establish seasonal variations. See Table 1 for a summary of the depths to groundwater encountered in our “B” boreholes.

Table 1 - Approximate Bedrock and Groundwater Depth Summary - Building Boreholes

Borehole	Depth to Bedrock (ft)	Depth to Groundwater (ft)
B-1	NE	10.5
B-2	26.0	10.0
B-3	19.25	12.0
B-4	19.0	13.0

NE = Not Encountered to depth explored.

6.1.1 Swell/Collapse Discussion

RockSol performed swell/consolidation tests on two samples, one from Borehole B-2 at 14-foot depth and one at Borehole B-4 at 9-foot depth. Based on the results, the native soil tested exhibited low collapse potential (0.3 to 0.4 percent collapse under 500 pounds per square foot (psf) surcharge pressure). The tests do indicate limitations on allowable bearing pressure for the deeper native soils that are present at this site.

Expansive soil conditions were not encountered within the overburden soils encountered at this site. Mancos Shale can possess swell potential, however, for the proposed construction the Mancos Shale does not pose a swell risk.

6.2 Subsurface Materials (Proposed Circulation Road Location)

Boreholes P-1 and P-2 were drilled and sampled to depths of 10.5 feet to assist with pavement design for the new proposed circulation road. Subsurface conditions generally consisted of coarse-grained native soils. Groundwater was encountered at depths ranging from 7 feet to 9 feet below existing grades. Descriptions of the surface and subsurface conditions encountered in the boreholes are provided below and are also summarized on the Borehole Logs presented in Appendix D.

Surface Materials

At Borehole P-1 approximately 4-inches of coarse gravel material was encountered at the ground surface.

At Borehole P-2 approximately 2-inches of asphalt pavement was encountered at the ground surface.

Native Soils

Native soils encountered generally consisted of dense, silty to gravelly sand to the total depths drilled.

Bedrock

Bedrock was not encountered in the pavement boreholes which were terminated at a depth of approximately 10.5 feet below existing grades.

Groundwater

Groundwater was encountered in each of the pavement boreholes at depths ranging from approximately 7 feet to 9 feet below existing grades at the time of exploration. These boreholes were backfilled after drilling. Additional long-term groundwater monitoring would be required to establish seasonal variations.

6.2.1 Proposed Roadway Subgrade Strength Characterization

An R-Value test was conducted on a combined bulk sample obtained from boreholes P-1 and P-2 from 0 to 4 feet depth. The test resulted in an R-Value of 67, which can be characterized as “very good” subgrade support material for pavement construction. Results of the R-Value test performed by CMT are included in Appendix E.

6.3 Geo-Chemical Discussion

6.3.1 Cement Type/Sulfate Resistance

Cementitious material requirements for concrete in contact with site soil or groundwater are based on the percentage of water-soluble sulfate in either soil or groundwater that will be in contact with concrete constructed for this project. The water-soluble sulfate concentration identifies the Sulfate Exposure Class, as recognized by CDOT and shown in Table 2 below, and in the CDOT Standard Specifications for Road and Bridge Construction, dated 2025 (CDOT Table 601-2). Water-soluble Sulfate Test Results are summarized in Table 3.

Table 2 – Concrete Sulfate Exposure Class Requirements (CDOT 2025)

Water-Soluble Sulfate (SO_4) in dry soil, percent	Water-Soluble Sulfate (SO_4) in water, ppm	Sulfate Exposure Class
0.00 to 0.10	0 to 150	Class 0
0.11 to 0.20	151 to 1,500	Class 1
0.21 to 2.0	1,501 to 10,000	Class 2
2.01 or greater	10,001 or greater	Class 3

Table 3 – Water-Soluble Sulfate Testing Summary

<table>
<tr><th>Borehole I.D.</th><th>Sample Depth (Feet)</th><th>Water-Soluble Sulfate (SO_4) in dry soil, percent</th><th>Sulfate Exposure Class</th></tr>
<tr><td>B-1*</td><td>0.5 – 4</td><td rowspan="4">0.07</td><td rowspan="4">Class 0</td></tr>
<tr><td>B-2*</td><td>0.42 – 4</td></tr>
<tr><td>B-3*</td><td>0.5 – 9</td></tr>
<tr><td>B-4*</td><td>0.56 – 4</td></tr>
<tr><td>B-1</td><td>9</td><td>0.03</td><td>Class 0</td></tr>
<tr><td>B-2**</td><td>36</td><td rowspan="3">0.12</td><td rowspan="3">Class 1</td></tr>
<tr><td>B-3**</td><td>24</td></tr>
<tr><td>B-4**</td><td>24</td></tr>
<tr><td>P-1***</td><td>0 – 4</td><td rowspan="2">0.48</td><td rowspan="2">Class 2</td></tr>
<tr><td>P-2***</td><td>0.17 – 4</td></tr>
</table>

* - Combined Into One Sample
** - Combined Into One Sample
*** - Combined Into One Sample

The concentration of water-soluble sulfates measured in soil samples obtained from RockSol’s boreholes ranged from 0.03 percent to 0.48 percent by weight (See Appendices D and E). Based on the results of the water-soluble sulfate testing, Exposure Class 1 cementitious material requirements are considered appropriate for concrete in contact with subgrade materials for the building location and Exposure Class 2 cementitious material requirements are considered appropriate for concrete in contact with subgrade materials for the pavement location. Refer to CDOT’s current *Standard Specifications for Road and Bridge Construction Section 601* for concrete mixtures that satisfy appropriate sulfate exposure *Class* requirements.

6.3.2 Corrosion Resistance Discussion

Water soluble sulfate and chloride content, pH and electrical resistivity tests were performed and are summarized in Table 4. The electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-57).

Table 4 – Corrosion Resistance Summary

Borehole Location	Sample Depth (ft)	Water Soluble Chloride (%)	Saturated Resistivity (Ohm-cm) at Moisture content (%)	Water Soluble Sulfate (% by weight)	pH	CR Level
B-1*	0.5 – 4	0.0366	1,400 @ 11.7	**0.07**	**8.7**	**CR 4**
B-2*	0.42 – 4					
B-3*	0.5 – 9					
B-4*	0.56 – 4					
B-1	9	--	--	0.03	--	CR 0
B-2**	36	**0.0525**	--	**0.12**	**8.9**	**CR 4**
B-3**	24					
B-4**	24					
P-1***	0 – 4	**0.1080**	--	**0.48**	8.3	**CR 3**
P-2***	0.17 – 4					

* - Combined Into One Sample
** - Combined Into One Sample
*** - Combined Into One Sample

Comparison of the test results of the sulfate, chloride, and pH testing performed with *Table 1 - Guidelines for Selection of Corrosion Resistance Levels as presented in the CDOT Pipe Materials Selection Guide,* dated April 30, 2015 (See Appendix G)*,* suggests corrosion resistance (CR) levels of CR 0, CR 3, and CR 4 are present within the project limits. Additional testing at specific structure locations may be performed to provide structure specific corrosion resistance recommendations. Of the three variables (water soluble sulfate, water soluble chloride, and pH) that are used in determining the CR level, pH appears to be the predominant component affecting the CR level selection. In Table 4, we have used “bold” text to identify the test result variable that is contributing to the CR Level above 0. Based on available data, the project site should be considered as a CR 4 category site. Based on the results of the electrical resistivity tests, the soils and bedrock should be considered as “aggressive” to unprotected metals at both building locations.

7.0 SEISMICITY DISCUSSION

The City of Grand Junction uses the 2024 International Building Code (IBC-2024) for development of seismic design parameters. The IBC-2021 references the American Society of Civil Engineers 7-22 (ASCE 7-22) seismic design code. Based on the subsurface conditions encountered, it is our opinion that the location of the proposed building meets criteria for Seismic Site Class D. Shear wave velocity testing was not performed by RockSol. Seismic design parameters for Seismic Site Class D are discussed in Section 7.1.

7.1 Seismic Design Parameters

Seismic design parameters for the Grand Junction Materials Recycling Center were obtained from the United States Geological Survey (USGS) Earthquake Design Maps using the 2024 International Building Code specifications which reference ASCE 7-22. Values were obtained using the USGS site: U.S. Seismic Design Maps (seismicmaps.org) (See Appendix H). Based on our understanding of the proposed building usage, it is our opinion that the CRC Building satisfies risk category II per Table 1604.5 of the IBC-2024. Interpolated values for Peak Ground Acceleration Coefficient for the geometric-mean maximum considered Earthquake (PGA_M), Spectral Acceleration Coefficient at Period 0.2 sec (S_s), and Spectral Acceleration Coefficient at Period 1.0 sec (S_1) were obtained using the latitude and longitude for the site. The seismic acceleration coefficients obtained (data based on 0.05-degree grid spacing) are presented in Table 5. The seismic design category was determined based on Figure 1613.2(1) in IBC-2024.

Table 5 – Seismic Acceleration Coefficients (IBC 2024)

Materials Recycling Facility (Latitude°/Longitude°)	Peak Ground Acceleration (PGA_M)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)	Seismic Design Category
39.062 N, 108.460 W	0.13	0.22	0.048	B

8.0 GEOTECHNICAL RECOMMENDATIONS – MRF BUILDING RENOVATIONS

In this report section RockSol provides geotechnical recommendations to assist with design and construction of the MRF Building renovations. A significant component of the renovation includes placement of many large steel-frame structures that will support several types of equipment, personnel walkways, metal staircases, and conveyor belt systems.

Section 8.1 provides discussion of the existing interior floor slab and the potential, and limitations, for equipment to be placed directly on the slab or on shallow foundations. Section 8.2 provides discussion and recommendations for interior load bearing wall modifications and equipment requiring deep foundations. Section 8.3 provides discussion and recommendations for the Tip Floor Pile area. Section 8.4 provides discussion and recommendations for the exterior loading docks located outside the building. Section 8.5 provides discussion and recommendations for permanent shoring at the proposed equipment pit locations.

8.1 Interior Floor Slab Discussion and Shallow Foundation Recommendations

Based on our observations and evaluation, the existing interior floor slab appears to have been designed as an unreinforced, 6-inch-thick slab and during construction, concrete placement thicknesses ranged between 5 to 7 inches. Testing of recovered cores indicates the slab concrete has a compressive strength above 5,000 psi. The lowest compressive strength value obtained was 5,600 psi. No flexural strength testing was performed by RockSol, however using a commonly accepted correlation of 9 times the square root of the compressive strength yields a flexural strength of 673 psi. This suggests a relatively strong floor slab, although likely not reinforced.

Based on the compressive strength of the concrete cores, RockSol does not anticipate punching shear failure through the slab to be a limiting design consideration for placement of the new equipment on the existing floor slab. RockSol considers excessive flexural deformation with cracking and compression/long-term settlement of the subgrade soils beneath the slab will control allowable loading.

The upper 5 to 7 feet of subgrade soil below the slab is dense sand and gravel material with some small cobbles and can be characterized as competent bearing material with a modulus of subgrade reaction (k value) of 300 pci. Based on these conditions, RockSol considers placement of equipment directly on the existing floor slab acceptable, with a maximum allowable bearing pressure of 4,500 psf.

Shallow foundations may be constructed after removal of the existing floor slab, if necessary, and an allowable bearing pressure of 3,500 psf is recommended but only applicable to a maximum depth of 2 feet below the top of the existing floor slab. If a shallow foundation must be placed at a lower elevation, RockSol can provide allowable bearing pressures, however they will decrease with depth below 2 feet. For the lower pit areas (6-foot depth) we recommend an allowable bearing pressure of 1,000 psf due to the underlying soil and groundwater conditions. Heavily loaded equipment in the pit locations may require deep foundations. Deep foundation recommendations are presented in Section 8.2. Lateral earth pressure parameters applicable to the pit walls are presented in Section 8.4.

8.2 Interior Load Bearing Wall Modifications/Deep Foundation Recommendations

Masonry load bearing walls located at Gridlines 5, 6,11, and 17 will be modified with removal of wall portions to allow placement of equipment and conveyors. The existing walls are founded on strip footings. These wall modifications will require additional foundation support. Depending on the load requirements, shallow or deep foundations will be required. For preliminary consideration, the shallow foundation parameters presented in Section 8.1 are applicable. If deep foundations are required, the following micropile parameters are presented.

Based on the subsurface conditions encountered, micropiles are a feasible deep foundation option for the MRF building renovations. A micropile foundation is recommended for its ability to carry heavier loads and minimize differential foundation movement. A micropile system may be used throughout the building if desired, or in conjunction with a shallow foundation system. Some equipment will impart significant vibration during facility operations. RockSol anticipates the Vibratory Feeder, and associated components, will likely impart significant vibration. Deep foundations are recommended to support such equipment. Depending on the final layout, type of equipment, and magnitude of vibration, further discussion may be needed regarding isolation of vibration as it would affect surrounding foundations.

Micropile foundations are comprised of reinforcing bars grouted into a predrilled suitable bearing substrate. There are 5 types of micropiles, named Type A through Type E, which differ by grouting method and are defined in AASHTO LRFD Article 10.9.1. Different micropile types will result in different resistance values. The preliminary recommendations presented below assume the use of Type A micropiles (gravity placed grout) because they are most appropriate for use in shale bedrock. The final micropile type should be selected by the specialty contractor responsible for micropile installation.

Micropiles will provide support by embedment into the Mancos Shale bedrock encountered at the site. Based on the subsurface conditions encountered, it is anticipated that hard to very hard Mancos Shale bedrock will be encountered between approximate depths 19 feet in the south half of the building and deepening to a depth of 26 feet in the northern portion of the building.

Based on our evaluation, recommended nominal (unfactored) tip resistance and nominal (unfactored) grout-to-ground (side) resistance values for the bedrock material are presented in Table 6.

Table 6 – Preliminary LRFD Base and Side Resistance Values for Micropiles

Bearing Stratum	Ultimate (Nominal) Resistance, α_b		Service Resistance (Note 1)	
	Tip (ksf)	Side (ksf)	Bearing (ksf)	Side (ksf)
Mancos Shale (Bedrock)	20 (Note 2)	10.8	10.0	5.4

Note 1: Service resistance values are based on an estimated total settlement of less than ½ inch.
Note 2: Tip resistance may only be considered when the grouted micropile is embedded at least 5 feet into bedrock.

The preliminary side resistance is applicable to the portion of the shaft embedded in Mancos Shale bedrock. For LRFD strength limit state evaluation, a resistance factor of 0.50 is recommended for tip resistance and a resistance factor of 0.55 is recommended for side resistance evaluation for preliminary evaluation of single micropiles based on AASHTO LRFD Table 10.5.5.2.5-1. For side and tip resistance for final design based on load testing, resistance values should be taken from AASHTO LRFD Table 10.5.5.2.3-1 but no greater than 0.70.

Micropile diameters, length, and reinforcement shall be sufficient to satisfy axial, bending, and lateral load resistance requirements. A minimum bedrock embedment of 10 feet is recommended to resist uplift forces. Additional embedment may be necessary to satisfy axial bearing requirements and for lateral stability requirements as determined by the structural engineer and micropile specialty contractor.

Additional design and construction considerations for micropiles are presented below:

(a) The final micropile design should be performed by a specialty contractor qualified to perform micropile design and construction.

(b) Micropile capacity shall be verified through the performance of micropile load tests as described in AASHTO LRFD Article 10.9.3.5.4.

(c) Micropiles should be constructed with minimum spacing at least three shaft diameters, or 30 inches, center to center. For closely spaced micropiles, the axial and lateral capacities should be appropriately reduced. Group action of micropiles should be analyzed on an individual basis to assess the appropriate reduction.

(d) Grout mix, steel reinforcement, and corrosion resistance methods appropriate for the micropiles shall be determined by the specialty contractor.

8.3 Tip Floor Pile Area Discussion and Recommendations

The tip floor pile area is planned at the south end of the building. This area will be a staging/storage area for the delivered recycling material. Delivery trucks will back into the area and unload their material. A medium sized “loader” will then manage the pile area and take material to a metering bin which will be the start of the material sorting process.

Preliminary plans call for a concrete block wall system around the tip pile area for containment purposes. Each concrete block is on the order of at least 2 feet wide, 2 feet deep and 3 feet long. The blocks will be vertically stacked to an approximate height of 12 to 15 feet high. Operational stability of the blocks should be considered. For bearing on the existing concrete floor slab, the blocks, if 15 feet high would impose a bearing pressure on the order of 2,250 psf. Based on the slab thickness, compressive strength of the recovered concrete cores, and the subgrade soils encountered in our boreholes, it is RockSol’s opinion that the existing slab is capable of supporting the proposed blocks. Preliminary plans call for a minimum distance of 3 feet between the proposed block wall and the existing column footings. In RockSol’s opinion, this separation is appropriate to not impose adverse loading on the column footings.

If a cast-in-place concrete wall is constructed with a shallow footing foundation, the allowable bearing pressure values presented in Section 8.1 apply.

Based on the slab thickness, compressive strength of the recovered concrete cores, and the subgrade soils encountered in our boreholes, it is RockSol's opinion that the existing slab is also capable of supporting a medium sized loader which will feed tip area recycle material into the metering bin. Discussions with the City and the Design Team have identified the potential risks to the Facility operations as the slab experiences long-term cracking and other fatigue-related distress. The City has recognized that long term maintenance of these slabs will be required.

8.4 Loading Docks Discussion and Recommendations

Two loading docks are proposed on the west side of the building. They will be sloped and recessed in the ground approximately 4 to 5 feet deep and will have concrete walls. Lateral earth pressures imposed on the walls will be affected by the subgrade soils and groundwater conditions. Groundwater is not expected to be a design or construction issue, provided an appropriate drainage system is provided to collect and dispose of water that is collected in the recessed loading dock. After excavation for the loading dock and construction of the walls and approach pavement, the existing site soils are suitable for backfill of the walls, or use of CDOT Structure Backfill Class 1 is also suitable. For the proposed loading docks lateral earth pressures will also be influenced by the width of the backfill zone adjacent to the structure walls. For narrow backfill zones, lateral earth pressures will be influenced by the existing in-place soils. For relatively wide backfill zones, lateral earth pressures will be influenced by the backfill soil. Recommended lateral earth pressure parameters are provided in Table 7.

Table 7 – Lateral Earth Pressure Parameters

Soil Type	Soil Unit Weight (pcf)	Effective Friction Angle, ϕ' (degrees)	Cohesion (psf)	Lateral Earth Pressure Coefficients (Notes 1 and 2)		
				Active (k_a)	At-Rest (k_o)	Passive (k_p) (Note 3)
CDOT Class 1 Structure Backfill (CDOT Section 703.08)	130	34	0	0.28	0.44	3.54
On-Site Soil Obtained within 5 feet of the Ground Surface (gravelly sand)	125	32	0	0.31	0.47	3.26

Note 1: Based on Rankine Theory of earth pressure.
Note 2: For horizontal backslope and foreslope.
Note 3: Full value, no reduction applied.

8.5 Interior Below-Grade Equipment Pit Recommendations

Due to height constraints within the existing building, some equipment and conveyor systems will need to be at elevations lower than the existing interior floor slab. At three locations within the building, recessed "pit" areas are proposed. The depth of the pits is proposed to be 6 feet below the top of the existing floor slab. Existing shallow footings that support interior columns are located close to the proposed pits. Where column footings are in close proximity to the proposed pits, RockSol recommends the use of permanent shoring to allow construction of the pits and maintain the stability of the existing footings.

9.0 ROADWAY SURFACING AND PAVEMENT DESIGN RECOMMENDATIONS

The Materials Recycling Facility renovations will include the construction of a paved circulation road on the south side of the property. In this report Hot Mix Asphalt (HMA) pavement is identified as flexible pavement. Portland Cement Concrete (PCC) pavement is identified as rigid pavement.

For the flexible pavement designs, RockSol used CDOT's 2021 M-E Pavement Design Manual, as modified in 2025, which uses Version 2.3.1 of AASHTO's Pavement Mechanistic-Empirical Design (PMED) software, and the PaveXpress software which uses the 1993 AASHTO flexible pavement design equations as recommended in Municipal Code 29.32.040(a).

For the rigid pavement designs, RockSol used CDOT's 2021 M-E Pavement Design Manual, as modified in 2025, which uses Version 2.3.1 of AASHTO's Pavement Mechanistic-Empirical Design (PMED) software, and the PaveXpress software which uses the 1998 AASHTO rigid pavement design equations as recommended in Municipal Code 29.32.040(b).

9.1 Traffic Loading

The Average Annual Daily Truck Traffic (AADTT) has a significant effect on the predicted pavement performance as compared to cars and pick-up trucks to closely match the design ESAL's in PaveXpress. RockSol after discussion with the City of Grand Junction estimates Average Annual Daily Traffic (AADTT) for the Materials Recycling Facility to be 40 trucks comprised of 30% FHWA Class 6 and 70% FHWA Class 9 vehicles per CDOT's vehicle classification.

Primary vehicle usage of the proposed circulation road will be for heavy duty trucks delivering the material for recycling. For pavement design purposes, RockSol recommends the use of 18,000-pound Equivalent Single Axle Loads (18-kip ESAL's) for a 30-year design life in accordance with Subsection 29.32.030 of the City of Grand Junction Transportation Engineering Design Standards (TEDS) for the circulation road. A compound growth rate of 0.5 percent over a 30-year design life was used to develop the flexible and rigid pavement 18,000-pound ESAL's for the input into PaveXpress. The 30-year flexible pavement 18-kip ESAL's were estimated to be 514,000 and the 30-year rigid pavement 18-kip ESAL's were estimated to be 796,000 for the PaveXpress design output. The 30-year flexible pavement 18-kip ESAL's were estimated to be 540,000 and the 30-year rigid pavement 18-kip ESAL's were estimated to be 790,000 for the PMED design output.

9.2 Pavement Subgrade Characterization

To assist with pavement design recommendations, RockSol obtained bulk samples of on-site soils at the P-1 and P-2 borehole locations. Classification testing indicates that the subgrade soils generally consist of non-plastic silty sand with an AASHTO soil classification of A-1-b (0).

To evaluate the subgrade support characteristics, one R-Value laboratory test was performed in accordance with AASHTO T-190 on a combined sample of material obtained within 0 to 4 feet of the surface from Boreholes P-1 and P-2. An R-Value of 67 was obtained. The R-Value test results are attached to this report in Appendix E. Based on R-Value testing, a conservative R-Value of 60 will be used for new pavement constructed on the existing site soils. The R-Value of 60 converts to a resilient modulus of 18,259 psi when using equation 3-2 from CAPA's Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways and 10,615 psi when using equation 4-1 from CDOT's 2021 Mechanistic-Empirical Pavement Design Manual as modified in 2025.

9.3 Pavement Design Parameter Summary

A summary of the pavement design input parameters used to evaluate the pavement thickness requirements for the proposed circulation road are presented below.

Table 8 – PMED Pavement Design Parameters

Pavement Design Parameter	Value
PMED 30-Year HMA Design Life ESAL's	540,000
PMED 30-Year PCC Design Life ESAL's	790,000
PMED Subgrade Resilient Modulus, M_R	10,615
Reliability, (R)	90%

Table 9 – AASHTO 93/98 Pavement Design Parameters

Pavement Design Parameter	Value
AASHTO 93 30-Year HMA Design Life ESAL's	514,000
AASHTO 98 30-Year PCC Design Life ESAL's	796,000
CAPA Subgrade Resilient Modulus, M_R	18,259
Serviceability Loss, (ΔPSI)	2.5
Overall Standard Deviation, S_O	0.44
Reliability, (R)	90%
Structural Coefficient of HMA	0.44
Structural Coefficient of Class 6 ABC	0.12

9.4 Pavement Section Thickness Evaluation (Circulation Road)

A summary of the pavement section thicknesses obtained from PaveXpress and PMED is presented in Table 10. The pavement design calculation sheets are presented in Appendices I, J, K, and L.

Table 10 – Circulation Road Section Thickness Summary

Pavement Location	Design ESALs (30 year)	Pavement Section (inches)	Appendix
Circulation Road	514,000	4.0 HMA Grading SX(75) PG 64-28 6.0 Class 6 Aggregate Base Course	J (PaveXpress)
	796,000	6.50 Class P Portland Cement Concrete 6.0 Class 6 Aggregate Base Course	L (PaveXpress)
	540,000	2.0 HMA Grading SX(75) PG 64-28 2.0 HMA Grading SX(75) PG 64-22 6.0 Class 6 Aggregate Base Course	I (PMED)
	790,000	7.0 Class P Portland Cement Concrete 6.0 Class 6 Aggregate Base Course	K (PMED)

HMA shall be placed in lifts not exceeding 2 inches in thickness.

9.5 Pavement Section Thickness Recommendations (Circulation Road)

A summary of the PMED minimum pavement section thickness using a 30-year design life for flexible pavement is presented in Table 11 and the pavement design output sheets are included in Appendix I.

Table 11 – PMED Flexible Pavement Section Minimum Thickness Recommendations

Pavement Location	Material Type	30-Year Design Life Pavement Thickness (in)
Circulation Road	HMA SX(75) PG 64-28	2.0
	HMA SX(75) PG 64-22	2.0
	Aggregate Base Course Class 6	6.0

A summary of the AASHTO 93 minimum pavement section thickness using a 30-year design life for flexible pavement is presented in Table 12 and the pavement design output sheets are included in Appendix J.

Table 12 – AASHTO 93 Flexible Pavement Section Minimum Thickness Recommendations

Pavement Location	Material Type	30-Year Design Life Pavement Thickness (in)
Circulation Road	HMA SX(75) PG 64-28	4.0 (Two lifts)
	Aggregate Base Course Class 6	6.0

A summary of the PMED minimum pavement section thickness using a 30-year design life for rigid pavement is presented in Table 13 and the pavement design output sheets are included in Appendix K.

Table 13 – PMED Rigid Pavement Section Minimum Thickness Recommendations

Pavement Location	Material Type	Thickness (inches)
Circulation Road	CDOT Class P PCC	7.0
	Aggregate Base Course Class 6	6.0

A summary of the AASHTO 98 minimum pavement section thickness using a 30-year design life for rigid pavement is presented in Table 14 and the pavement design output sheets are included in Appendix L.

Table 14 – AASHTO 98 Rigid Pavement Section Minimum Thickness Recommendations

Pavement Location	Material Type	Thickness (inches)
Circulation Road	CDOT Class P PCC	6.5
	Aggregate Base Course Class 6	6.0

If flexible pavement is selected for the circulation road, RockSol recommends the pavement thicknesses shown in Table 11 be used since the PMED software accounts for site specific variables that AASHTO 1993 does not. Flexible or rigid pavement shall consist of CDOT-approved mix designs. The top layer of HMA should consist of Grading SX(75) PG 64-28. The bottom layer of HMA should consist of Grading SX(75) PG 64-22. HMA shall be placed in lifts not exceeding 2 inches in thickness. Aggregate base course should consist of material meeting CDOT Class 6 Aggregate Base per CDOT 703.03.

Based on the traffic loading, a Grading SX with 75-gyration mix is appropriate for the Recycle Center. However, the CDOT library does not currently contain a 75 gyration mix with a PG 64-28 binder for use in the PMED software, therefore, the ME Pavement Design output sheets, included in Appendix I used a 100 gyration mix with PG 64-28.

If rigid pavement is selected for the circulation road, RockSol recommends the pavement thicknesses shown in Table 13 be used since the PMED software accounts for site specific variables that AASHTO 1998 does not. If rigid pavement is selected for the circulation road, RockSol recommends a CDOT Class P concrete meeting the requirements for Class 2 sulfate resistance. A 12-ft slab width is recommended with joint spacing of 12-ft or less, 1-inch dowel bars, and tied shoulders.

10.0 EARTHWORK

10.1 Subgrade Preparation

Unless otherwise specified in this report, RockSol recommends moisture conditioning of the upper twelve inches of the existing soil in areas where pavement and slab-on-grade will be constructed. Vegetation, brush, sod, trash, and other deleterious substances shall not be placed in embankment, excavation backfill, or structural backfill.

10.2 Compaction Specifications

All embankment, backfill placement and subgrade preparation shall be performed in accordance with City of Grand Junction requirements, or as specified by recommendations in this report, and project specification when developed. The minimum compaction recommended for all soil classifications for this project by RockSol is presented in Table 15.

Table 15 – Compaction Specifications

AASHTO Classification (AASHTO M 145)	Relative Compaction Percent of Maximum	Moisture Content Deviation from Optimum
Clay Soils A-6 and A-7	95% Min. ASTM D698 (Standard Proctor Method)	0% to +3%
Sands, Gravels and Silts A-1, A-2, A-3, A-4, and A-5	90% Min. ASTM D1557 (Modified Proctor Method)	-2% to +2%

The soils encountered at this site are primarily A-1-b in the upper 7 feet and A-6 type soils below that, extending to the Mancos Shale. The purpose of the moisture content requirements shown in Table 15 for A-6 and A-7 soils is to reduce and control swell potential of the subgrade soils. A representative of the geotechnical engineer shall observe and test fill placement operations.

11.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices and adherence to project plans and specifications should be followed during site preparation, earthwork, excavations, and construction of utilities, pavements, and structures for the suitable long-term performance of the proposed improvements. Excavation support should be provided to maintain onsite safety and the stability of excavations and slopes. Excavations shall be constructed in accordance with local, state, and federal regulations including OSHA guidelines. The contractor must provide a competent person to determine compliance with OSHA excavation requirements. For preliminary planning, existing site soils should be considered as OSHA Type C soils, and the Mancos Shale as OSHA Type B soils.

The actual subsurface conditions between boring locations may vary from the information obtained at specific boring locations and described in this report.

Surface drainage patterns may be altered during construction and surface drainage must be controlled to prevent water ponding and excessive moisture infiltration into the subgrade soils during and after construction.

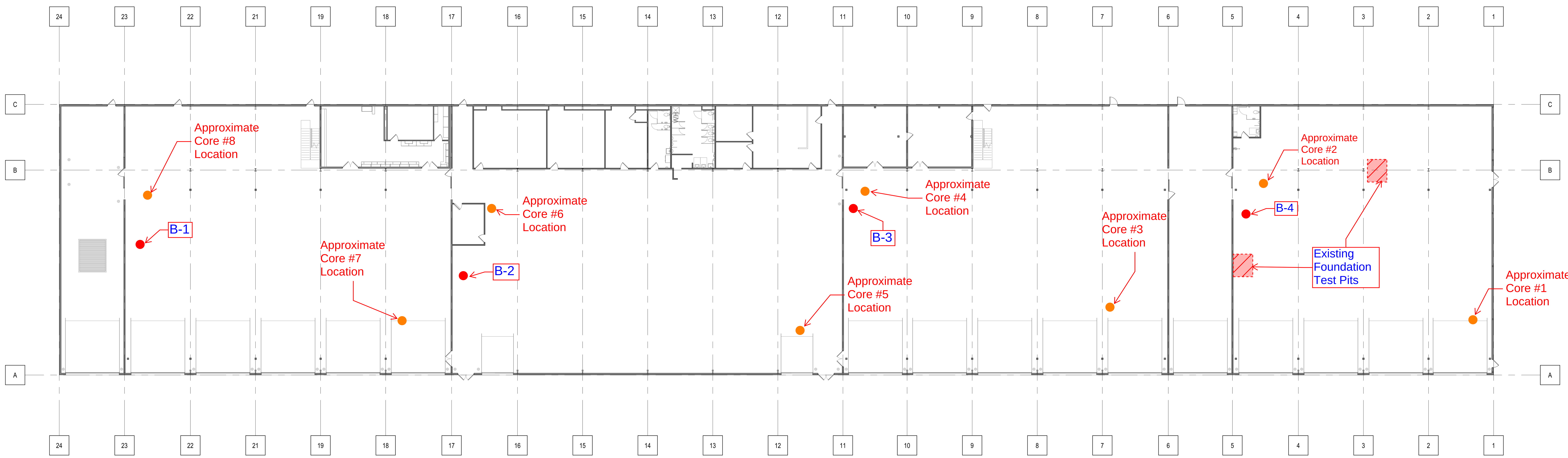
12.0 LIMITATIONS

This geotechnical investigation was conducted in general accordance with the scope of work. The geotechnical practices are similar to that used in Colorado with similar soil conditions and our understanding of the proposed work.

The subsurface investigation program was conducted to obtain information on the subsurface soil, groundwater, and bedrock conditions at the proposed Materials Recycling Facility. Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's geotechnical scope of work.

This report has been prepared by RockSol for the City of Grand Junction exclusively for the project described in this report. The report is based on our exploratory boreholes, recovered floor slab cores, our site observations and does not take into account variations in the subsurface conditions that may exist between boreholes. Additional investigation is required to address such variation. If during construction activities, materials or groundwater conditions appear to be different from those described herein, RockSol should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. RockSol is not responsible for liability associated with interpretation of subsurface data by others. This report shall not be reproduced without written consent from RockSol.

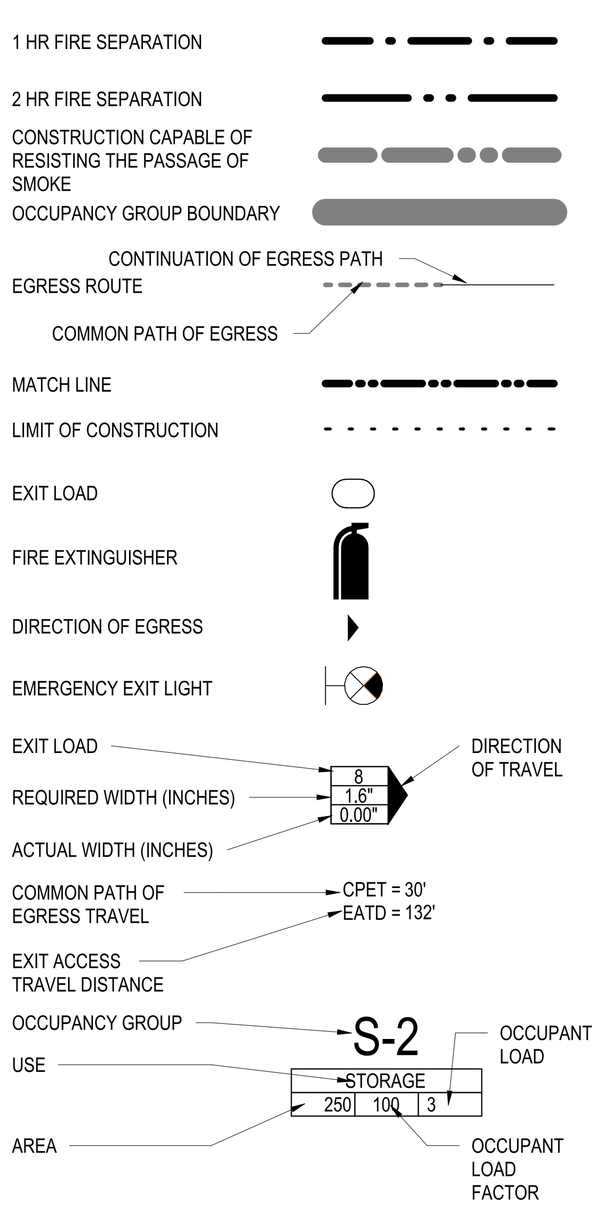
Figure 1A: Building Borehole Location Plan



NORTH

1 G1-1 LIFE SAFETY PLAN
1" = 20'-0"

LIFE SAFETY PLAN LEGEND



NOTE: SOME SYMBOLS SHOWN MAY NOT BE USED ON THIS PROJECT.

BUILDING CODE ANALYSIS

CODE JURISDICTION:
2018 IBC

OCCUPANCY:
__: __: __

OCCUPANT LOADS:
__=__: __=__: __=__

CONSTRUCTION TYPE:
CONSTRUCTION TYPICAL OF TYPE _______.

AUTOMATIC SPRINKLER SYSTEM:
WILL BE PROVIDED

BUILDING AREA:
ACTUAL TOTAL BUILDING: _______ SF
ALLOWED [IBC 506.1] _______ SF

BUILDING HEIGHT:
ACTUAL HEIGHT: __'-_" AFF, _____ STORY
ALLOWABLE HEIGHT: __ STORIES [IBC 504]; ___ STORIES PER GJ Z&D

FIRE RESISTANCE RATING REQUIREMENTS:
(FOR TYPE _____ CONSTRUCTION) [IBC TABLE 601]
STRUCTURAL FRAME: ___ HRS
BEARING WALLS, EXTERIOR: ___ HRS
BEARING WALLS, INTERIOR: ___ HRS
NON-BEARING WALLS, EXTERIOR: ___ HRS*
*1 HR IF < 10 FT FIRE SEPARATION DISTANCE [IBC TABLE 602]
NON-BEARING WALLS, INTERIOR: ___ HRS
FLOOR CONSTRUCTION: ___ HRS
ROOF CONSTRUCTION: ___ HRS

EXIT TRAVEL DISTANCE:
FOR ___ OCCUPANCY:
COMMON PATH OF EGRESS TRAVEL: ___ FT WITH SPRINKLER SYSTEM [IBC TABLE 1006.2.1]
EXIT ACCESS TRAVEL DISTANCE: ___ FT WITH SPRINKLER SYSTEM [IBC TABLE 1017.2]

FOR ___ OCCUPANCY:
COMMON PATH OF EGRESS TRAVEL: ___ FT WITH SPRINKLER SYSTEM [IBC TABLE 1006.2.1]
EXIT ACCESS TRAVEL DISTANCE: ___ FT WITH SPRINKLER SYSTEM [IBC TABLE 1017.2]

FOR ___ OCCUPANCY:
COMMON PATH OF EGRESS TRAVEL: ___ FT WITH SPRINKLER SYSTEM [IBC TABLE 1006.2.1]
EXIT ACCESS TRAVEL DISTANCE: ___ FT WITH SPRINKLER SYSTEM [IBC TABLE 1017.2]

PLUMBING FIXTURE COUNT:

OCCUPANCY TYPE		OCC LD	MEN	WOMEN	WC'S REQ'D M / W	WC'S PROV M /W	LAV REQ'D M / W	LAV PROV M / W	DF REQ'D	DF PROV	SS REQ'D	PROV
________	(_)	___	___	___	_ / _	_ / _	_ / _	_ / _	_	_	_	_
________	(_)	___	___	___	_ / _	_ / _	_ / _	_ / _	_	_	_	_
________	(_)	___	___	___	_ / _	_ / _	_ / _	_ / _	_	_	_	_
TOTALS M / W					_ / _	_ / _	_ / _	_ / _				
UNISEX					____		____					
TOTAL FOR BUILDING					___	___	___	___	___	___	___	___

BG+ co.
Architecture
Interior Design
Project Management
622 Rood Avenue
Grand Junction, CO 81501
970-242-1058 office
BLYTHE GROUP + co.

PROJECT NAME

ENTER ADDRESS HERE

LIFE SAFETY PLAN

PROJECT STATUS

REV. DESC. DATE:

DATE: ISSUE DATE

PROJECT #: PROJECT NUMBER

SHEET #: G1-1

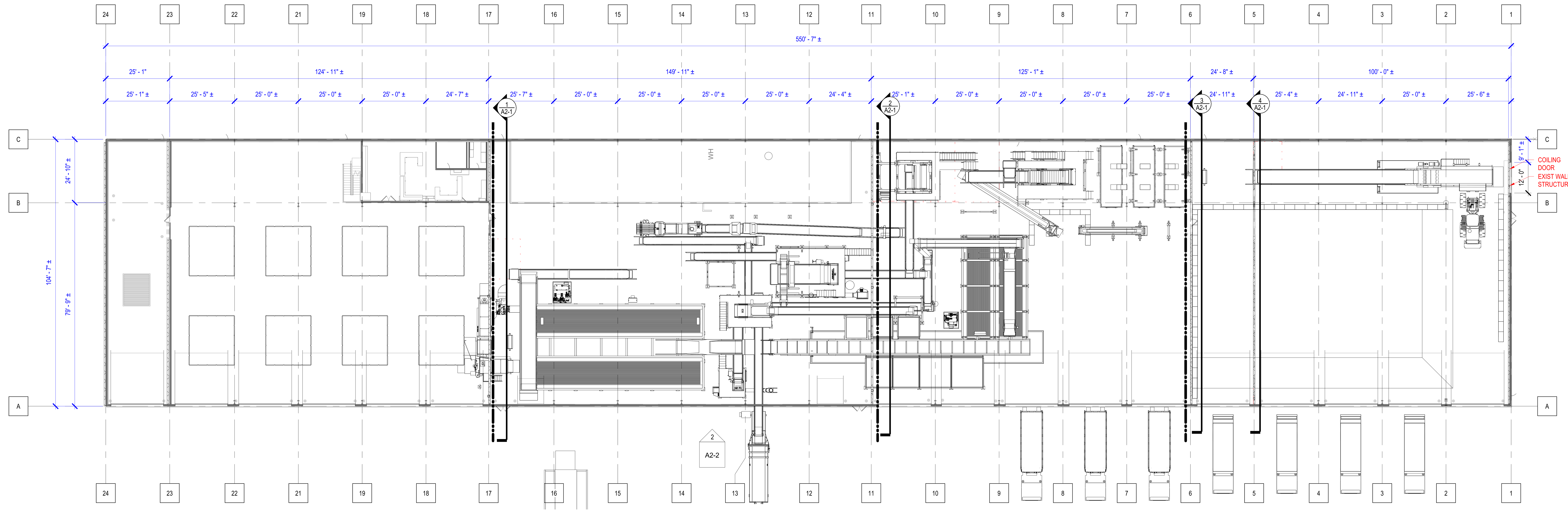
Project Team:
Print Date: 09/17/2025 2:15:00 PM

Figure 1B

Borehole Location Plan – Circulation Road Pavement Boreholes (Google Earth, 2025)

APPENDIX A

BUILDING RENOVATION FLOOR PLAN – OVERALL
(SHEET A-1-1)



NORTH

1 A1-1 FLOOR PLAN - OVERALL
1" = 20'-0"

RENOVATION LEGEND

EXIST WALL

NEW WALL

EXIST DOOR

NEW DOOR

NO ARCHITECTURAL RENOVATION WORK

NEW CMU WALL

GENERAL NOTES

1. ALL INTERIOR PARTITIONS ARE TYPE 1, UNO. REFERENCE ASSEMBLIES DRAWING FOR ADDITIONAL WALL TYPES & CONSTRUCTION.
2. WALLS LOCATED ON GRID LINES ARE CENTERED ON THE GRID LINE UNO.
3. INTERIOR DIMENSIONS ARE TO F.O. STUD, UNO.
4. EXTERIOR DIMENSIONS ARE TO F.O. STUD, MASONRY, OR CONC, UNO.
5. REFERENCE FINISH DRAWINGS FOR INTERIOR FINISHES.
6. DIMENSIONS TO EXISTING WALLS ARE TO FINISH FACE, UNO.
7. ALL ITEMS ARE NEW UNLESS NOTED AS EXISTING

KEYPLAN

A	B	C	D

PROJECT NORTH TRUE NORTH

BG+ co.

Architecture
Interior Design
Project Management

622 Rood Avenue
Grand Junction, CO 81501
970-242-1058 office

BLYTHE GROUP + co.

CITY OF GRAND JUNCTION - MATERIALS RECOVERY FACILITY

365 32 RD, GRAND JUNCTION, CO 81520

RENOVATION FLOOR PLAN - OVERALL

CONSTRUCTION DOCUMENTS

NOT FOR CONSTRUCTION

REV.	DESC.	DATE:

DATE: 10/30/2025

PROJECT #: 25034

SHEET #:

A1-1

Project Team:

Print Date: 11/24/2025 4:32:32 PM

APPENDIX B

BULK HANDLING SYSTEMS EQUIPMENT LAYOUT PLANS
(SHEETS G-002-1,2,3)

EQUIPMENT LIST

EQUIP#	DESCRIPTION	MODEL#
AIR01	AIR COMPRESSORS	AIR-235
BAL01	BALER	BALER
C0002	PRE SORT CONVEYOR	C15-060-S
C0004	OCC POST SORT CONVEYOR	C15-048-S
C0006	OCC BUNKER LEVELING CONVEYOR	C15-048-S
C0008	DRS UNDERS COLLECTION CONVEYOR	IC-36
C0010	DRS UNDERS TRANSFER CONVEYOR	IC-36
C0012	PS INFEED CONVEYOR	C15-048-S
C0013	PS OVERS COLLECTION CONVEYOR	C15-036-S
C0014	PS OVERS TRANSFER CONVEYOR 1	C15-036-S
C0016	PS OVERS TRANSFER CONVEYOR 2	C15-036-S
C0018	PS OVERS QC CONVEYOR	C15-048-S
C0020	OCC POST SORT COLLECTION CONVEYOR	C08-018-S
C0022	RESIDUE & CONTAINER COLLECTION CONVEYOR	C15-036-S
C0024	PS UNDERS COLLECTION CONVEYOR	C15-030-S
C0026	ECS INFEED CONVEYOR	C15-030-S
C0028	ECS EJECTS COLLECTION CONVEYOR	C15-036-S
C0030	ECS DEFAULT COLLECTION CONVEYOR	C15-024-S

EQUIPMENT LIST

EQUIP#	DESCRIPTION	MODEL#
C0032	ECS DEFAULT TRANSFER CONVEYOR #1	C15-030-S
C0034	ECS DEFAULT TRANSFER CONVEYOR #2	C15-030-S
C0036	CONTAINER BUNKER 1 LEVELING CONVEYOR	C15-030-S
C0038	CONTAINER LINE BUFFER BIN COLLECTION CONVEYOR	HDS-72
C0040	CONTAINER LINE BUFFER BIN TRANSFER CONVEYOR	C15-036-S
C0042	OPTICAL #1 ACCELERATION CONVEYOR	ACL-120
C0044	OPTICAL DEFAULT COLLECTION REVERSING CONVEYOR	C15-024-S
C0046	CONTAINER LOOP MAX-AI® AIR INFEED CONVEYOR	C15-084-S
C0048	MAX02 EJECTS CONTAINER COLLECTION CONVEYOR	C15-018-S
C0050	CONTAINER TRANSFER CONVEYOR #1	C15-030-S
C0052	CONTAINER TRANSFER REVERSING CONVEYOR #2	C15-030-S
C0054	CONTAINER BUNKER 2 LEVELING CONVEYOR	C15-030-S
C0056	MAX02 DEFAULT COLLECTION CONVEYOR	C15-030-S
C0058	MAX02 DEFAULT TRANSFER CONVEYOR	C15-030-S
C0060	CONTAINER BIN SHUTTLE INFEED CONVEYOR	C15-024-S
C0062	RESIDUE COLLECTION CONVEYOR	C15-030-S
C0064	RESIDUE TRANSFER CONVEYOR	C15-030-S
C0066	COMPACTOR INFEED CONVEYOR	C15-030-S
C0068	CONTAINER BIN COLLECTION CHAINBELT	CBI-60
C0070	BALER INFEED CONVEYOR	HDS-60
DRS01	BHS DEBRIS ROLL SCREEN®	DRS60-19-236
E0001	OCC WALKING FLOOR	KWF-10
E0002	FIBER WALKING FLOOR	KWF-10
E0003	CONTAINER LINE WALKING FLOOR #1	KWF-10
E0004	CONTAINER LINE WALKING FLOOR #2	KWF-10
E0005	OCC BUNKER DOOR CHAIN HOIST	PBGW-H
E0006	FIBER BUNKER DOOR CHAIN HOIST	PBGW-H
E0013	PNEUMATIC TRANSPORT - UBC	PTS-16-15HP

EQUIPMENT LIST

EQUIP#	DESCRIPTION	MODEL#
E0014	CONTAINER LINE MAX-AI® TOTAL VIS	MTV-01
E0015	OPTICAL INFEED VIBRATORY FEEDER	VPF-116x162
E0016	VOLUMETRIC SCANNER	BUYOUT
E0017	COMPACTOR	BUYOUT
ECS01	EDDY CURRENT SEPARATOR	ECSNES100-5005
HMI01	HMI CONTROL PANEL	HMI
HPU01	FIBER WALKING FLOORS HPU	HPU-KWF
HPU02	CONTAINER WALKING FLOORS HPU	HPU-KWF
MAG01	FERROUS MAGNET	MAGNET
MAX01	MAX-AI® AIR - AUTONOMOUS QC - ALUMINUM	MAXAIR-36
MAX02	MAX-AI® AIR - CONTAINER LOOP QC	MAXAIR-84
MCC01	MOTOR CONTROL CABINENT #1	MCC
MCC02	MOTOR CONTROL CABINENT #2	MCC
MGB01	METERING BIN	MB-30
NRT01	OPTICAL #1 - CONTAINERS	AXS-SPYDIR-120HS
OCC01	BHS OCC SCREEN	DRS66-7-6-762
PSS01	BHS POLISHING SCREEN	108-16F
S0001	PRESORT PLATFORM	PLAT-SORT
S0002	OCC STRUCTURE AND PLATFORM	PLAT-EQUIP
S0003	POST SORT PLATFORM	PLAT-SORT
S0004	PS SUPPORT STRUCTURE	ST-NS-PS-SO<120
S0005	MAGNET STRUCTURE	ST-MAG-SS
S0006	FERROUS CONTAINER BIN	CBin-H
S0007	UBC CONTAINER BIN	CBin-H
S0008	CONTAINER BINS	CBin-H
S0012	EDDY CURRENT SEPARATOR SUPPORT STRUCTURE	PLAT-EQUIP
S0013	MAX-AI® AIR - ALUMINUM QC PLATFORM	PLAT-SORT
S0014	VIBRATORY FEEDER SUPPORT STRUCTURE	ST-MAG-C&D
S0015	CONTAINER LINE OPTICAL SUPPORT STRUCTURE	PLAT-EQUIP
S0016	CONTAINER WALKING FLOOR BUNKERS	BW-LBB
S0017	BALER HMI STAND	STAND
S0020	CONTAINER BIN SHUTTLE CONVEYOR STRUCTURE	ST-MAG-SS
S0022	INFEED PIT COVERS	STPLAT-MISC
S0023	DRS PIT COVERS	STPLAT-MISC
S0700	PRESORT CHUTES	CHUTE
S0702	POST SORT CHUTES	CHUTE
S0704	OCC OVERS CHUTE	OCCOC
S0716	ECS INFEED SPREADER CHUTE	CHUTE
S0726	VIBRATORY FEEDER INFEED SPREADER CHUTE	CHUTE
VIS01	OPTICAL #1 MAX-AI® VISION SYSTEM	VIS-120
XFMR1	TRANSFORMER	TRF

FOR YOUR APPROVAL

APPROVAL DUE TO BHS BY
DELIVERY WILL BE DELAYED ACCORDINGLY
FOR EACH ADDITIONAL DAY.

SIGN AND RETURN ONE COPY

☐ APPROVED ______ DATE ______

☐ APPROVED AS NOTED ______ DATE ______

PRIMARY PAINT COLOR:

GUARD PAINT COLOR:

POWER VOLTAGE/HERTZ:

CONTROL VOLTAGE/HERTZ:

BHS
BulkHandling SYSTEMS
BULK HANDLING SYSTEMS
3592 WEST 5TH AVENUE
EUGENE, OR 97402
PHONE: (541) 485-0999
FAX: (541) 485-6341

REV	DESCRIPTION	DRN	DATE
1	ISSUED FOR APPROVAL	CLM	11/12/2025

PROJECT#: 2380
AREA#:
EQUIP#:
SERIAL#:
MODEL#: N/A
WEIGHT:

DRAWING TITLE: RESIDENTIAL SINGLE STREAM SYSTEM
CLIENT: CITY OF GRAND JUNCTION
LOCATION: GRAND JUNCTION, CO.
DWG FILE: 2380-G-002-GA.dwg

REV #: 1
DRAWING #: G-002-1

BHS

BulkHandling SYSTEMS

BULK HANDLING SYSTEMS

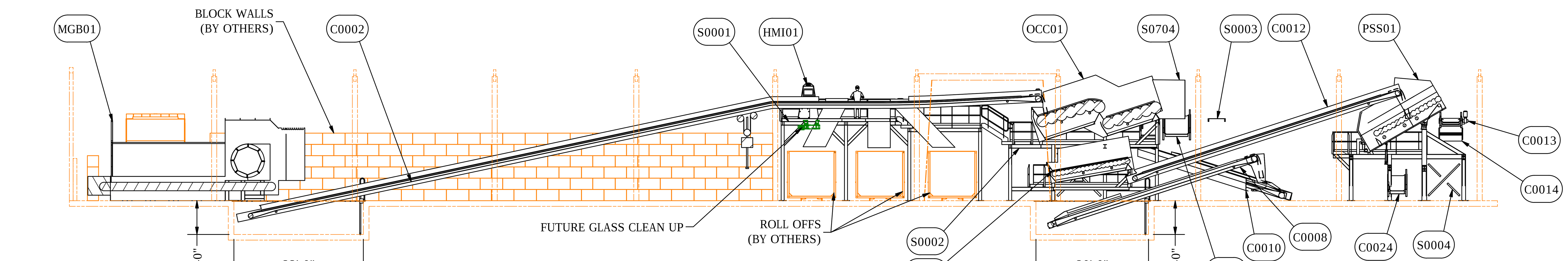
3592 WEST 5TH AVENUE
EUGENE, OR 97402
PHONE: (541) 485-0999
FAX: (541) 485-6341

REV	DESCRIPTION	DRN	DATE
1	ISSUED FOR APPROVAL	CLM	11/12/2025

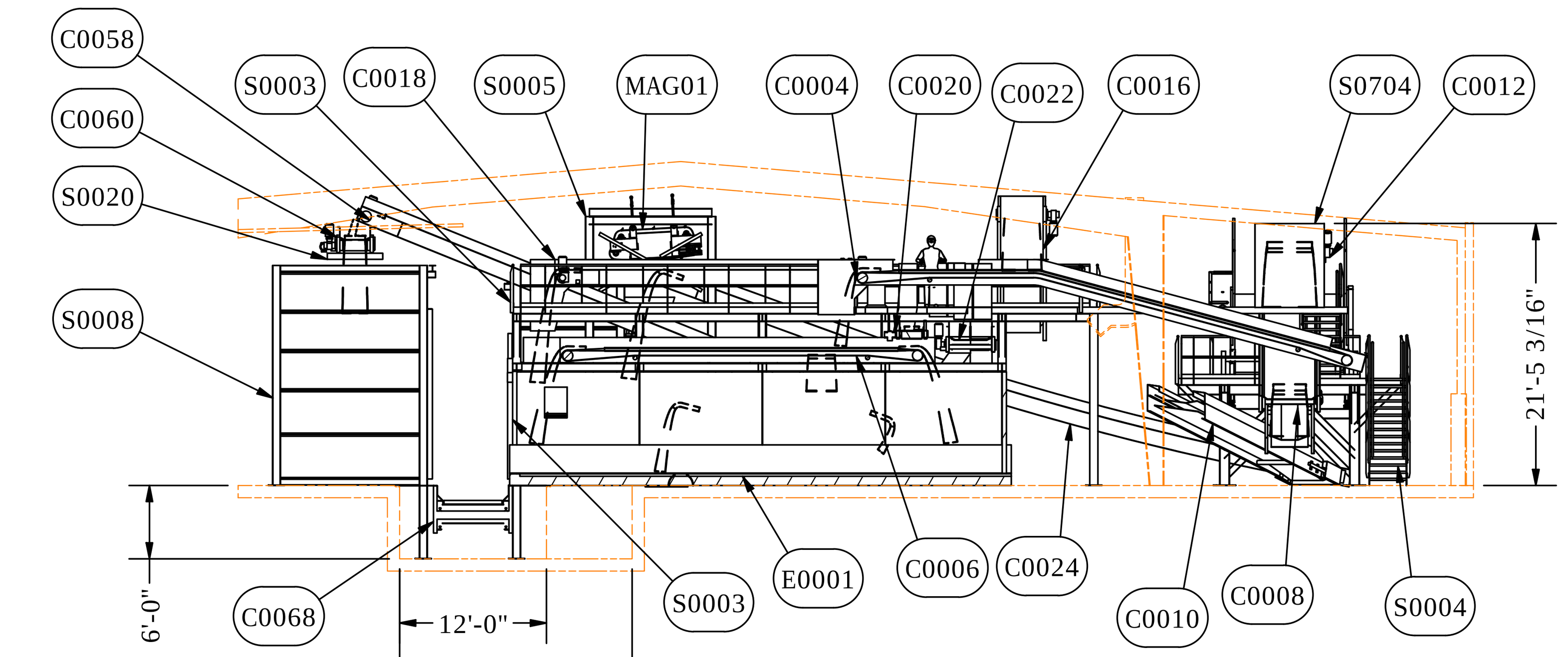
PROJECT#: 2380
AREA#:
EQUIP#:
SERIAL#:
MODEL#:
WEIGHT: N/A

DRAWING TITLE: RESIDENTIAL SINGLE STREAM SYSTEM
CLIENT: CITY OF GRAND JUNCTION
LOCATION: GRAND JUNCTION, CO.
DWG FILE: 2380-G-002-GA.dwg

REV #: 1
DRAWING #: G-002-2



SECTION A-A



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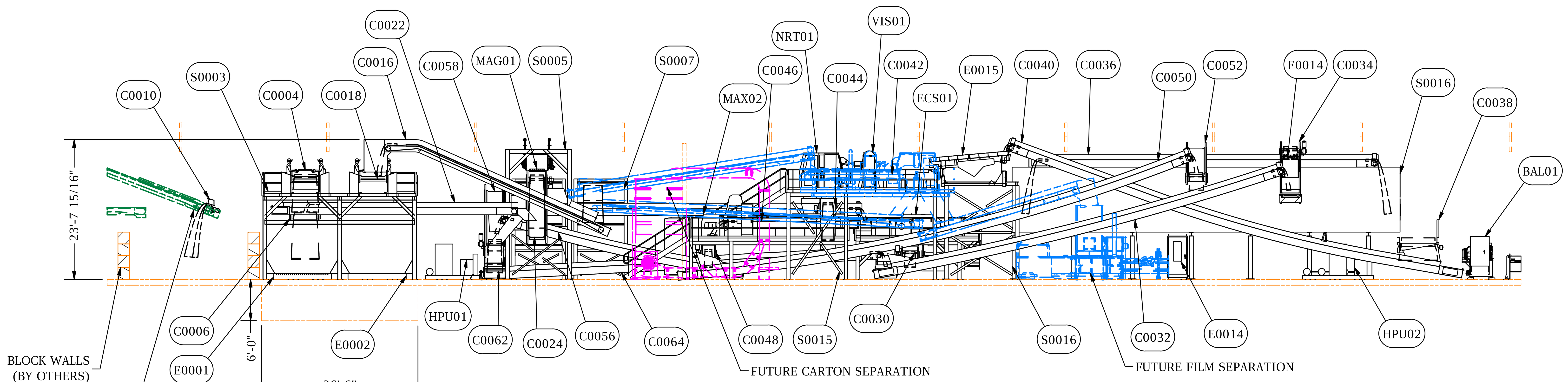

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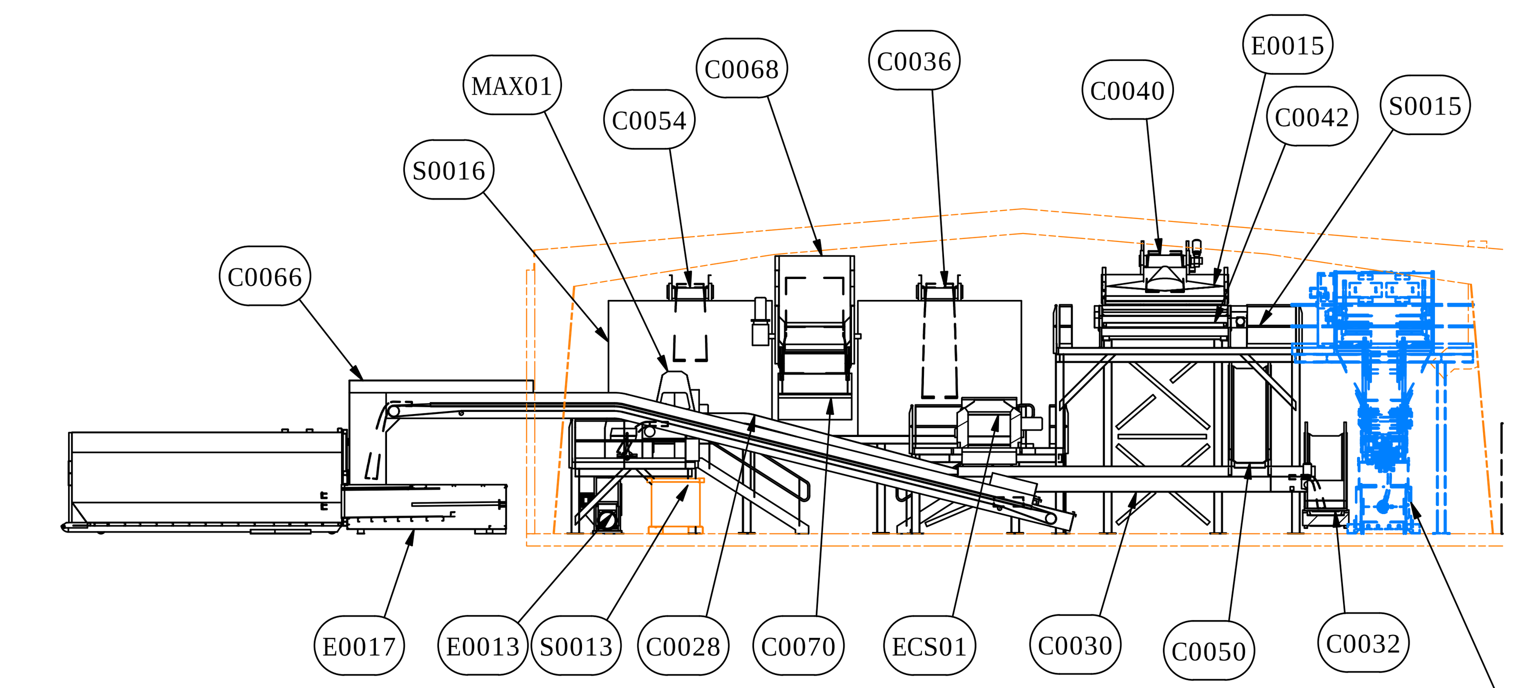
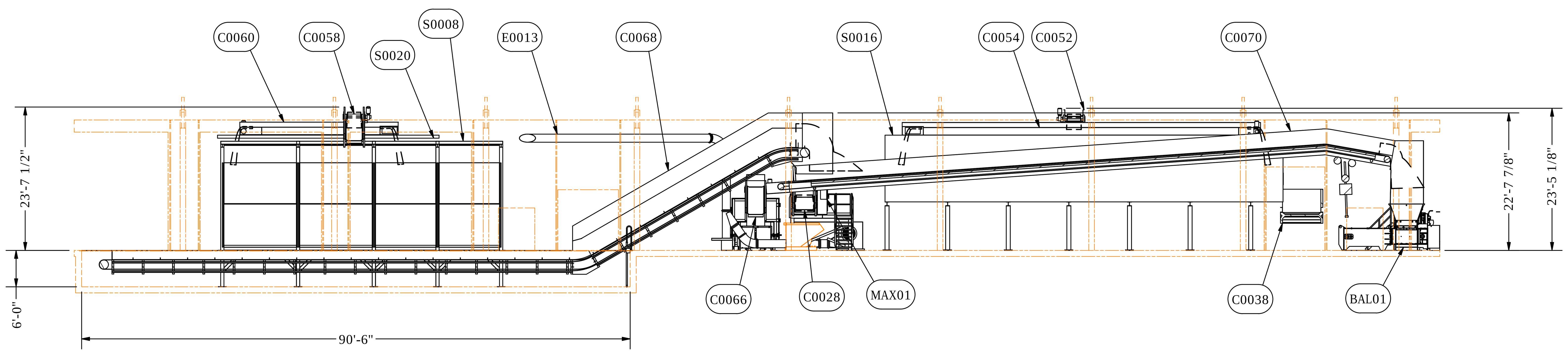
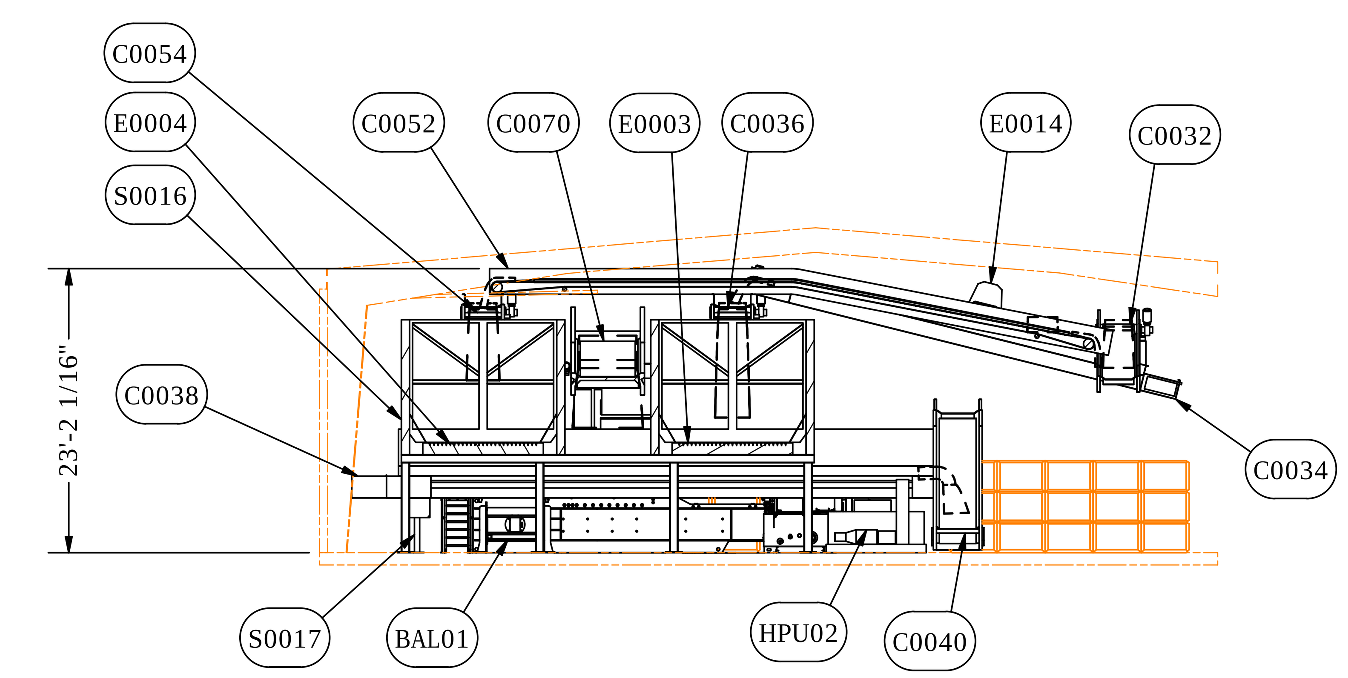


SECTION 2-2



SECTION C-C



SECTION 3-3

BULK HANDLING SYSTEMS

3592 WEST 5TH AVENUE
EUGENE, OR 97402
PHONE: (541) 485-0999
FAX: (541) 485-6341

REV	DESCRIPTION	DRN	DATE
1	ISSUED FOR APPROVAL	CLM	11/12/2025

PROJECT#: 2380
AREA#:
EQUIP#:
SERIAL#:
MODEL#:
WEIGHT: N/A

DRAWING TITLE: RESIDENTIAL SINGLE STREAM SYSTEM
CLIENT: CITY OF GRAND JUNCTION
LOCATION: GRAND JUNCTION, CO.
DWG FILE: 2380-G-002-GA.dwg

REV #: 1
DRAWING #: G-002-3

APPENDIX C

EXISTING INTERIOR WALL AND COLUMN FOUNDATION PHOTOGRAPHS

Interior Column Isolated Spread Footing
Dimensions: 4’ x 4’ x 12” thickness

Interior Wall Continuous Strip Footing

Dimensions: 12" thick strip footing

APPENDIX D

LEGEND AND INDIVIDUAL BOREHOLE LOGS

RockSol Consulting Group, Inc.

LEGEND

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado

LITHOLOGY

- **Asphalt Pavement**
- **Concrete Slab**
- **Fill - GRAVEL, sandy**
- **Fill - SAND, gravelly**
- **Native - SAND**
- **Native - SAND, silty**
- **Native - SAND, gravelly**
- **Native - SAND, clayey**
- **Native - CLAY**
- **Native - CLAY, sandy**
- **Bedrock - SHALE**

SAMPLE TYPE

BULK SAMPLE (Auger Cuttings)

MODIFIED CALIFORNIA SAMPLER
2.5" O.D. AND 2" I.D.
WITH BRASS LINERS INCLUDED

SPLIT SPOON SAMPLER
2" O.D. AND 1 3/8" I.D.
NO LINERS

Fines Content indicates amount of material, by weight, passing the US No 200 Sieve (%)

15/12 Indicates 15 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 12 inches.

50/11 Indicates 50 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 11 inches.

5,5,5 Indicates 5 blows, 5 blows, 5 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 18 inches.

Material descriptions based on ASTM D2488 Visual-Manual Procedure

GROUND WATER AT TIME OF DRILLING

RockSol Consulting Group, Inc.

BORING : B-1

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado
DATE STARTED 11/10/25 **COMPLETED** 11/10/25
GROUND ELEVATION 100.0 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Bay 2 Approx 50' East of Door
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
▼ **WATER DEPTH** 10.5 ft on 11/10/25

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
100.0	0.0		CONCRETE SLAB, approximately 6-inches thick										
			(Fill) GRAVEL, sandy with cobbles at approximately 6-inches in diameter, slightly moist, gray, dense **Approximate Bulk Depth 0.5-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 21.2 Sulfate= 0.07										
97.5	2.5			B BULK			0.07			NP	NP	NP	21.2
				SS	67/12								
			(Native) SAND, silty to gravelly, slightly moist, gray to tan, medium dense	SS	14/12/16								
95.0	5.0												
92.5	7.5		(Native) CLAY, very moist, gray, medium stiff										
90.0	10.0			SS	2/3/3		0.03			36	16	20	97.5
		▼											
			(Native) CLAY, wet, gray, soft										
87.5	12.5												
				MC	3/12								
85.0	15.0												
			Bottom of hole at 15.0 feet.										

LOG - STANDARD 803.64_CITY OF GJ MATERIALS RECYCLING FACILITY.GPJ 12/4/25

BORING : B-2

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado
DATE STARTED 11/10/25 **COMPLETED** 11/10/25
GROUND ELEVATION 100.0 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Bay 7, 6' from North Wall
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
▼ **WATER DEPTH** 10.0 ft on 11/10/25

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
100.0	0	CONCRETE SLAB, approximately 5-inches thick										
		(Fill) SAND, silty to gravelly, moist, brown, medium dense										
		(Native) SAND, gravelly, slightly moist, tan, dense **Approximate Bulk Depth 0.42-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 21.2 Sulfate= 0.07	BULK			0.07			NP	NP	NP	21.2
95.0	5		SS	58/12								19.2
		(Native) SAND, clayey, moist, gray, loose										
90.0	10	▼	MC	9/12								41.6
		(Native) SAND, wet, brown, very loose										
85.0	15		MC	3/12	-0.4		93.5	26.4				6.5
		(Native) SAND, silty with cobbles in parts, wet, brown, dense										
80.0	20		SS	54/14					NP	NP	NP	15.0
75.0	25											
		(Bedrock) SHALE, moist, black to dark gray, very hard										
70.0	30		SS	50/2								
65.0	35											
		Bottom of hole at 36.1 feet.	SS	50/1		0.12						

LOG - STANDARD 803.64_CITY OF GJ MATERIALS RECYCLING FACILITY.GPJ 12/4/25

BORING : B-3

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado
DATE STARTED 11/10/25 **COMPLETED** 11/10/25
GROUND ELEVATION 100.0 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Bay 9
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
▼ **WATER DEPTH** 12.0 ft on 11/10/25

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
100.0	0	CONCRETE SLAB, approximately 6-inches thick										
		(Native) SAND, gravelly, slightly moist, tan, dense **Approximate Bulk Depth 0.5-9** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 21.2 Sulfate= 0.07	BULK			0.07			NP	NP	NP	21.2
95.0	5		SS	25/30/31								16.8
		(Native) CLAY, sandy, slightly moist, brown, very stiff										
90.0	10		MC	21/12					34	14	20	69.7
		(Native) SAND, gravelly with silt, moist to wet, brown, dense ▼										
85.0	15		SS	50/12								
		(Bedrock) SHALE, moist, gray, very hard	SS	50/6								
80.0	20											
			SS	50/2		0.12						
		Bottom of hole at 24.2 feet.										

ATTERBERG LIMITS: LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX

BORING : B-4

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado
DATE STARTED 11/11/25 **COMPLETED** 11/11/25
GROUND ELEVATION 100.0 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Bay 15 Approx 65' E of Garage Bay Door
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 13.0 ft on 11/11/25

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
100.0	0	CONCRETE SLAB, approximately 6.75-inches thick										
		(Fill) SAND, gravelly to silty, moist, brown, medium dense	BULK			0.07			NP	NP	NP	21.2
		(Native) SAND, gravelly to silty, cobbles in parts, slightly moist, brown, dense **Approximate Bulk Depth 0.56-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 21.2 Sulfate= 0.07	SS	13/14/15								
95.0	5		SS	15/41/27								16.1
		(Native) SAND, clayey, very moist, brown, loose										
90.0	10		MC	9/12	-0.3		103.3	21.3				37.7
		(Native) SAND, gravelly, wet, brown, dense										
85.0	15		SS	55/9					NP	NP	NP	4.9
		(Bedrock) SHALE, moist, dark gray, very hard	SS	50/2								
80.0	20											
75.0	25		SS	50/2		0.12						
			SS	100/1								
		Bottom of hole at 29.1 feet.										

BORING : P-1

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado
DATE STARTED 11/10/25 **COMPLETED** 11/10/25
GROUND ELEVATION 100.0 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: West portion of gravel lot
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
▼ **WATER DEPTH** 7.0 ft on 11/10/25

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
100.0	0.0		(Fill) GRAVEL, sandy, light gray, gravel lot surfacing material, approximately 4-inches thick										
			(Native) SAND, gravelly slightly silty, traces of clay in parts 5-7ft, moist, dense Cobbles in parts **Approximate Bulk Depth 0-4** Liquid Limit= 15 Plastic Limit= 13 Plasticity Index= 2 Fines Content= 22.1 Sulfate= 0.48	BULK			0.48			15	13	2	22.1
97.5	2.5			SS	50/8								
				SS	41/17/14					NP	NP	NP	21.8
95.0	5.0		(Native) SAND, gravelly with clay in parts, moist, tan to brown, dense										
		▼	(Native) SAND, gravelly, wet, brown, dense										
92.5	7.5												
90.0	10.0			SS	15/16/25					NP	NP	NP	2.9
			Bottom of hole at 10.5 feet.										

RockSol Consulting Group, Inc.

BORING : P-2

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
ROCKSOL PROJECT NUMBER 803.64
CLIENT PROJECT NUMBER 365 32 Road, Grand Junction, Colorado
DATE STARTED 11/10/25 **COMPLETED** 11/10/25
GROUND ELEVATION 100.0 ft
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Southeast portion of gravel lot
LOGGED BY R. Lepro
GROUND WATER LEVELS:
NOTES
▼ **WATER DEPTH** 9.0 ft on 11/10/25

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
100.0	0.0	ASPHALT PAVEMENT, approximately 2-inches thick										
		(Native) SAND, gravelly, moist, brown to gray, dense **Approximate Bulk Depth 0.17-4** Liquid Limit= 15 Plastic Limit= 13 Plasticity Index= 2 Fines Content= 22.1 Sulfate= 0.48	B BULK			0.48			15	13	2	22.0
97.5	2.5		SS	64/12								22.1
			SS	58/12								
95.0	5.0	(Native) SAND, clayey, moist, brown										
		(Native) SAND, gravelly, wet, brown to grey, dense										
92.5	7.5											
		▼ (water level at 9.0 ft)										
90.0	10.0		SS	38/21/27								
		Bottom of hole at 10.5 feet.										

APPENDIX E

LABORATORY TEST RESULTS

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME Materials Recycling Facility

PROJECT NUMBER 803.64

PROJECT LOCATION 365 32 Road, Grand Junction, Colorado

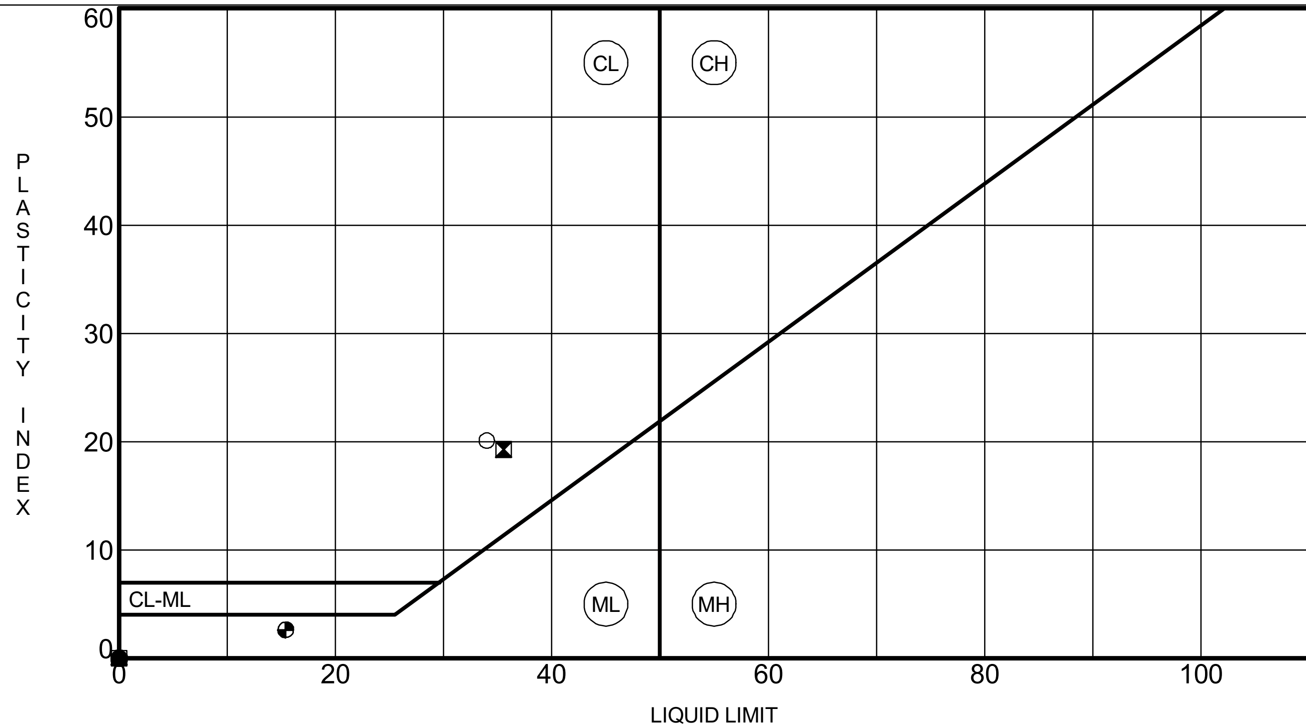
Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
B-1	0.5-4	NP	NP	NP		21	SM	A-1-b (0)				0.07	1,400 @ 11.7%	8.7	0.0366			
B-1	9	36	16	20		98	CL	A-6 (20)				0.03						
B-2	0.42-4	NP	NP	NP		21	SM	A-1-b (0)				0.07	1,400@11.7%	8.7	0.0366			
B-2	4					19												
B-2	9					42												
B-2	14				-0.4	7			26.4	93.5								
B-2	19	NP	NP	NP		15	SM	A-1-b (0)										
B-2	36											0.12		8.9	0.0525			
B-3	0.5-9	NP	NP	NP		21	SM	A-1-b (0)				0.07	1,400@11.7%	8.7	0.0366			
B-3	4	NP	NP	NP		17	GM	A-1-b (0)										
B-3	9	34	14	20		70	CL	A-6 (11)										
B-3	24											0.12		8.9	0.0525			
B-4	0.56-4	NP	NP	NP		21	SM	A-1-b (0)				0.07	1,400@11.7%	8.7	0.0366			
B-4	4					16												
B-4	9				-0.3	38			21.3	103.3								
B-4	14	NP	NP	NP		5	GP	A-1-a (0)										
B-4	24											0.12		8.9	0.0525			
P-1	0-4	15	13	2		22	SM	A-1-b (0)				0.48		8.3	0.1080			
P-1	5	NP	NP	NP		22	SM	A-2-4 (0)										
P-1	9	NP	NP	NP		3	GP	A-1-a (0)										
P-2	0.17-4	15	13	2		22	SM	A-1-b (0)				0.48		8.3	0.1080			
P-2	2					22												

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Materials Recycling Facility

PROJECT NUMBER 803.64 **PROJECT LOCATION** 365 32 Road, Grand Junction, Colorado



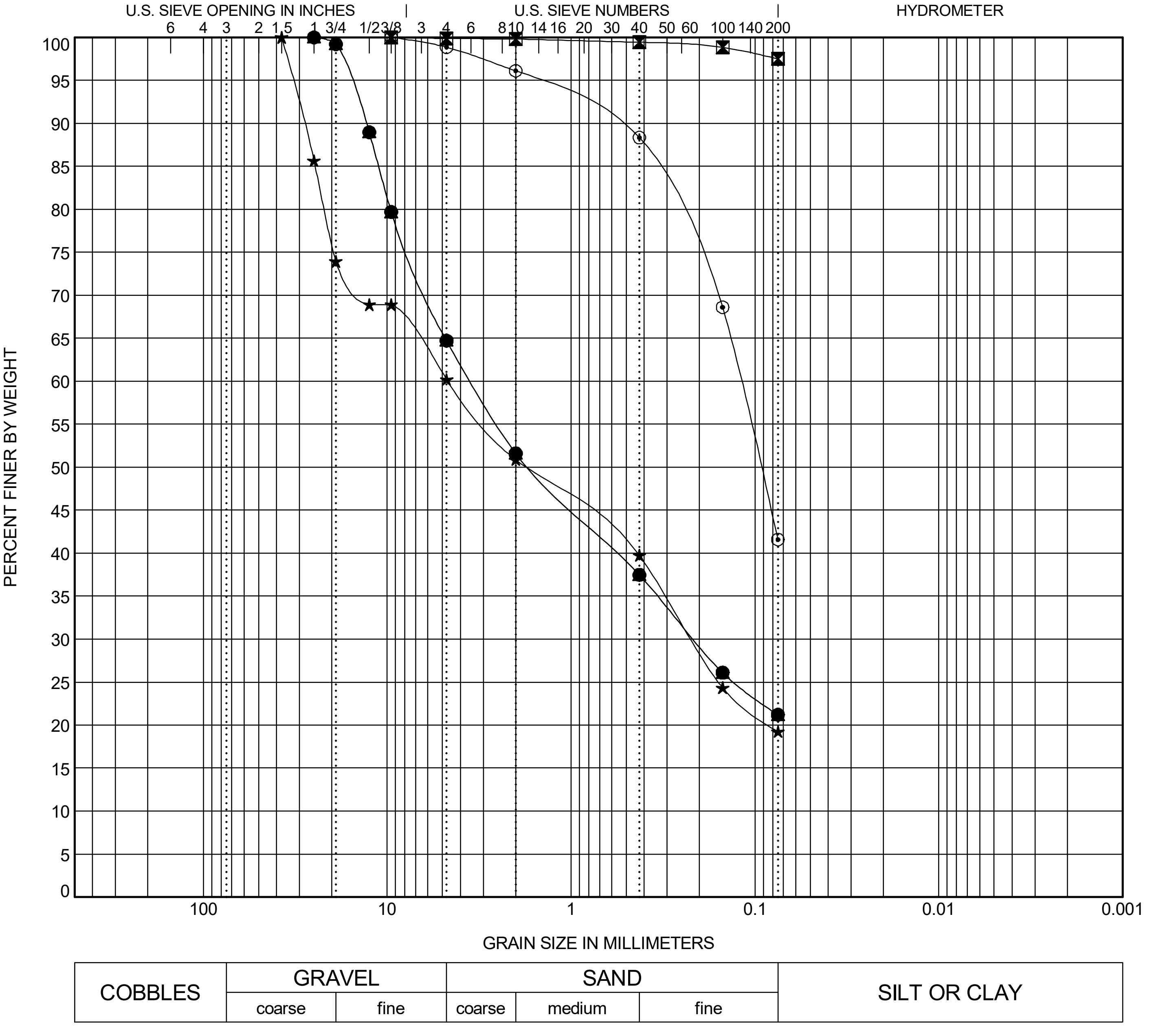
	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-1	0.5-4.0	NP	NP	NP	21.2	SILTY SAND with GRAVEL (SM) (A-1-b)
⧗	B-1	9.0	36	16	20	97.5	LEAN CLAY (CL) (A-6)
▲	B-2	0.4-4.0	NP	NP	NP	21.2	SILTY SAND with GRAVEL (SM) (A-1-b)
★	B-2	19.0	NP	NP	NP	15.0	SILTY SAND with GRAVEL (SM) (A-1-b)
⊙	B-3	0.5-9.0	NP	NP	NP	21.2	SILTY SAND with GRAVEL (SM) (A-1-b)
✿	B-3	4.0	NP	NP	NP	16.8	SILTY GRAVEL with SAND (GM) (A-1-b)
○	B-3	9.0	34	14	20	69.7	GRAVELLY LEAN CLAY (CL) (A-6)
△	B-4	0.6-4.0	NP	NP	NP	21.2	SILTY SAND with GRAVEL (SM) (A-1-b)
⊗	B-4	14.0	NP	NP	NP	4.9	POORLY GRADED GRAVEL with SAND (GP) (A-1-a)
⊕	P-1	0.0-4.0	15	13	2	22.0	SILTY SAND with GRAVEL (SM) (A-1-b)
□	P-1	5.0	NP	NP	NP	21.8	SILTY SAND (SM) (A-2-4)
◉	P-1	9.0	NP	NP	NP	2.9	POORLY GRADED GRAVEL with SAND (GP) (A-1-a)
◕	P-2	0.2-4.0	15	13	2	22.0	SILTY SAND with GRAVEL (SM) (A-1-b)

GRAIN SIZE DISTRIBUTION

RockSol

CLIENT City of Grand Junction **PROJECT NAME** Materials Recycling Facility

PROJECT NUMBER 803.64 **PROJECT LOCATION** 365 32 Road, Grand Junction, Colorado



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	0.5-4.0	**SILTY SAND with GRAVEL (SM) (A-1-b)**	NP	NP	NP		
⧗	B-1	9.0	**LEAN CLAY (CL) (A-6)**	36	16	20		
▲	B-2	0.4-4.0	**SILTY SAND with GRAVEL (SM) (A-1-b)**	NP	NP	NP		
★	B-2	4.0	**GRAVELLY SAND**					
⊙	B-2	9.0	**CLAYEY SAND**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-1	0.5-4.0	25	3.479	0.214		48.4	14.1	16.3	21.2	
⧗	B-1	9.0	9.5				0.2	0.4	1.9	97.5	
▲	B-2	0.4-4.0	25	3.479	0.214		48.4	14.1	16.3	21.2	
★	B-2	4.0	37.5	4.657	0.22		49.1	11.1	20.5	19.2	
⊙	B-2	9.0	9.5	0.12			3.9	7.8	46.8	41.6	

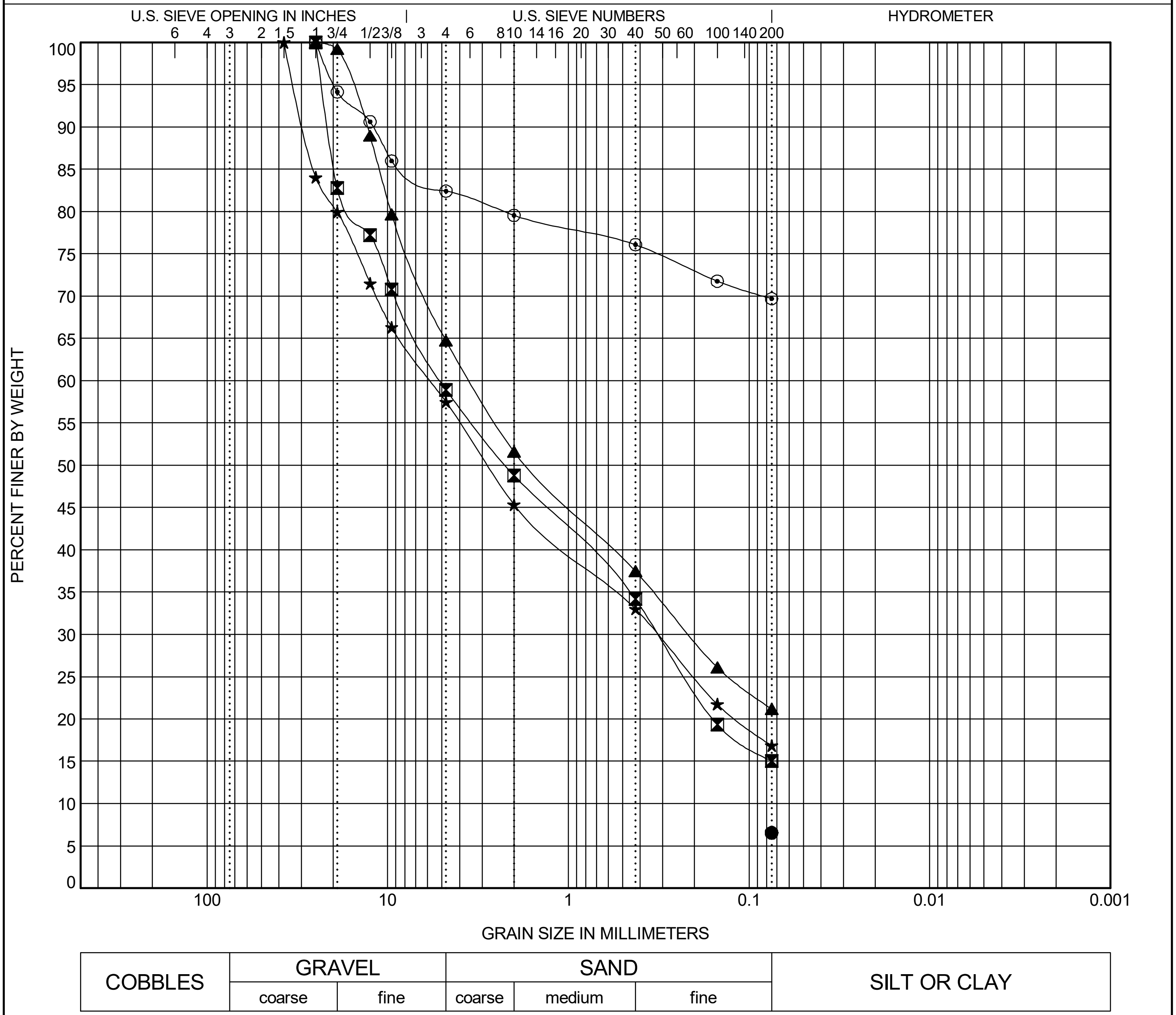
GRADATION - STANDARD 803.64_CITY OF GJ MATERIALS RECYCLING FACILITY.GPJ ROCKSOL TEMPLATE.GDT 12/5/25

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc. RockSol

CLIENT City of Grand Junction **PROJECT NAME** Materials Recycling Facility

PROJECT NUMBER 803.64 **PROJECT LOCATION** 365 32 Road, Grand Junction, Colorado



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-2	14.0	**SAND**					
⧗	B-2	19.0	**SILTY SAND with GRAVEL (SM) (A-1-b)**	NP	NP	NP		
▲	B-3	0.5-9.0	**SILTY SAND with GRAVEL (SM) (A-1-b)**	NP	NP	NP		
★	B-3	4.0	**SILTY GRAVEL with SAND (GM) (A-1-b)**	NP	NP	NP		
⊙	B-3	9.0	**GRAVELLY LEAN CLAY (CL) (A-6)**	34	14	20		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-2	14.0	0.075							6.5	
⧗	B-2	19.0	25	5.057	0.317		51.2	14.6	19.1	15.0	
▲	B-3	0.5-9.0	25	3.479	0.214		48.4	14.1	16.3	21.2	
★	B-3	4.0	37.5	5.784	0.322		54.7	12.3	16.2	16.8	
⊙	B-3	9.0	25				20.4	3.5	6.4	69.7	

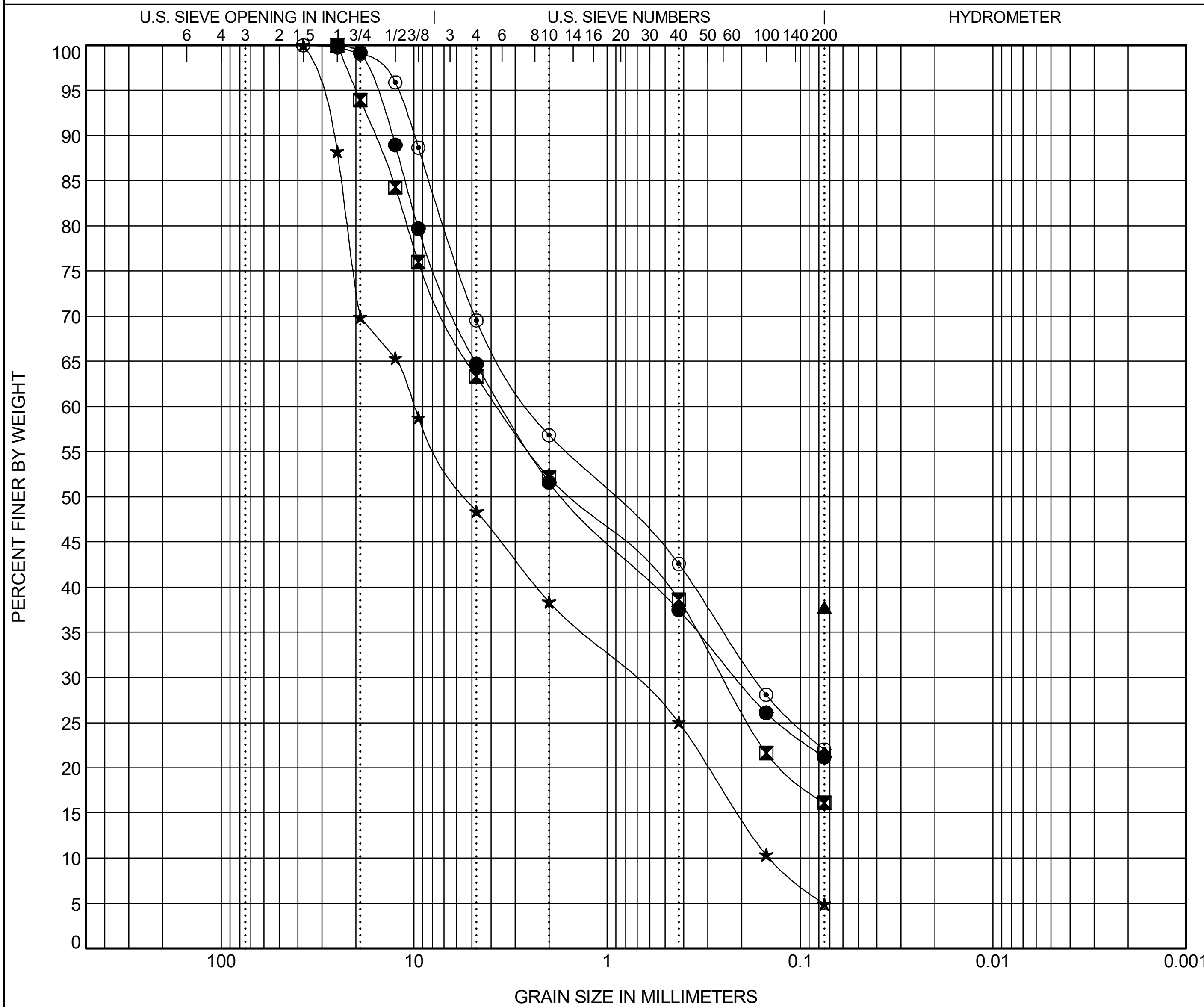
GRADATION - STANDARD 803.64_CITY OF GJ MATERIALS RECYCLING FACILITY.GPJ ROCKSOL TEMPLATE.GDT 12/5/25

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc. RockSol

CLIENT City of Grand Junction **PROJECT NAME** Materials Recycling Facility

PROJECT NUMBER 803.64 **PROJECT LOCATION** 365 32 Road, Grand Junction, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-4	0.6-4.0	SILTY SAND with GRAVEL (SM) (A-1-b)	NP	NP	NP		
⊠ B-4	4.0	SILTY SAND with GRAVEL					
▲ B-4	9.0	CLAYEY SAND					
★ B-4	14.0	POORLY GRADED GRAVEL with SAND (GP) (A-1-a)	NP	NP	NP	0.40	69.85
⊙ P-1	0.0-4.0	SILTY SAND with GRAVEL (SM) (A-1-b)	15	13	2		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
● B-4	0.6-4.0	25	3.479	0.214		48.4	14.1	16.3	21.2	
⊠ B-4	4.0	25	3.678	0.25		47.9	13.5	22.5	16.1	
▲ B-4	9.0	0.075							37.7	
★ B-4	14.0	37.5	10.004	0.757	0.143	61.6	13.3	20.1	4.9	
⊙ P-1	0.0-4.0	37.5	2.482	0.172		43.2	14.2	20.6	22.0	

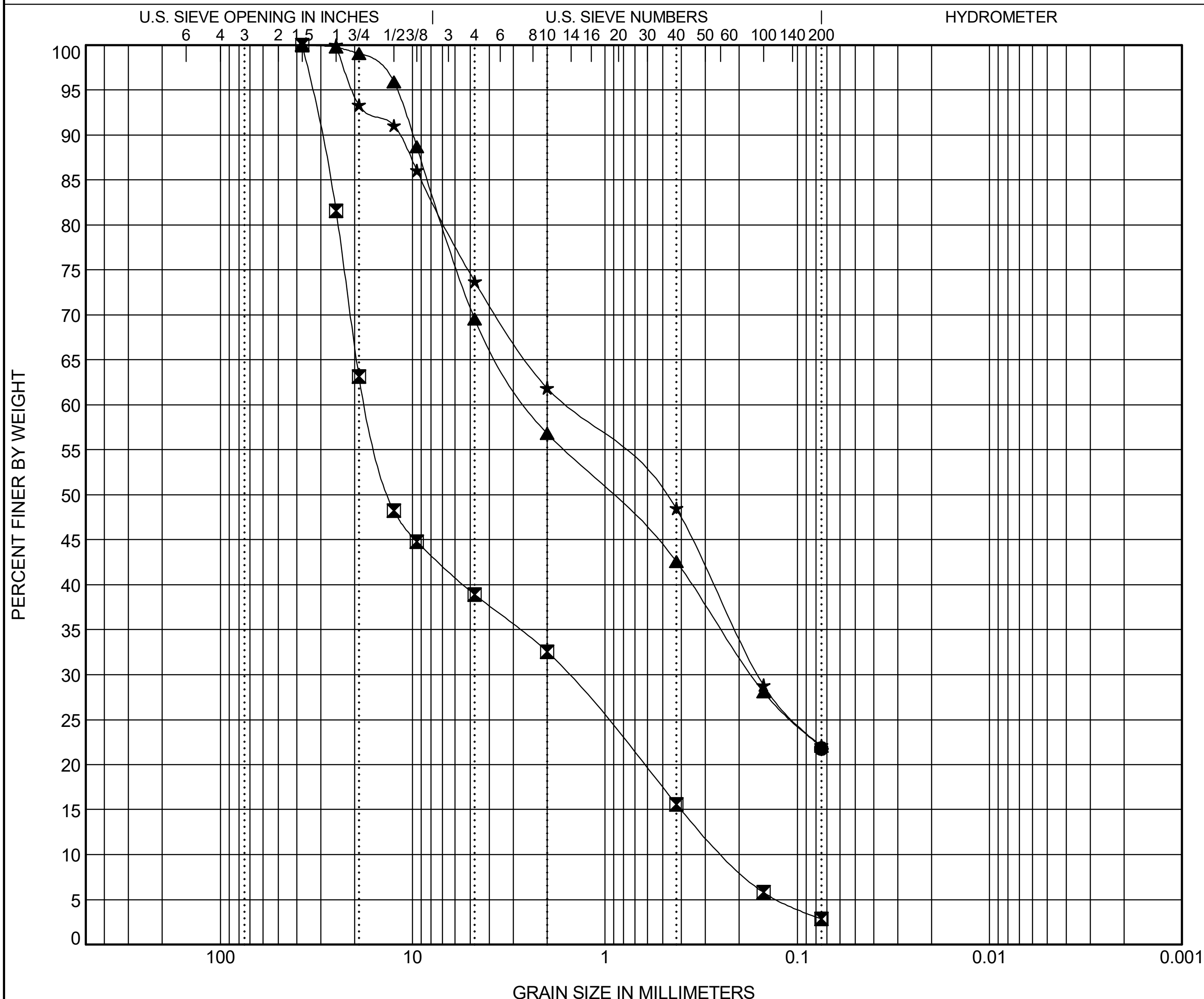
GRADATION - STANDARD 803.64_CITY OF GJ MATERIALS RECYCLING FACILITY.GPJ ROCKSOL TEMPLATE.GDT 12/5/25

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc. RockSol

CLIENT City of Grand Junction **PROJECT NAME** Materials Recycling Facility

PROJECT NUMBER 803.64 **PROJECT LOCATION** 365 32 Road, Grand Junction, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

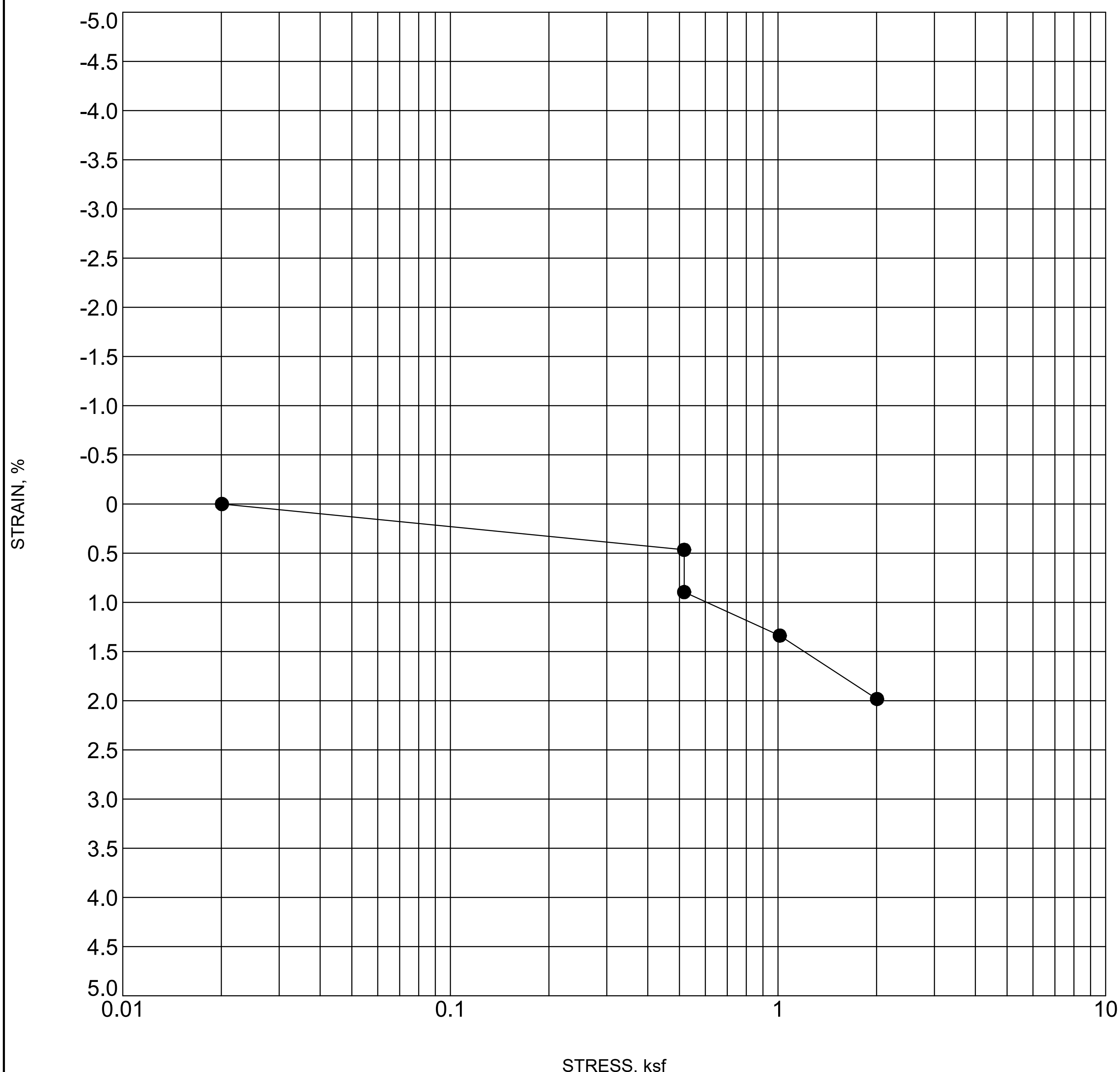
	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**P-1**	**5.0**	**SILTY SAND (SM) (A-2-4)**	**NP**	**NP**	**NP**		
⧗	**P-1**	**9.0**	**POORLY GRADED GRAVEL with SAND (GP) (A-1-a)**	**NP**	**NP**	**NP**	**0.61**	**74.17**
▲	**P-2**	**0.2-4.0**	**SILTY SAND with GRAVEL (SM) (A-1-b)**	**15**	**13**	**2**		
★	**P-2**	**2.0**	**GRAVELLY SAND**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	**P-1**	**5.0**	**0.075**							**21.8**	
⧗	**P-1**	**9.0**	**37.5**	**17.383**	**1.582**	**0.234**	**67.4**	**17.0**	**12.7**	**2.9**	
▲	**P-2**	**0.2-4.0**	**37.5**	**2.482**	**0.172**		**43.2**	**14.2**	**20.6**	**22.0**	
★	**P-2**	**2.0**	**25**	**1.611**	**0.16**		**38.1**	**13.4**	**26.4**	**22.1**	

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Materials Recycling Facility
PROJECT NUMBER 803.64
PROJECT LOCATION 365 32 Road, Grand Junction, Colorado



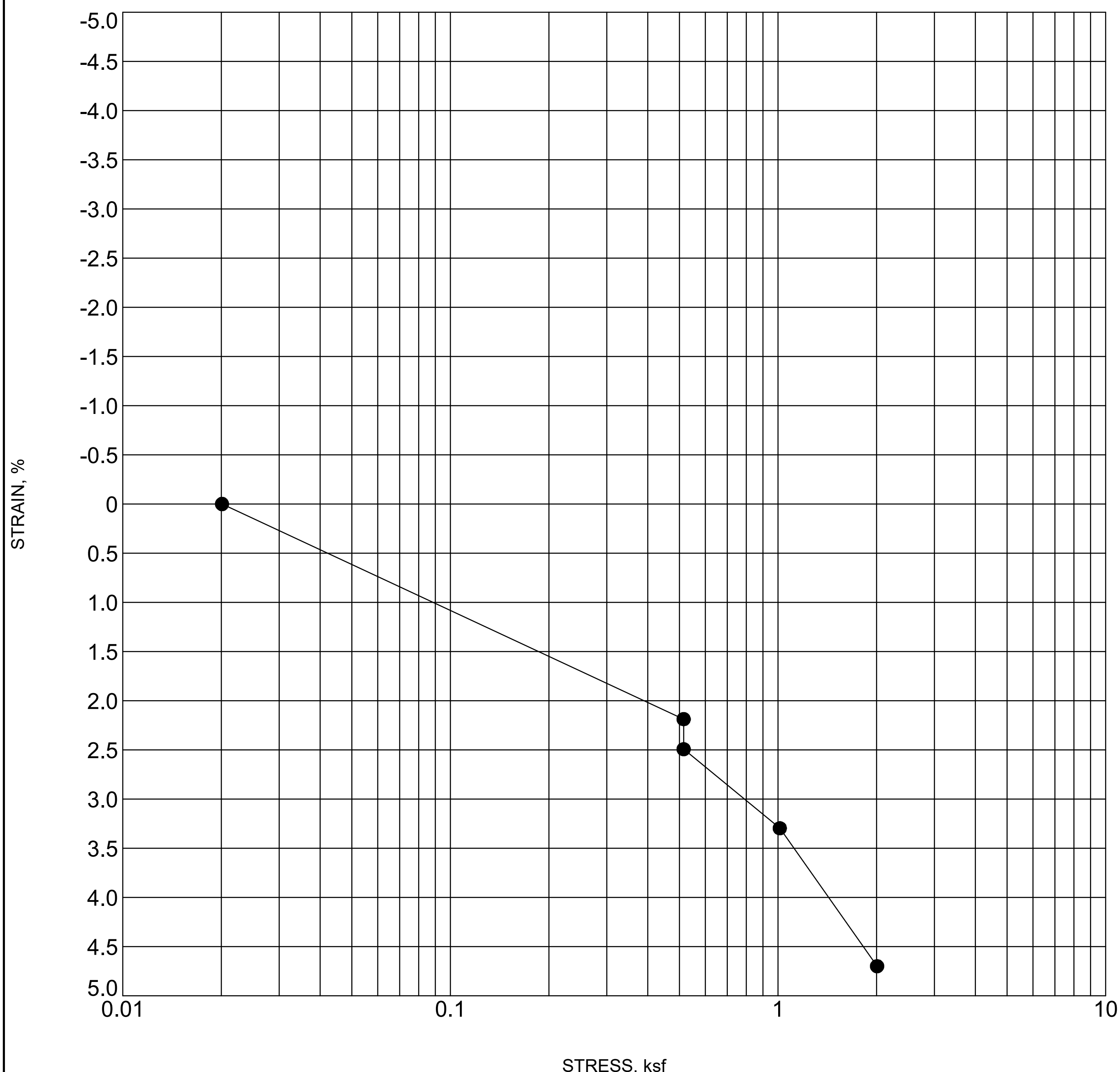
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-2**	**14**	**SAND**	**-0.4**		

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Materials Recycling Facility

PROJECT NUMBER 803.64 **PROJECT LOCATION** 365 32 Road, Grand Junction, Colorado



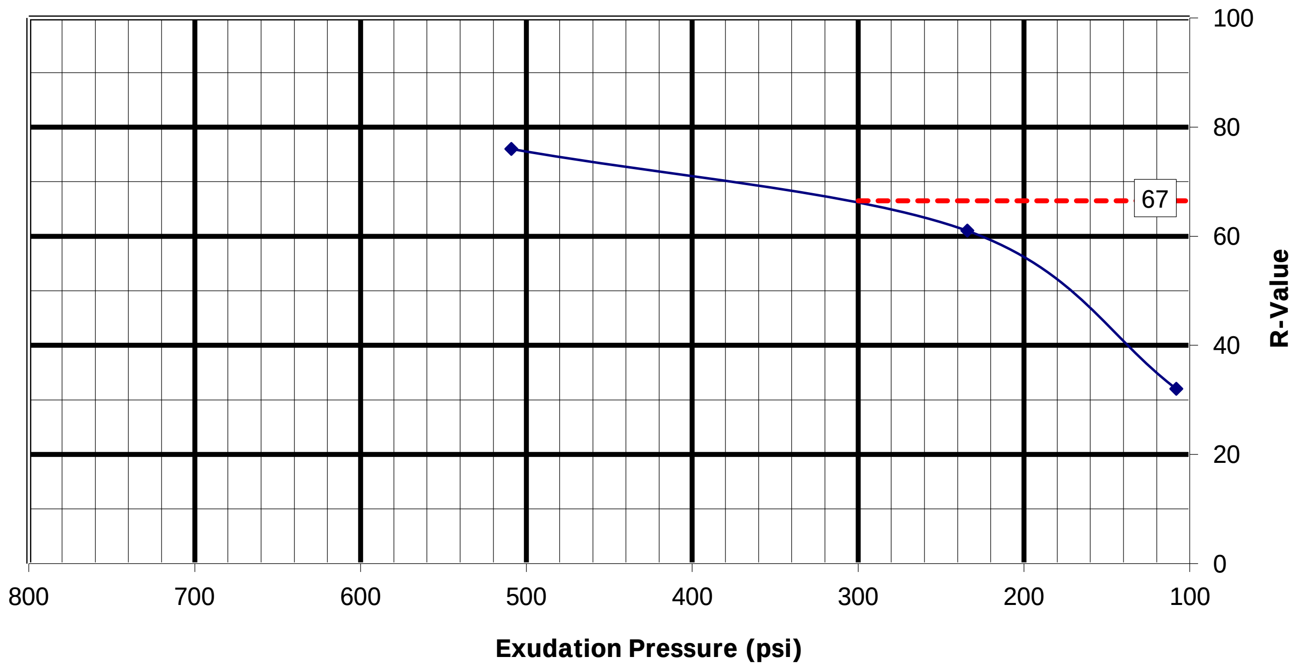
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-4**	**9**	**CLAYEY SAND**	**-0.3**		

CMT TECHNICAL SERVICES

AASHTO ACCREDITED

R-VALUE TEST GRAPH (AASHTO T190)

Project number	25.022; Rocksol Consulting	Date	11/20/25
Project name	GJ Recycling Facilities (RockSol Project No. 803.64)	Technician	J. Holiman
Lab ID number	255313	Reviewer	G. Hoyos
Sample location	P-1 and P-2 at 0 to 4.0 feet - SB Washington		
Visual description	SAND, silty, with gravel, light brown		



R-Value @ Exudation Pressure 300 psi:	**67**
Specification:	

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29]+3$ **S_1 = 8.49**

$M_R = 10^{[(S_1+18.72)/6.24]}$ **M_R = 22,953**

M_R = Resilient Modulus, psi

S_1 = the Soil Support Value

R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	6.0	6.4	7.4
Expansion Pressure, psi:	-0.15	-0.33	-0.49
Dry Density, pcf:	140.7	139.7	139.0
R-Value:	76	61	32
Exudation Pressure, psi:	509	234	108

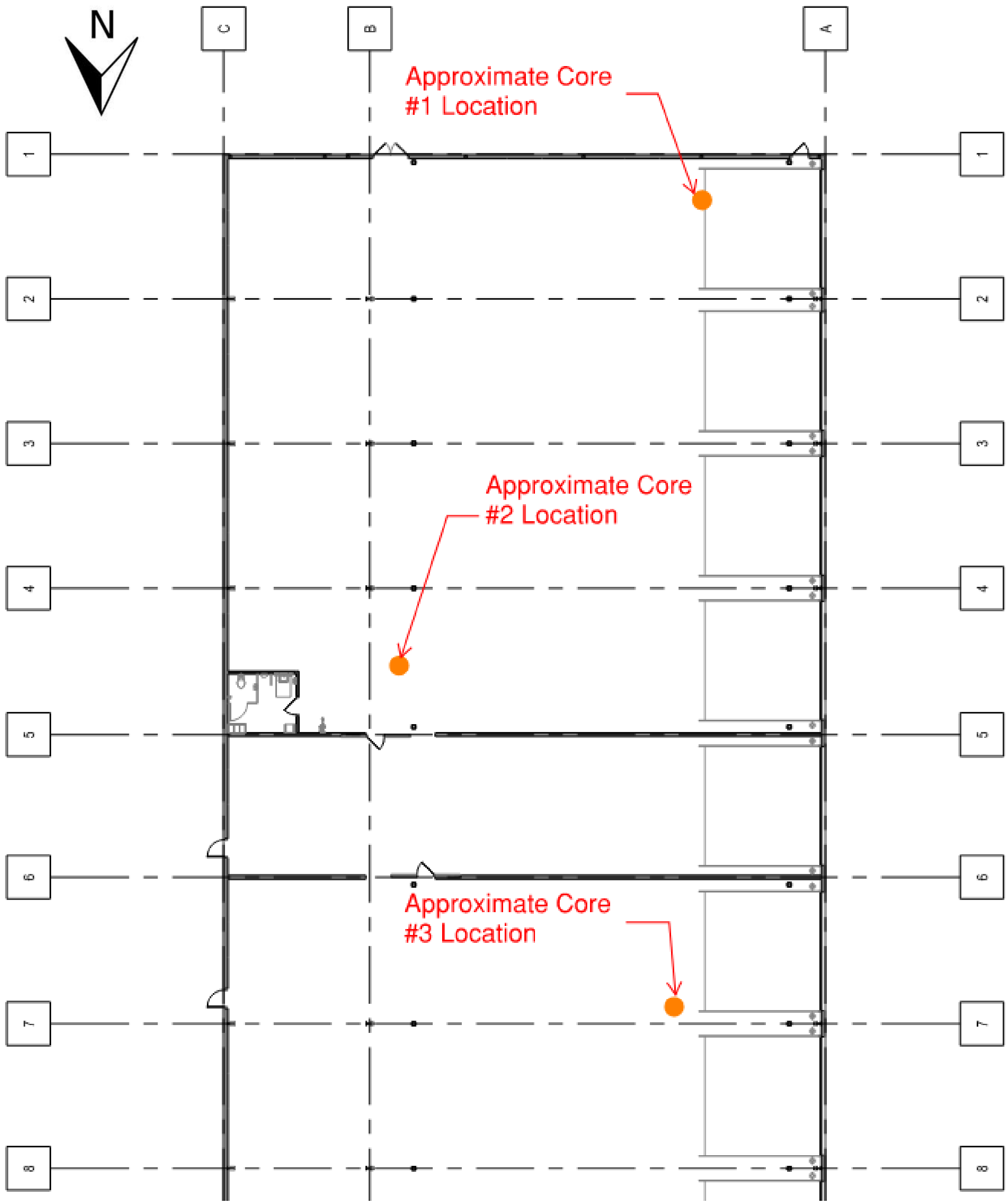
Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

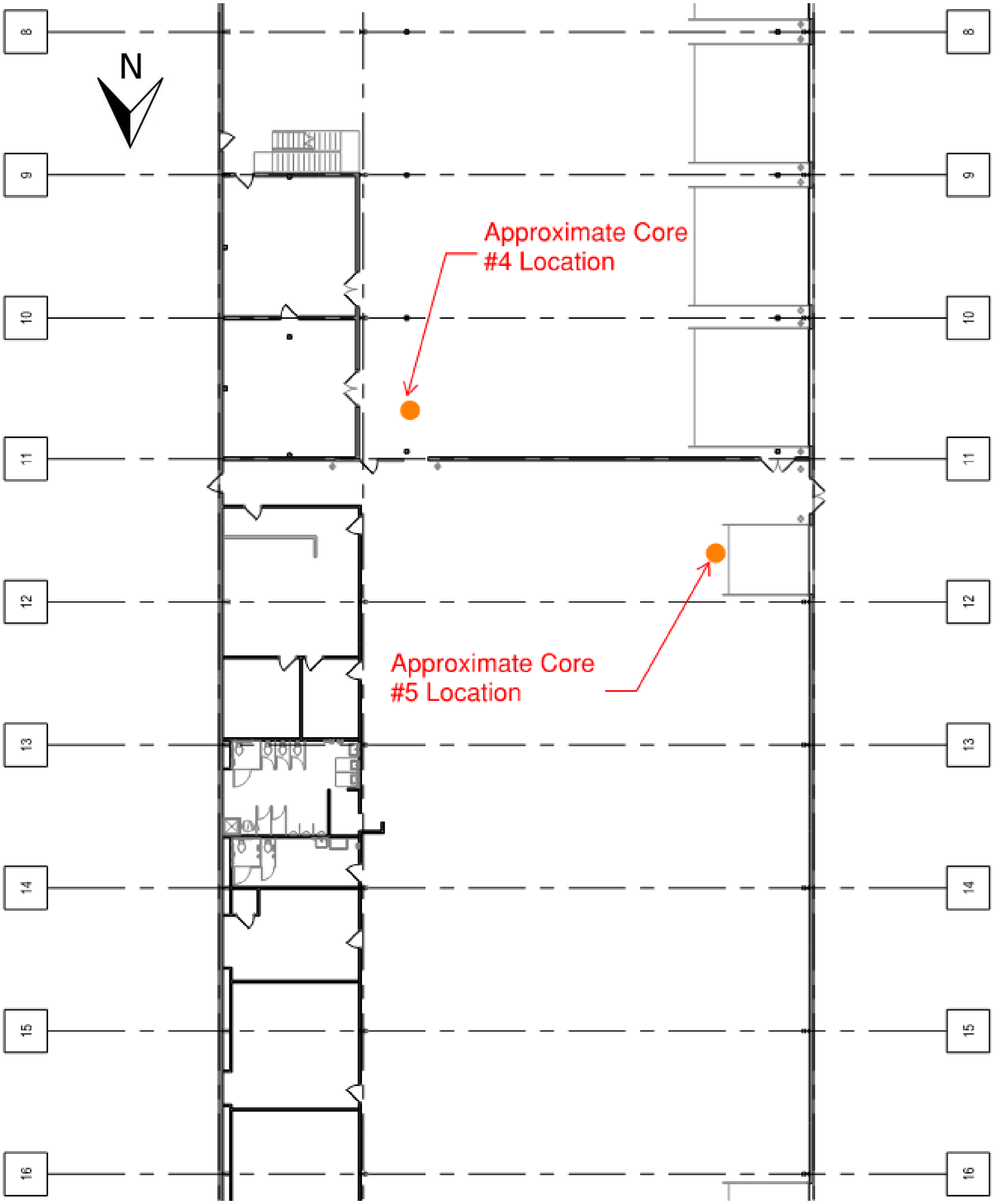
APPENDIX F

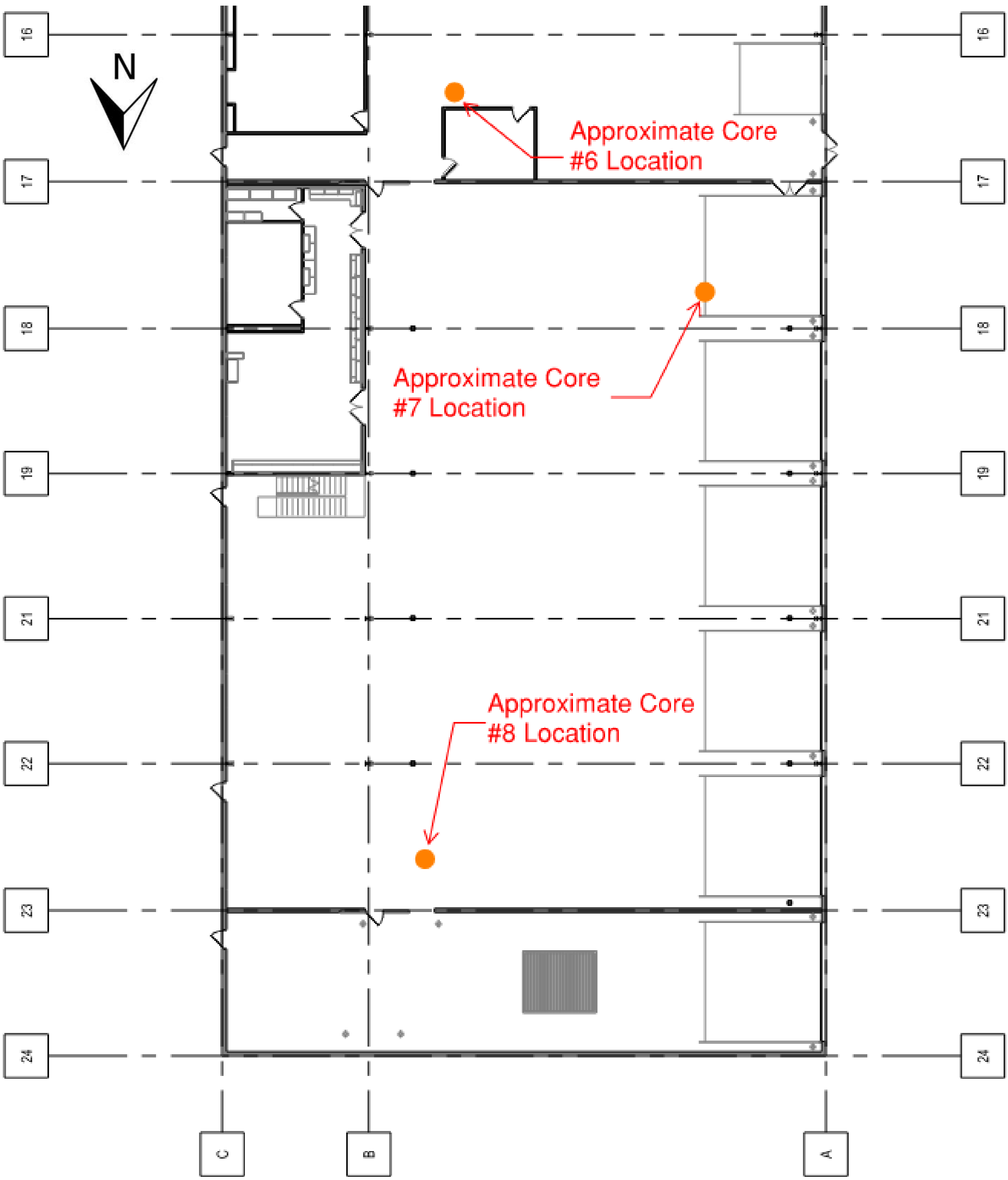
CONCRETE SLAB CORE SUMMARY

Existing Floor Slab Core Summary

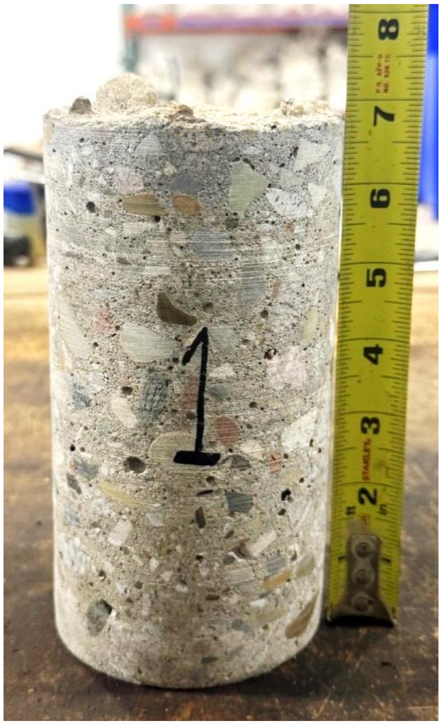
Core Locations relative to the building layout plan shown in Figure 1A are shown below. Photographs of the recovered cores are shown on the following pages.




N
Approximate Core
#4 Location
Approximate Core
#5 Location
8
9
10
11
12
13
14
15
16


N
Approximate Core
#6 Location
Approximate Core
#7 Location
Approximate Core
#8 Location
16
17
18
19
21
22
23
24
C
B
A

Existing Floor Slab Core Summary

Core Photograph:	
	**Core ID:** 1 **Date Cored:** 10/14/2025 **Slab Thickness:** **7 inches** **Core Diameter:** 4” **Description:** No reinforcing steel encountered. **Approximate Location:** West half of building, between gridlines 1 and 2.
Core Photograph: 	**Core ID:** 2 **Date Cored:** 10/14/2025 **Slab Thickness:** **6.75 inches** **Core Diameter:** 4” **Description:** No reinforcing steel encountered. **Approximate Location:** East half of building, between gridlines 4 and 5.

Existing Floor Slab Core Summary

Core Photograph:

Core ID: 3

Date Cored: 10/14/2025

Slab Thickness: **7.25 inches**

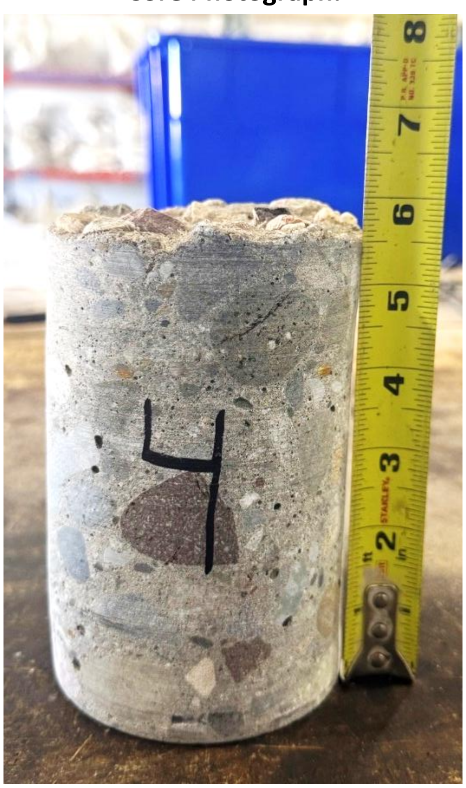
Core Diameter: 4”

Description: No reinforcing steel encountered.

Approximate Location:

West half of building, between gridlines 6 and 7.

Core Photograph:



Core ID: 4

Date Cored: 10/14/2025

Slab Thickness: **5.75 inches**

Core Diameter: 4”

Description: No reinforcing steel encountered.

Approximate Location:

East half of building, between gridlines 10 and 11.

Existing Floor Slab Core Summary

Core Photograph:	
	**Core ID:** 5 **Date Cored:** 10/14/2025 **Slab Thickness:** **6.0 inches** **Core Diameter:** 4” **Description:** No reinforcing steel encountered. **Approximate Location:** West half of building, between gridlines 11 and 12.
Core Photograph: 	**Core ID:** 6 **Date Cored:** 10/14/2025 **Slab Thickness:** **5.25 inches** **Core Diameter:** 4” **Description:** No reinforcing steel encountered. **Approximate Location:** East half of building, between gridlines 16 and 17.

Existing Floor Slab Core Summary	
Core Photograph: 	**Core ID:** 7 **Date Cored:** 10/14/2025 **Slab Thickness:** **6.5 inches** **Core Diameter:** 4” **Description:** No reinforcing steel encountered. **Approximate Location:** West half of building, between gridlines 17 and 18.
Core Photograph: 	**Core ID:** 8 **Date Cored:** 10/14/2025 **Slab Thickness:** **6.0 inches** **Core Diameter:** 4” **Description:** No reinforcing steel encountered. **Approximate Location:** East half of building, between gridlines 22 and 23.

City of Grand Junction Materials Recycling Facility Concrete Floor Slab Core Data

Core #	Pre-Cut Length (in)	Post-Cut Length (in)	Diameter 1 & 2 (in)	Area (in^2)	L/D Correction Factor	Peak Load (lbs)	Compressive Strength (psi)
1	7"	6.75"	3.71" x 3.72"	10.87	0.00	63440	5840
2	6.75"	6.25"	3.72" x 3.72"	10.87	0.98	62385	5620
3	7.25"	6.75"	3.71" x 3.71"	10.81	0.00	74500	6890
4	5.75"	5.25"	3.71" x 3.72"	10.87	0.96	110655	9770
5	6.00"	5.50"	3.72" x 3.71"	10.87	0.96	63370	5600
6	5.25"	4.50"	3.72" x 3.72"	10.87	0.93	75650	6470
7	6.5"	5.50"	3.71" x 3.71"	10.81	0.96	74520	6620
8	6"	5.50"	3.72" x 3.72"	10.87	0.96	63410	5600

APPENDIX G

CDOT PIPE MATERIALS SELECTION GUIDE

CDOT PIPE MATERIAL SELECTION GUIDE Revised April 30, 2015

Implementation

The *CDOT Pipe Material Selection Policy* was initially developed by the Project Development Branch for approval by the Chief Engineer. However, this document is no longer required to be a separate policy document that requires the Chief Engineer's approval. Therefore, it will now be referred to as the *CDOT Pipe Material Selection Guide* and when the Drainage Design Manual is updated this guide will be incorporated as a design procedure in the Drainage Design Manual. Until such time it will continue to be "stored" on the Bulletins and Manuals webpage as a "stand alone" document (https://www.codot.gov/business/designsupport/bulletins_manuals).

These Procedures for Pipe Material Selection (as updated April 30, 2015) supersede and replace all previous procedures, guidelines, and policies regarding the selection of pipe materials used by CDOT.

These procedures also replace the CDOT Chief Engineer memo dated February 8, 1984, *Pipe to be Used in Storm Drains.*

CDOT PIPE MATERIAL SELECTION GUIDE

Revised April 30, 2015

Introduction

This guide will enable Project Managers (PMs) to select the allowable pipe material options for each installation on a specific project. The Contractor will choose the final pipe material from the list of options provided in the Contract and as specified in applicable sections of the CDOT *Standard Specifications for Road and Bridge Construction.* Any pipe that meets the corrosion and abrasion criteria in this guide and is installed per the plans and specifications is assumed to have a 50-year service life.

Background

This policy/guide was originally developed to comply with the provisions of the Final Rule published in 23 CFR 635.411 (b) published in the Federal Register on November 15, 2006. On July 6, 2012 the Moving Ahead for Progress in the 21st Century Act (MAP-21) was signed into law, with the passage MAP-21 the federal requirement for this policy/guide was nullified. The Colorado Department of Transportation (CDOT) has determined the additional performance criteria outlined in the original policy (now guide) is beneficial to the state. Therefore this revised guide retains much of the original policy and is to be incorporated into all CDOT design projects. CDOT will follow its standard practices for the hydraulic and structural design of pipes. This guide replaces all previous policies regarding the selection of pipe material for Storm Drains, Cross Drains, and Side Drains.

Selection Considerations

CDOT will evaluate the risk associated with the performance of the pipe materials. Risk will be considered to the extent that it is influenced by the pipe, other materials, or installation techniques as they are used in construction.

The CDOT Pipe Material Selection Guide identifies the specific engineering and performance criteria used to evaluate the acceptability of alternative pipe materials. CDOT will allow alternative pipe materials where appropriate. A record of the determination of abrasion and corrosion levels will be documented and maintained in the project design files.

The following exemptions are not intended to be covered by this guide.

A. Subsurface Drains and Embankment Protector Type 3 (M-Standard 615).

B. Pipe extensions of existing pipes or systems shall be completed using similar material and sizes. Exceptions to this may be made when conditions and engineering justifications merit otherwise.

C. Local agencies and other organizations that will own and maintain the new pipe should be consulted for guidance on pipe material type selection. Only pipe material types that have been evaluated and approved for use by CDOT shall be used. In the event a local agency or organization will own and maintain the new pipe and the guidance provided differs from this guide, the guidance from the local agency or organization shall govern.

Definitions

<u>Cross Drain</u> –Pipes or culverts that convey flows from one side of the road to the other, and are typically open on each end. Also known as a Cross Culvert.

<u>Side Drain</u> – A pipe or culvert which is typically parallel to the roadway and under a driveway or a road approach to the mainline roadway.

<u>Storm Drain</u> – A network of pipes that connects inlets, manholes, and other drainage features to an outfall.

Subsurface Drain – A network of piping used to collect ground water, or relieve water pressure from a wall or structure, and transport it to a location where it will not harm the roadway features, or where it can be conveyed by another system, often a storm sewer. A common example is a French Drain.

Type III Embankment Protector – See M-Standard 615-1

Durability - A pipe or culverts ability to resist wear and tear or decay. Although structural condition is a very important element in the performance of pipes, durability problems are a common cause for replacement. Pipes are more likely to "wear away" than fail structurally. Durability is affected by two mechanisms: corrosion and abrasion. Each is discussed in the following sections.

Corrosion – Corrosion is the deterioration of material due to chemical or electrochemical reaction with the environment. Corrosion of pipe materials may occur in many different types of soils and waters. Corrosive types of soil and water may contain acids, alkalis, dissolved salts, organics, industrial wastes or chemicals, mine drainage, sanitary effluents, and dissolved or free gases. Pipe corrosion is generally related to water and the chemicals that have reacted to, become dissolved in, or been transported by the water.

Abrasion – Abrasion is the process of wearing down or grinding away the surface material of pipes, as water laden with sand, gravel, or stones flow through a pipe. The abrasive force increases with rising pipe velocity.

Alternative Materials – Alternative materials are the various pipe materials that will meet the project requirements. The alternative materials will be identified in the Contract, and the Contractor may select any one of them for use on the project.

Selection Process/Responsibility – All decisions regarding pipe material type will be based on best engineering practices and judgments. The PM is responsible for all aspects of the design of the project and for ensuring timely completion of tasks associated with project advertisement. The PM will schedule work associated with this procedure to ensure compliance with the project schedule. The PM will consider such factors as durability, environmental considerations, soil conditions, fill heights, need for water tight joints, pipe minimum and maximum slope (i.e. pipe velocity), hydraulic characteristics of pipe material inside surfaces, and other factors relevant to the project and or specific pipe location.

The PM will specify on the plans or in the special provisions when water tight joints are required. Siphons, irrigation systems, and storm drain systems require water tight joints.

In some cases the results of the material type selection process may produce alternative materials types in differing pipe diameters. In such cases the PM may specify the appropriate diameter for each material type or specify only the largest pipe diameter (produced by the selection process regardless of the material type) in the plans.

When a specific manning's "n" value is critical to the pipe's performance, the maximum/minimum value shall be shown on the plans. If the larger diameter will not meet the minimum cover requirements, or the material will not meet the Manning's "n" value range, then that material type shall be disqualified at those location(s). Any Material type disqualified at a location during design should be stated as such on the plans.

Step I: Determine Application – The PM will use the latest version of CDOT's *Drainage Design Manual* and CDOT's *Project Development Manual.* The pipe selection process begins when the PM determines the location of the new pipe. The PM will then determine and document the specific use of the pipe:

- Cross Drain
- Side Drain
- Storm Drain

Step II: Determine Abrasion Level – An estimate of the potential for abrasion is required to determine acceptable pipe types and whether there is a need for invert protection.

The PM with concurrence of the project hydraulics engineer will estimate and document the abrasive forces that will have an effect on the pipe material; and document the following items:

- Measure or estimate the velocity of the water based upon 2-year flow and less.
- Estimate the bed-loading as:
    - No bed load
    - Minor bed load – silt and sand
    - Moderate bed load – silt, sand, and gravel
    - Heavy bed load – silt, sand, gravel, and rock
- Determine whether the abrasion level is 1, 2, 3, or 4 as defined below.
    - Abrasion Level 1 – This level applies where the conditions are nonabrasive. Nonabrasive conditions exist in areas of no bed load and very low velocities. This is the level assumed for the soil side of drainage pipes. This is also the level assumed for the inverts of cross drains and side drains installed in typically dry drainages.
    - Abrasion Level 2 – This level applies where low abrasive conditions exist. Low abrasive conditions exist in areas of minor bed loads of sand and velocities of 5 fps or less.
    - Abrasion Level 3 – This level applies where moderately abrasive conditions exist. Moderately abrasive conditions exist in areas of moderate bed loads of sand and gravel and velocities between 5 fps and 15 fps.
    - Abrasion Level 4 – This level applies where severely abrasive conditions exist. Severely abrasive conditions exist in areas of heavy bed loads of sand, gravel, and rock and velocities exceeding 15 fps.

Abrasion levels are intended to help the PM consider the impacts of bed-load wear on the invert of pipe materials. The PM will determine the expected level of abrasion through visual examination and documentation of the size of the materials in the stream bed and the average slope of the channel. In some case sampling of the streambed material may be required to assist the PM in determining the level of abrasion.

Where existing pipes are in place in the same drainage, the conditions of their inverts should be documented and used as guidance. The expected stream velocity should be based upon 2-year flow and less.

Step III: Determine Corrosion Level – The station of each proposed pipe will be determined by the PM. The PM will schedule the soil and water testing to ensure compliance with the project advertisement date. Resistivity, PH, and moisture levels will be determined in the field by the Region as these tests are most efficiently and effectively conducted at the time of sampling. The CDOT Materials and Geotechnical group is available to perform sulfate and chloride testing, however, the PM will schedule this work appropriately to avoid project delays. The Region should develop their ability to perform these simple tests in the Region to expedite project design. The resulting sample testing information will be used in flow charts (Figures 1 and 2) to select appropriate material.

CDOT PIPE MATERIAL SELECTION GUIDE

Revised April 30, 2015

The PM will document the following properties of the soil and water using the designated test procedure:

- Sulfate Levels - **CPL 2103**
- Chloride Levels - **CPL 2104**
- Resistivity - **ASTM G57**
- pH - **ASTM G51**
- Moisture Levels

This information will be obtained at all pipe locations supplied by the PM and documented in the project records by the PM. If the alluvium of the area is sufficiently homogeneous, a reduced sampling schedule will be acceptable. This determination should only be made with input from the Region Materials Engineers (or Staff Materials) and the Region Hydraulics Engineer.

Table 1

Guidelines for selection of corrosion resistance levels

	SOIL			WATER		
CR Level	Sulfate	Chloride		Sulfate	Chloride	
	(SO_4)	(Cl)	pH	(SO_4)	(Cl)	pH
	% max	% max		ppm (max)	ppm (max)	
*CR 0	0.05	0.05	6.0-8.5	50	50	6.0-8.5
CR 1	0.10	0.10	6.0-8.5	150	150	6.0-8.5
CR 2	0.20	0.20	6.0-8.5	1,500	1,500	6.0-8.5
CR 3	0.50	0.50	6.0-8.5	5,000	5,000	6.0-8.5
CR 4	1.00	1.00	5.0-9.0	7,500	7,500	5.0-9.0
CR 5	2.00	2.00	5.0-9.0	10,000	10,000	5.0-9.0
CR 6	>2.00	>2.00	<5** or >9	>10,000	>10,000	<5** or >9

*No special corrosion protection recommended when values are within these limits. **Concrete pipe used when the pH of either the soil or water is less than 5 shall be coated in accordance with subsection 706.07. When needed, specify the coating in a special provision or plan note.

Table 2

Minimum Pipe Thickness for Metal Pipes Based on the Resistivity and pH of the Adjacent Soil

SOIL SIDE		MINIMUM REQUIRED GAUGE THICKNESS FOR METAL PIPE MATERIAL
Resistivity, R (Ohm – cm)	pH	
≥1,500	5.0-9.0	0.052 in (18 Gauge) Aluminized Type 2
≥250	3.0-12.0	0.052 in (18 Gauge) Polymer Coated

For Storm Drains use Standard Specification 603, and write a Project Special Provision stating the required corrosion classification as determined by this guide. (i.e., sulfate class). Use appropriate pay items in these cases.

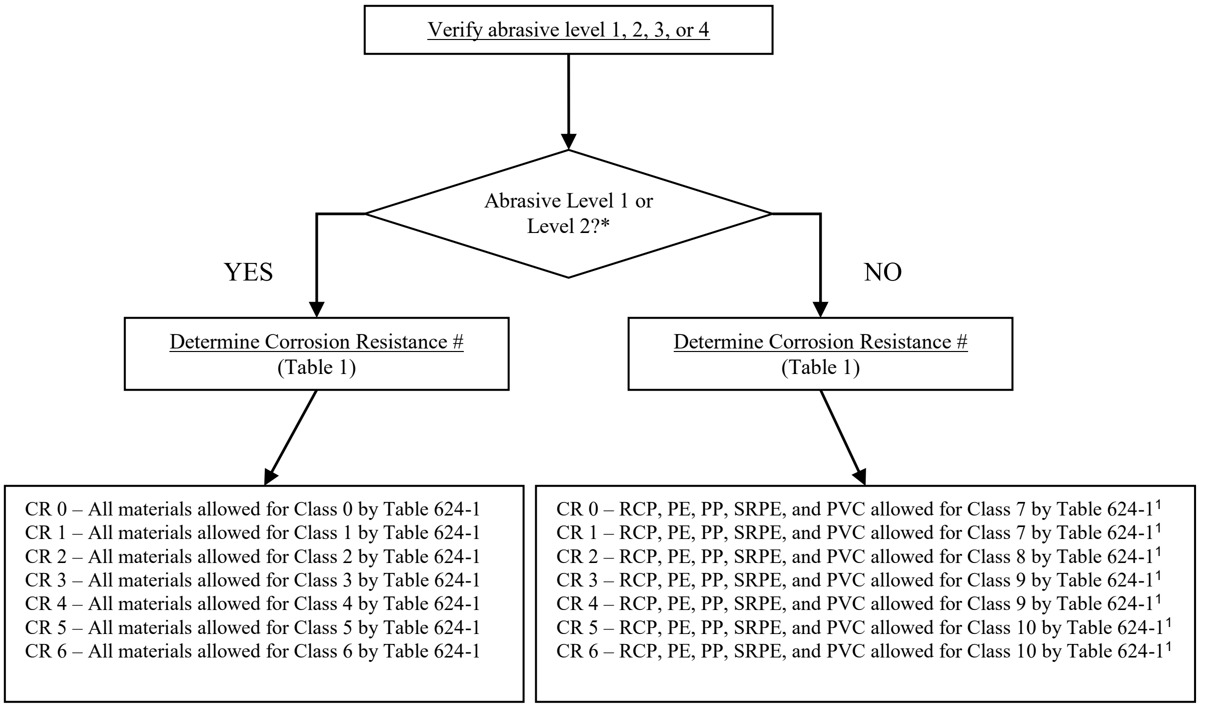
Step IV: Selection of Pipe Material Type – Use the flowcharts in this document to identify acceptable pipe material types. Use Figure 1 to determine if metal pipe is an allowable material type, and then use, Table 2 to determine whether there are additional requirements for metal pipes.

Step V: Verify Fill Height – Check Fill Height tables in the Standard Plans. Determine if Project Special Provisions are required and/or if any other Standard Special Provisions are applicable. Use the latest versions of these specifications, found at: http://www.coloradodot.info/business/designsupport/construction-specifications/2011-Specs

Step VI: Address Exceptions to CDOT Pipe Materials Selection Guide – When sound engineering judgment justifies an exception to this guide, the PM shall document this in a justification letter. All justification letters shall be approved by the Region Program Engineer (PE III) or their designee prior to final design.

Step VII: Documentation – All design decisions regarding pipe material type selection must be documented and a letter placed in the project file. Copies of all selection letters are to be sent to the Region Program Engineer or their designee prior to final design decisions being made, for guidance and to verify consistency.

Figure 1
CROSS – DRAINS and SIDE – DRAINS



*Aluminum alloy pipe not allowed in environments with an Abrasion Level higher than 1.

[1] ***When concrete pipe is selected the sulfate content dictates the CR level***. Cementitious requirements for Sulfate Protection Classes are listed in 601.04. A higher level of protection may be used. Concrete shall have a minimum compressive strength of 4,500 psi and maximum water to cementitious ratio (w/cm) listed in 601.04. Concrete may be used when the pH and chlorides exceed the levels listed in Table 1

For Metal pipes, see “Minimum Pipe Thickness for Metal Pipes Based on the Resistivity and pH Of the Adjacent Soil” (Table 2) in this document.

When extending an existing pipe, the same size and type of material must be specified. If conditions are Abrasive level 1 or 2 **and** CR 0, specify material type from Section 603 pay items.

Figure 2

STORM-DRAINS

CDOT will only allow the use of reinforced concrete pipe (RCP), Polypropylene (PP), Steel Reinforced Polyethylene (SRPE), or Polyvinyl Chloride Pipe (PVC) in accordance with Standard Plans M-603-2 and M-603-5 for storm drains

Determine Corrosion Resistance #
(Table 1)

↓

CR 0 – RCP, PP, SRPE, or PVC allowed for Class 7 by Table 624-1[1]
CR 1 – RCP, PP, SRPE, or PVC allowed for Class 7 by Table 624-1[1]
CR 2 – RCP, PP, SRPE, or PVC allowed for Class 8 by Table 624-1
CR 3 – RCP, PP, SRPE, or PVC allowed for Class 9 by Table 624-1[1]
CR 4 – RCP, PP, SRPE, or PVC allowed for Class 9 by Table 624-1[1]
CR 5 – RCP, PP, SRPE, or PVC allowed for Class 10 by Table 624-1[1]
CR 6 – RCP, PP, SRPE, or PVC allowed for Class 10 by Table 624-1[1]

[1] – If abrasion level is 3 or 4, concrete shall have a minimum compressive strength of 4,500 psi. Cementitious requirements for Sulfate Protection Classes are listed in 601.04. A higher level of protection may be used.

When extending an existing pipe, the same size and type of material must be specified. If conditions are Abrasive level 1 or 2 **and** CR 0, specify material type from Section 603 pay items.

TRIAL INSTALLATIONS & EVALUATION PROCESS FOR NEW PIPE MATERIAL

At any time, Manufacturers may request in writing to have materials not approved herein evaluated for a specific application. Requests for trial installations shall follow the requirements of P.D. 1401.1. Contact information for that procedure is given below:

Product Evaluation Coordinator
Colorado Department of Transportation
Materials and Geotechnical Branch
4670 Holly Street, Unit A
Denver, CO 80216
303-398-6500

- Manufacturers will provide all of the materials, equipment, and labor required for the pipe material to be evaluated at no cost to CDOT.
- The pipe material to be evaluated must meet applicable AASHTO and ASTM design and material standards.
- Manufacturers will be responsible for all coordination with the Contractor, and any additional cost incurred by the Contractor as a result of the trial installation.
- CDOT will determine a suitable location for the trial installation.
- During installation, the manufacturer shall have a representative at the installation site. The manufacturer will provide documentation to CDOT that the pipe material was designed and installed per all current and applicable AASHTO and CDOT design and installation standards.
- Trial installations shall perform satisfactorily for at least one year before conclusions regarding product performance are made.

- During the one year evaluation period, at a time chosen by CDOT, the manufacturer shall provide laser video inspection services on the trial installation utilizing an inspection contractor approved by CDOT.
- The results of the laser video inspection shall be used to evaluate trial installations. The results shall demonstrate compliance with CDOT and AASHTO deflection, joint separation, buckling, tearing, sagging, and cracking standards.
- Monitoring may include research of the trial material in use in other states.
- If further evaluation is required beyond one year, the supplier will be notified of the justification for this evaluation extension.
- An independent evaluation performed by a local agency or other organization may be substituted for this trial installation and evaluation process if all of the following are true.
    - The local agency or other organization owns and maintains the material being evaluated.
    - A representative with the local agency or organization can be contacted to verify the information supplied.
    - The installation specifications are available for CDOT to review.
    - A trial installation was performed in Colorado on site applications similar to CDOT projects.
    - A laser video inspection was performed (or can be performed) a minimum of 1 year after installation that produced satisfactory results.
- Upon successful completion of the monitoring period, CDOT's Drainage Advisory Committee will review the performance and determine the acceptability of the material for future inclusion into the *CDOT Pipe Material Selection Guide*.
- If changes to this guide, including the introduction of new materials or drainage products, are requested, they will be evaluated through the following process:
    - The Drainage Advisory Committee will evaluate documentation concerning changes to the guide.
    - Documentation supporting the proposed change shall be submitted by the supplier to the Product Evaluation Coordinator (PEC) at the address above.
    - The PEC will compile all submitted documentation and submit it to the chair and secretary of the Drainage Advisory Committee.
    - The Drainage Advisory Committee will determine the future acceptability of the material for inclusion into the CDOT Pipe Material Selection Guide. The Drainage Advisory Committee will forward recommendations to the Chief Engineer for signature.

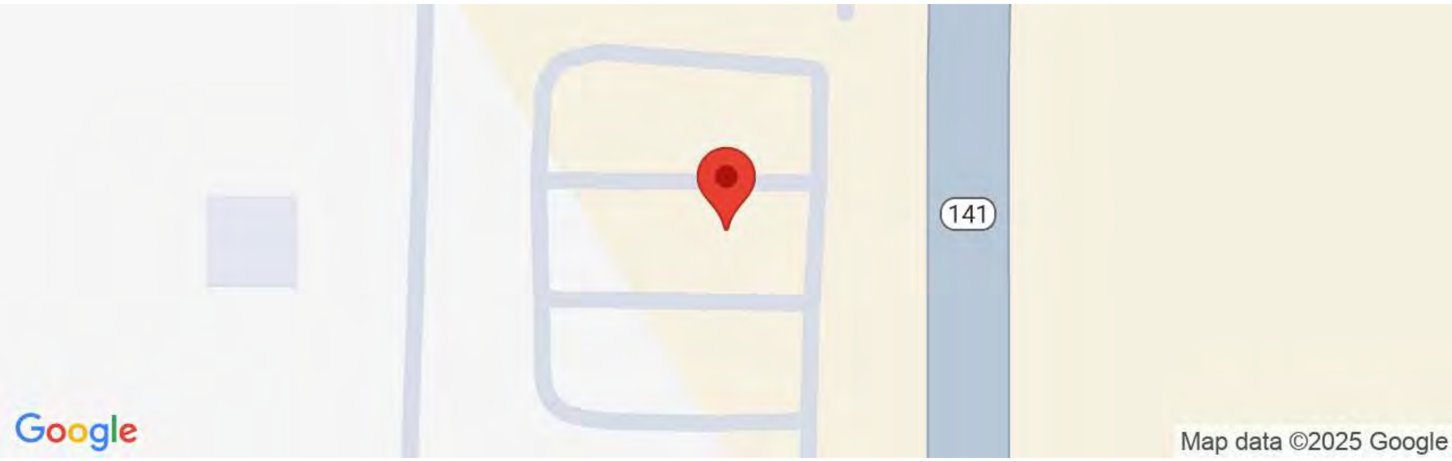
APPENDIX H

SEISMIC COEFFICIENTS OUTPUT SHEET

Announcement
ASCE 7-22 is now available.

OSHPD

Latitude, Longitude: 39.06150858, -108.46005571



Date	11/24/2025, 10:59:36 AM
Design Code Reference Document	ASCE7-22
Risk Category	II
Site Class	D

Type	Value	Description (Data)
S_S	0.22	The MCE_R spectral response acceleration at 0.2 seconds for Site Class BC, in units of g.
S_1	0.048	The MCE_R spectral response acceleration at 1 second for Site Class BC, in units of g.
S_{MS}	0.27	S_{MS} = 1.5 x S_{DS}, the Risk-Targeted Maximum Considered Earthquake (MCE_R) spectral response acceleration for short periods (of the two-period spectrum) and the user-specified Site Class.
S_{M1}	0.11	S_{M1} = 1.5 x S_{D1}, the MCE_R spectral response acceleration for 1 second (of the two-period spectrum) and the user-specified Site Class.
S_{DS}	0.18	The design spectral response acceleration for short periods (of the two-period spectrum) and the user-specified Site Class, in units of g.
S_{D1}	0.073	The design spectral response acceleration for 1 second (of the two-period spectrum) and the user-specified Site Class, in units of g

Type	Value	Description (Data Contd.)
SDC	B	Seismic design category
PGA_M	0.13	PGA_M, the Geometric-Mean Maximum Considered Earthquake (MCE_G) peak ground acceleration for the user-specified Site Class, in units of g
T_S	0.402	$T_S = S_{D1}/S_{DS}$, in seconds, for construction of the two-period design spectrum
T_0	0.0804	T_0 = 0.2 x T_S, in seconds, for construction of the two-period design response spectrum
T_L	4	T_L, the long-period transition period, in seconds, for construction of the two-period design response spectrum

Type	Value	Description (Underlying Data and Metadata)
PGA_{uh}	0.13	Probabilistic uniform-hazard (2%-in-50-years), geometric-mean peak ground acceleration, in units of g.
PGA_{84th}		Deterministic 84th-percentile, geometric-mean peak ground acceleration (without deterministic lower limit), in units of g.
V_{S30}	260	The shear-wave velocity used for the user-specified Site Class, in units of m/s
Spatial Interpolation Method	linearloglinear	Identifier for spatial interpolation method used to obtain values for location of interest from underlying gridded values: "linearloglinear" for bilinear of natural logarithm of values.
PGA_{dFloor}	0.53	Deterministic lower limit peak ground acceleration (PGA_G) for the user-specified Site Class, in units of g.
riskTargetedSpectrum		Probabilistic risk-targeted, maximum direction response spectrum (for 1%-in-50-years collapse risk)
eightyFourthSpectrum		Deterministic 84^{th}-percentile, maximum-direction response spectrum (without deterministic lower limit)

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Multi Period

Period T(s)	Design Spectrum Ordinates (g)	MCE_R Spectrum Ordinates (g)
0	0.095	0.14
0.01	0.1	0.16
0.02	0.15	0.22
0.03	0.17	0.26
0.05	0.22	0.33
0.075	0.24	0.35
0.1	0.24	0.36
0.15	0.23	0.34
0.2	0.2	0.3
0.25	0.18	0.27
0.3	0.16	0.24
0.4	0.14	0.21
0.5	0.12	0.19
0.75	0.093	0.14
1	0.073	0.11
1.5	0.048	0.071
2	0.033	0.05
3	0.02	0.03
4	0.014	0.02
5	0.0095	0.014
7.5	0.0052	0.0079
10	0.0034	0.0051

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Two Period

Period T(s)	Design Spectrum Ordinates (g)	MCE_R Spectrum Ordinates (g)
0	0.073	0.11
0.025	0.11	0.16
0.05	0.14	0.21
0.08	0.18	0.27
0.1	0.18	0.27
0.15	0.18	0.27
0.2	0.18	0.27
0.25	0.18	0.27
0.3	0.18	0.27
0.35	0.18	0.27
0.4	0.18	0.27
0.4	0.18	0.27
0.45	0.16	0.24
0.5	0.15	0.22
0.55	0.13	0.2
0.6	0.12	0.18
0.65	0.11	0.17
0.7	0.1	0.16
0.75	0.098	0.15
0.8	0.092	0.14
0.85	0.086	0.13
0.9	0.081	0.12
0.95	0.077	0.12

Period T(s)	Design Spectrum Ordinates (g)	MCE_R Spectrum Ordinates (g)
1	0.073	0.11
1.05	0.07	0.1
1.1	0.067	0.1
1.15	0.064	0.096
1.2	0.061	0.092
1.25	0.059	0.088
1.3	0.056	0.085
1.35	0.054	0.081
1.4	0.052	0.079
1.45	0.051	0.076
1.5	0.049	0.073
1.55	0.047	0.071
1.6	0.046	0.069
1.65	0.044	0.067
1.7	0.043	0.065
1.75	0.042	0.063
1.8	0.041	0.061
1.85	0.04	0.059
1.9	0.039	0.058
1.95	0.038	0.056
2	0.037	0.055
2.05	0.036	0.054
2.1	0.035	0.052
2.15	0.034	0.051
2.2	0.033	0.05
2.25	0.033	0.049
2.3	0.032	0.048
2.35	0.031	0.047
2.4	0.031	0.046
2.45	0.03	0.045
2.5	0.029	0.044
2.55	0.029	0.043
2.6	0.028	0.042
2.65	0.028	0.042
2.7	0.027	0.041
2.75	0.027	0.04
2.8	0.026	0.039
2.85	0.026	0.039
2.9	0.025	0.038
2.95	0.025	0.037
3	0.024	0.037
3.05	0.024	0.036
3.1	0.024	0.035
3.15	0.023	0.035
3.2	0.023	0.034
3.25	0.023	0.034
3.3	0.022	0.033
3.35	0.022	0.033
3.4	0.022	0.032
3.45	0.021	0.032

Period T(s)	Design Spectrum Ordinates (g)	MCE_R Spectrum Ordinates (g)
3.5	0.021	0.031
3.55	0.021	0.031
3.6	0.02	0.031
3.65	0.02	0.03
3.7	0.02	0.03
3.75	0.02	0.029
3.8	0.019	0.029
3.85	0.019	0.029
3.9	0.019	0.028
3.95	0.019	0.028
4	0.018	0.028
4.05	0.018	0.027
4.1	0.017	0.026
4.15	0.017	0.026
4.2	0.017	0.025
4.25	0.016	0.024
4.3	0.016	0.024
4.35	0.016	0.023
4.4	0.015	0.023
4.45	0.015	0.022
4.5	0.014	0.022
4.55	0.014	0.021
4.6	0.014	0.021
4.65	0.014	0.02
4.7	0.013	0.02
4.75	0.013	0.02
4.8	0.013	0.019
4.85	0.012	0.019
4.9	0.012	0.018
4.95	0.012	0.018
5	0.012	0.018

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Probabilistic & Deterministic

Period T(s)	Risk Targeted Spectrum Ordinates (g)	84^{th} Spectrum Ordinates(g)
0	0.14	
0.01	0.16	
0.02	0.22	
0.03	0.26	
0.05	0.33	
0.075	0.35	
0.1	0.36	
0.15	0.34	
0.2	0.3	
0.25	0.27	
0.3	0.24	
0.4	0.21	
0.5	0.19	
0.75	0.14	
1	0.11	
1.5	0.071	
2	0.05	

Period T(s)	Risk Targeted Spectrum Ordinates (g)	84th Spectrum Ordinates(g)
3	0.03	
4	0.02	
5	0.014	
7.5	0.0079	
10	0.0051	

DISCLAIMER

APPENDIX I

PAVEMENT M-E DESIGN
FLEXIBLE PAVEMENT OUTPUT SHEETS

New HMA for GJ Recycle Center PG 64-28

File Name: C:\Users\goldbaum\OneDrive\Documents\My PMED Designs\My ME Design\Projects\City of GJ Recycle Center\New HMA for GJ Recycle Center PG 64-28.dgpx

Design Inputs

Design Life: 30 years
Design Type: FLEXIBLE

Base construction: May, 2027
Pavement construction: June, 2027
Traffic opening: September, 2027

Climate Data Sources (Lat/Lon): 39.134, -108.538

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R3 Level 1 SX(100) PG 64-28	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	2.0
NonStabilized	Crushed gravel	6.0
Subgrade	A-1-b	6.0
Subgrade	A-1-b	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	10.7
Air voids (%)	5.7

Traffic

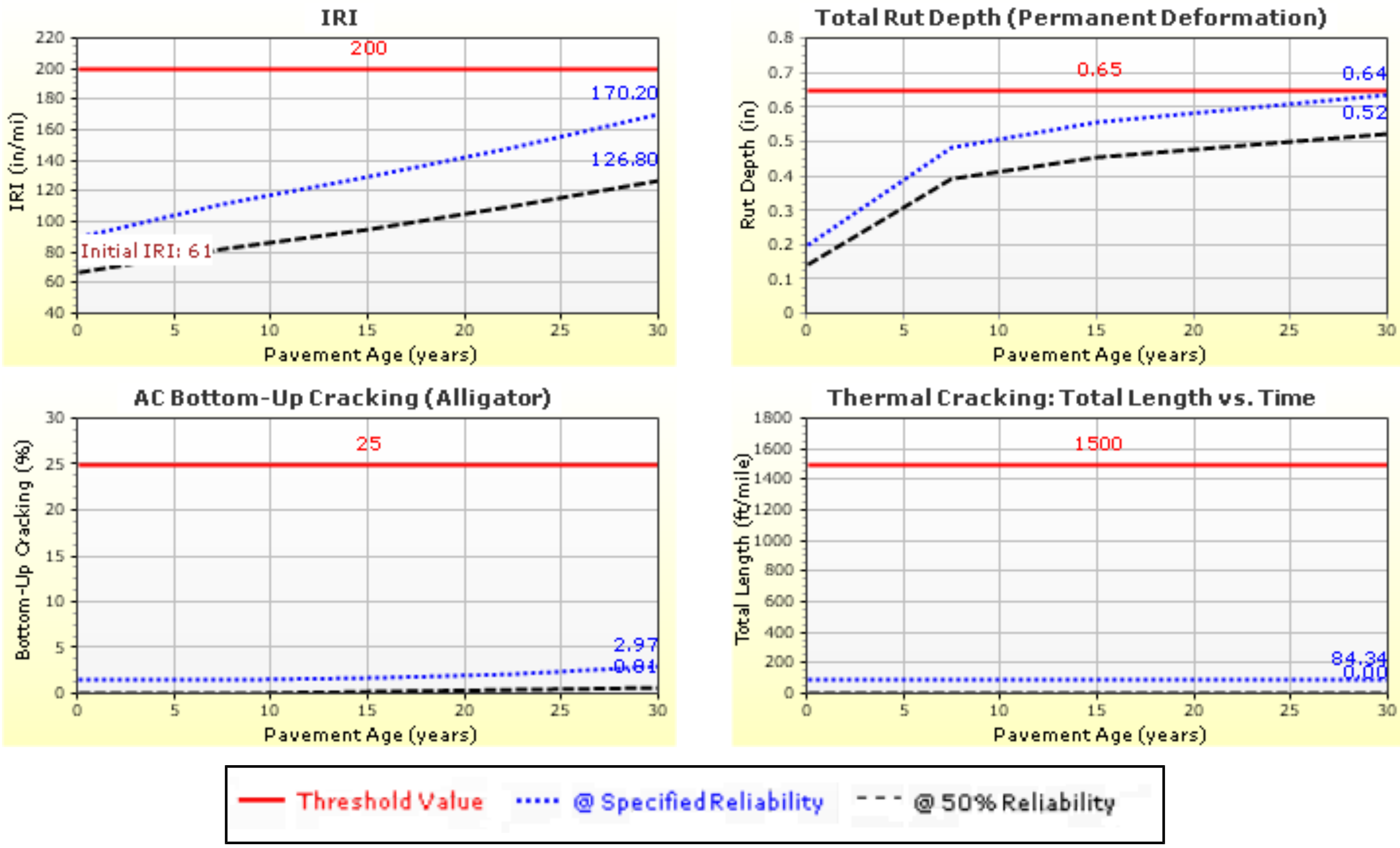
Age (year)	Heavy Trucks (cumulative)
2027 (initial)	40
2042 (15 years)	226,989
2057 (30 years)	471,611

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	170.22	90.00	98.46	Pass
Permanent deformation - total pavement (in)	0.65	0.64	90.00	92.37	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	2.97	90.00	100.00	Pass
AC thermal cracking (ft/mile)	1500.00	84.34	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	3000.00	2995.48	90.00	90.04	Pass
Permanent deformation - AC only (in)	0.65	0.14	90.00	100.00	Pass

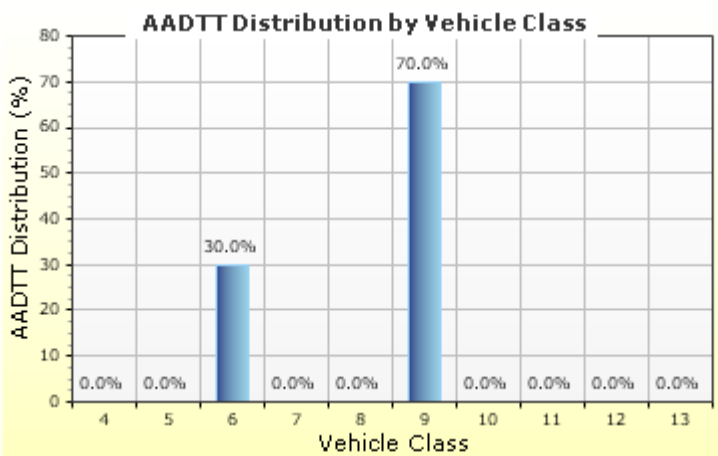
Distress Charts

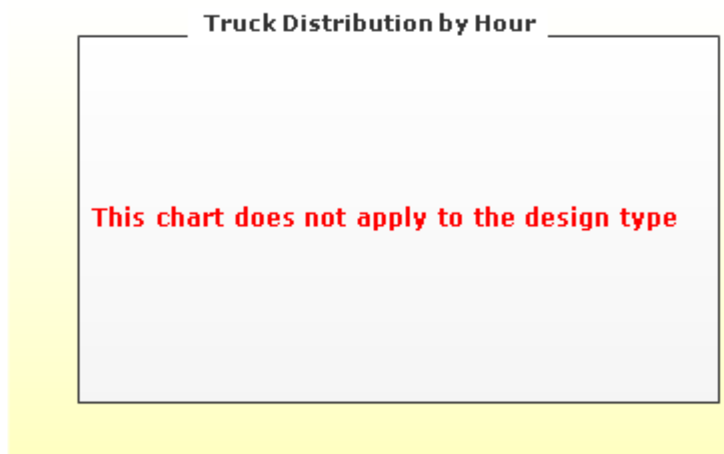


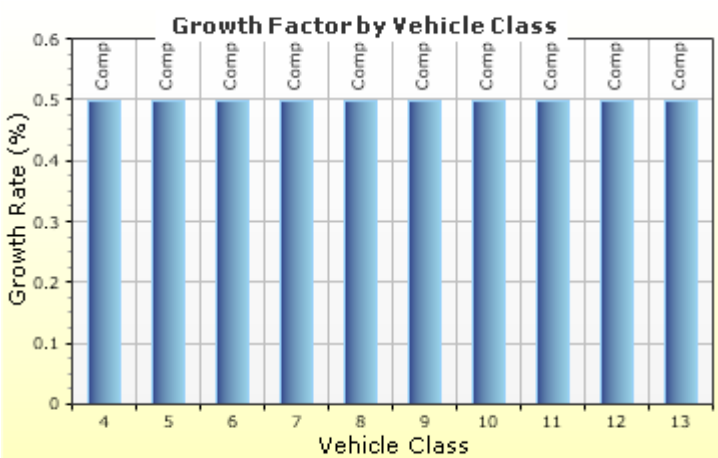
Traffic Inputs

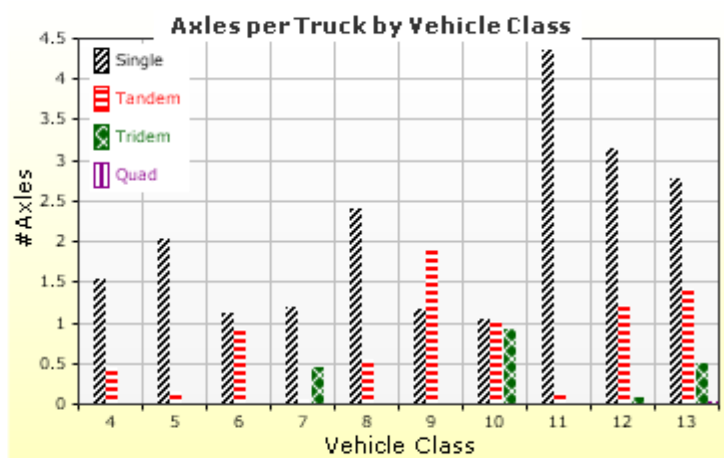
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	40	Percent of trucks in design direction (%):	100.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	25.0

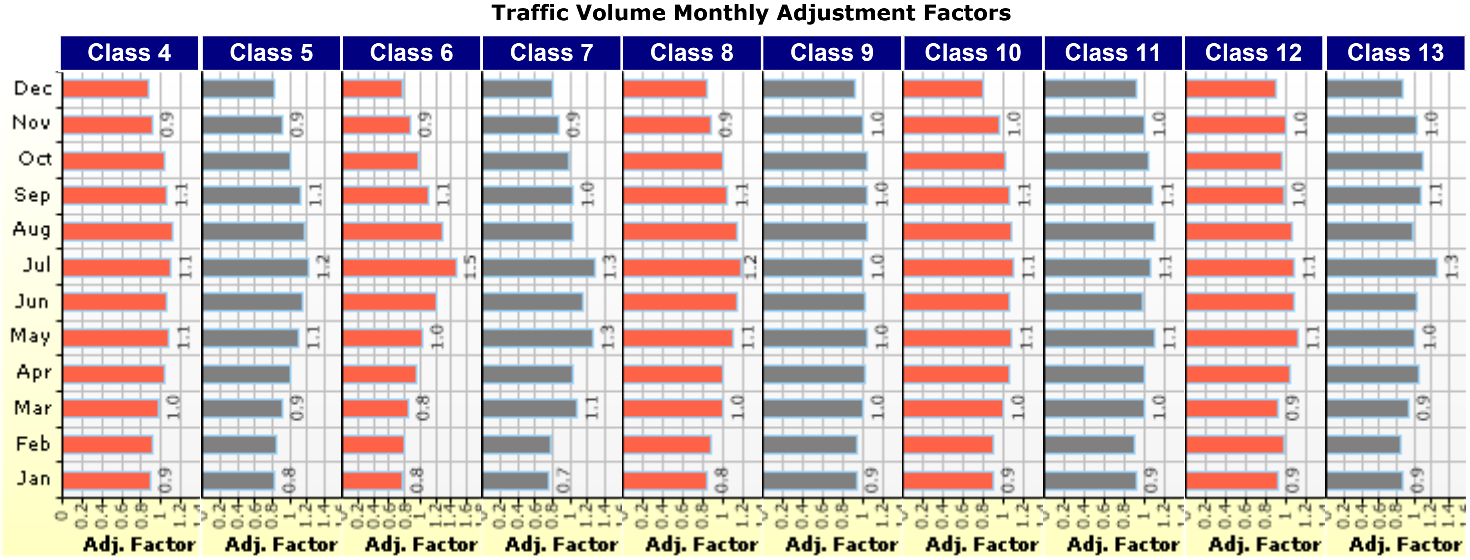








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	0%	0.5%	Compound
Class 5	0%	0.5%	Compound
Class 6	30%	0.5%	Compound
Class 7	0%	0.5%	Compound
Class 8	0%	0.5%	Compound
Class 9	70%	0.5%	Compound
Class 10	0%	0.5%	Compound
Class 11	0%	0.5%	Compound
Class 12	0%	0.5%	Compound
Class 13	0%	0.5%	Compound

Truck Distribution by Hour does not apply

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

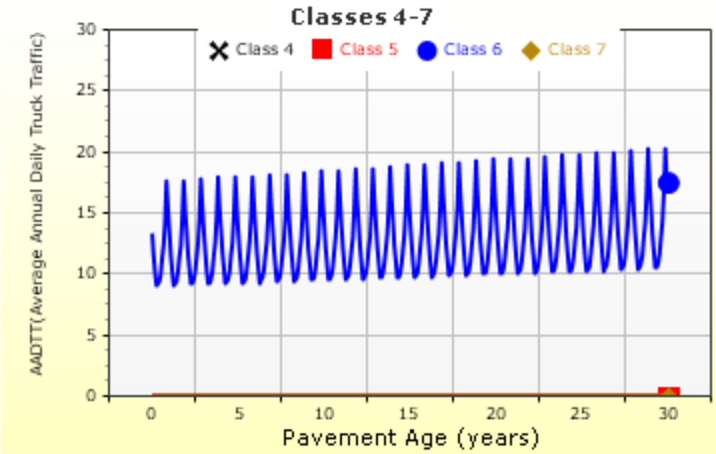
Wheelbase does not apply

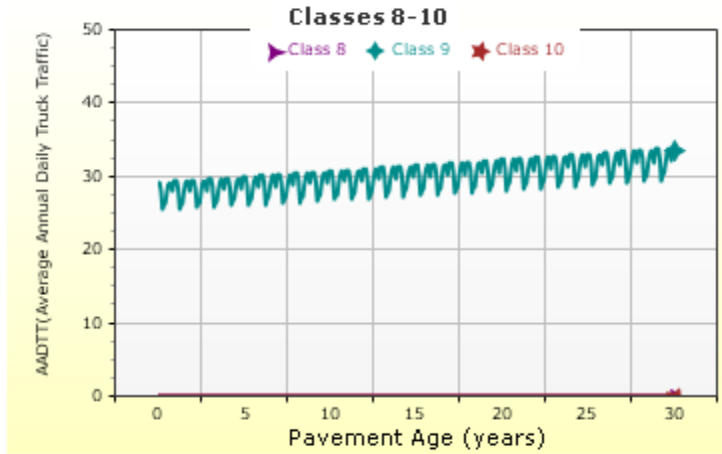
Number of Axles per Truck

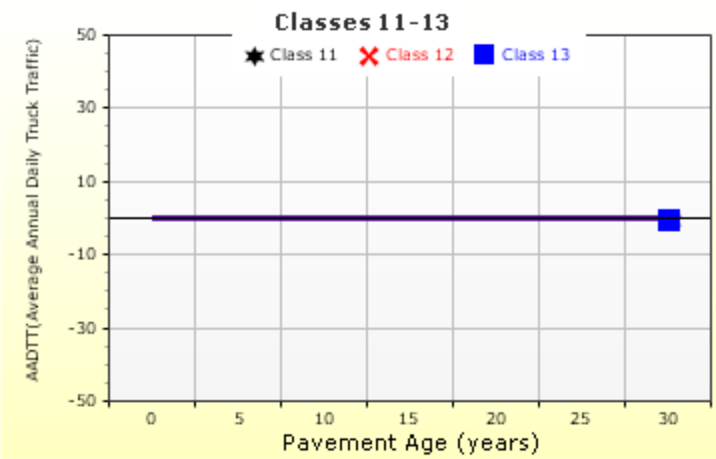
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

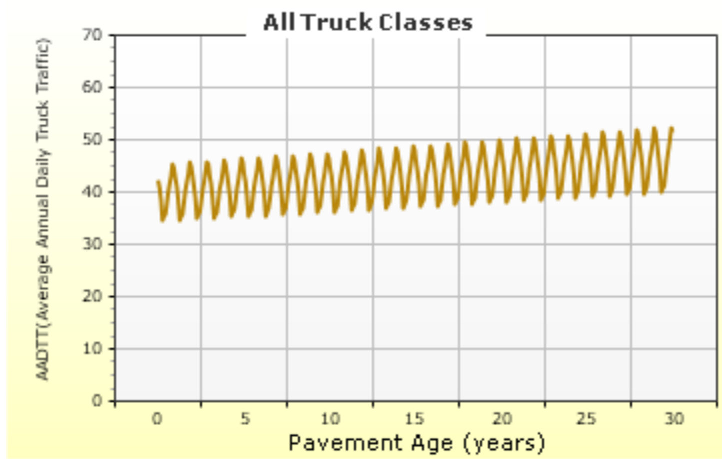
AADTT (Average Annual Daily Truck Traffic) Growth

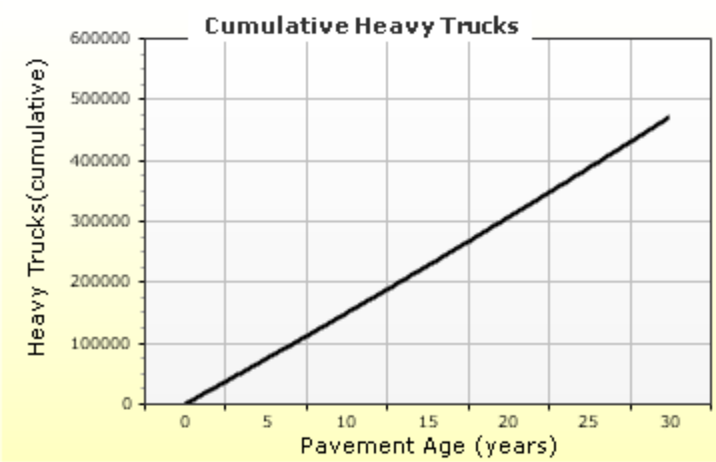
*** Traffic cap is not enforced**







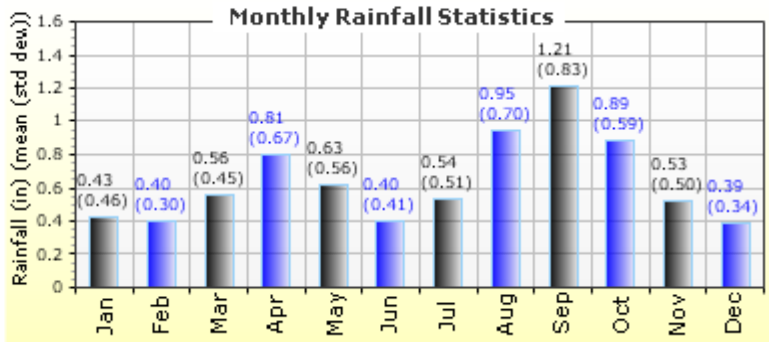




Climate Inputs

Climate Data Sources:

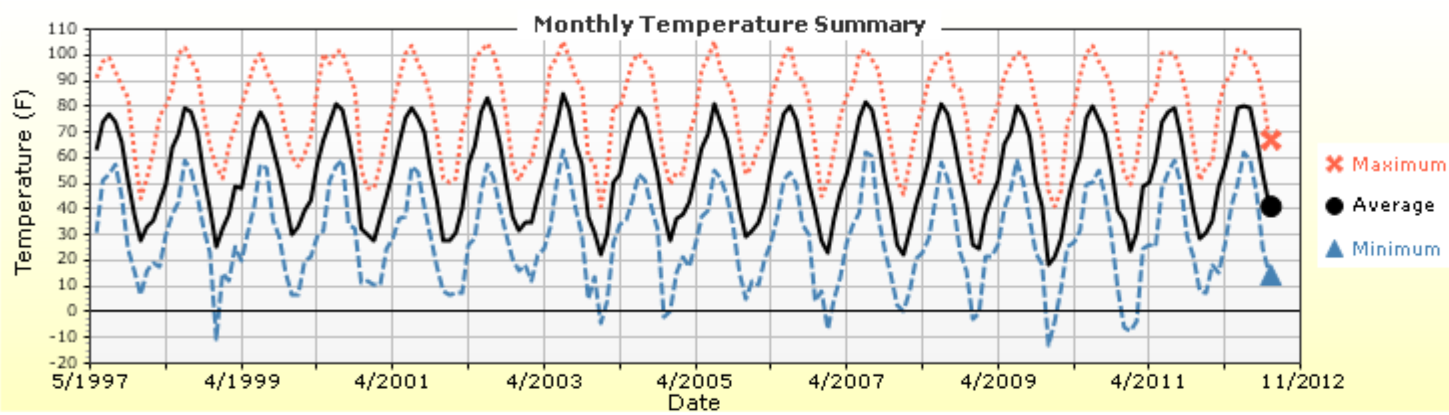
Climate Station Cities:	Location (lat lon elevation(ft))
GRAND JUNCTION, CO	39.13400 -108.53800 4839

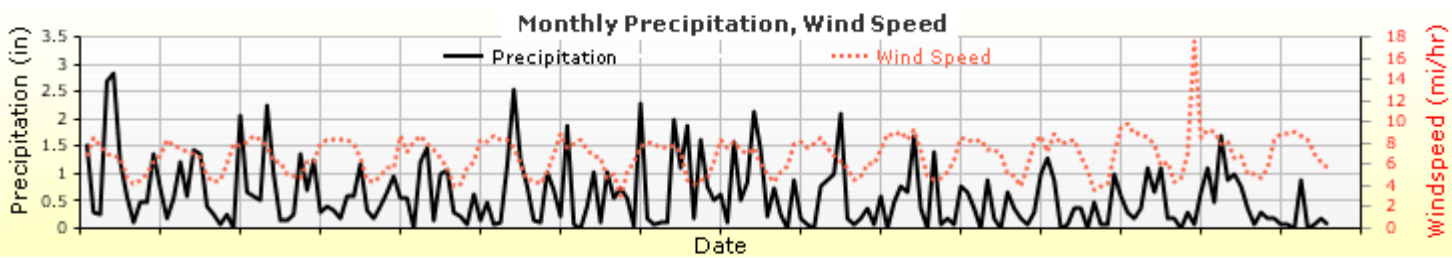


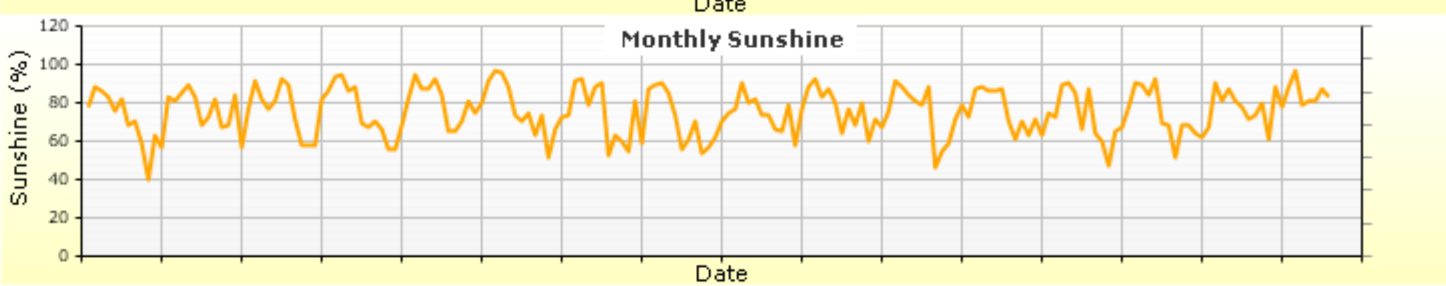
Annual Statistics:

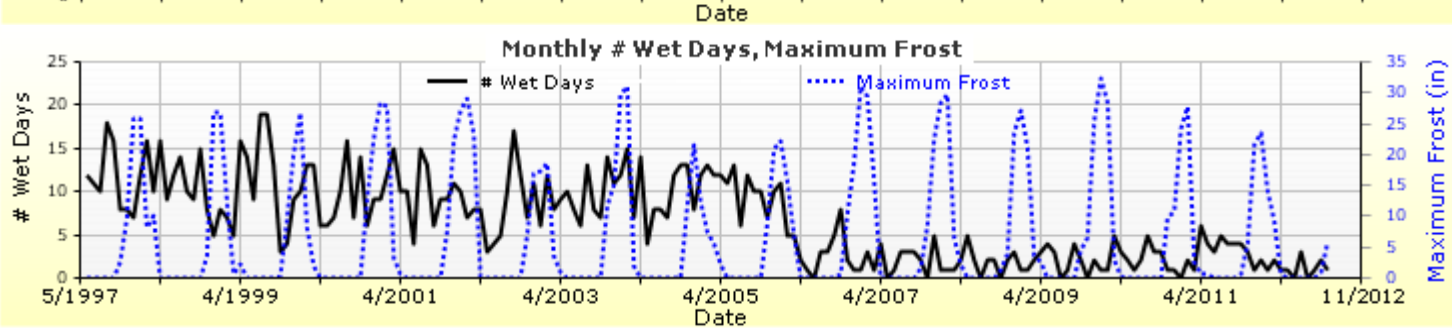
Mean annual air temperature (ºF)	53.55
Mean annual precipitation (in)	7.76
Freezing index (ºF - days)	398.73
Average annual number of freeze/thaw cycles:	111.77
Water table depth (ft)	4.00

Monthly Climate Summary:

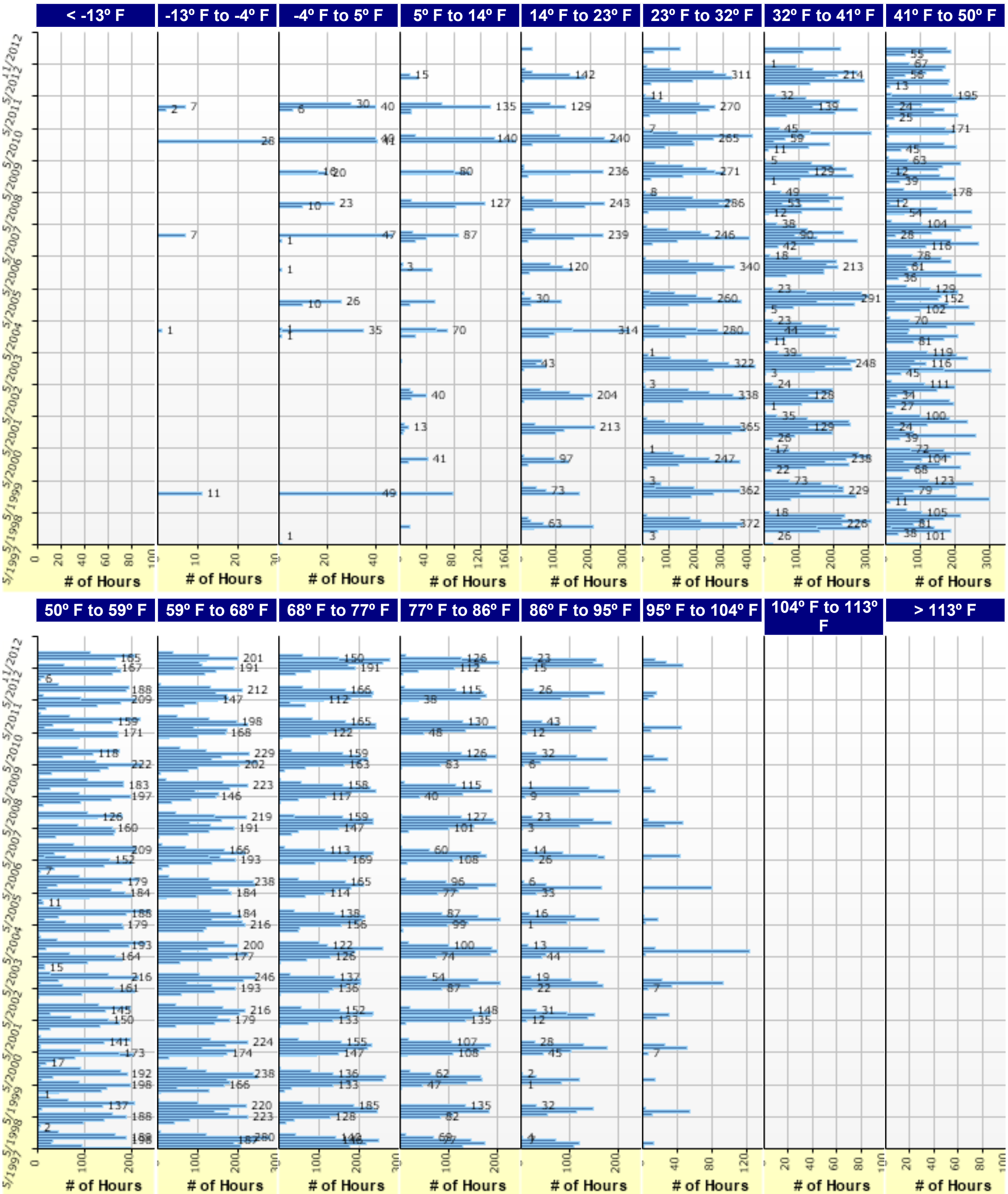








Hourly Air Temperature Distribution by Month:



Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

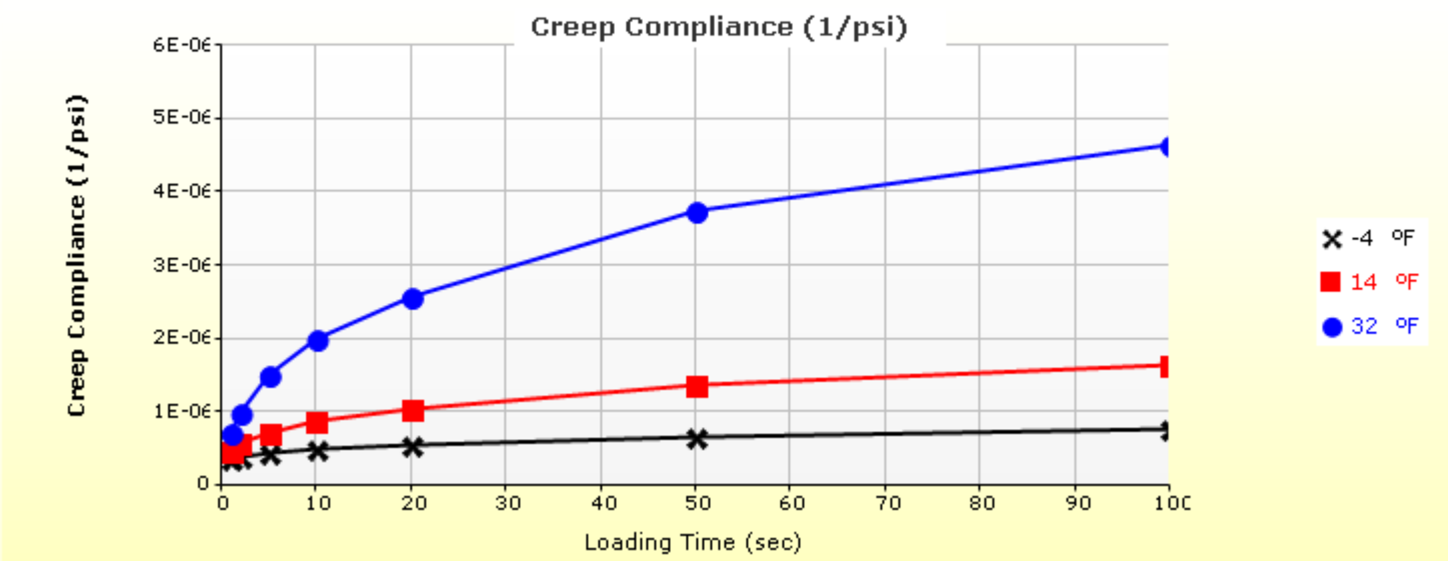
Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R3 Level 1 SX (100) PG 64-28	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Crushed gravel	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : A-1-b	Subgrade (5)	1.00
Layer 5 Subgrade : A-1-b	Subgrade (5)	-

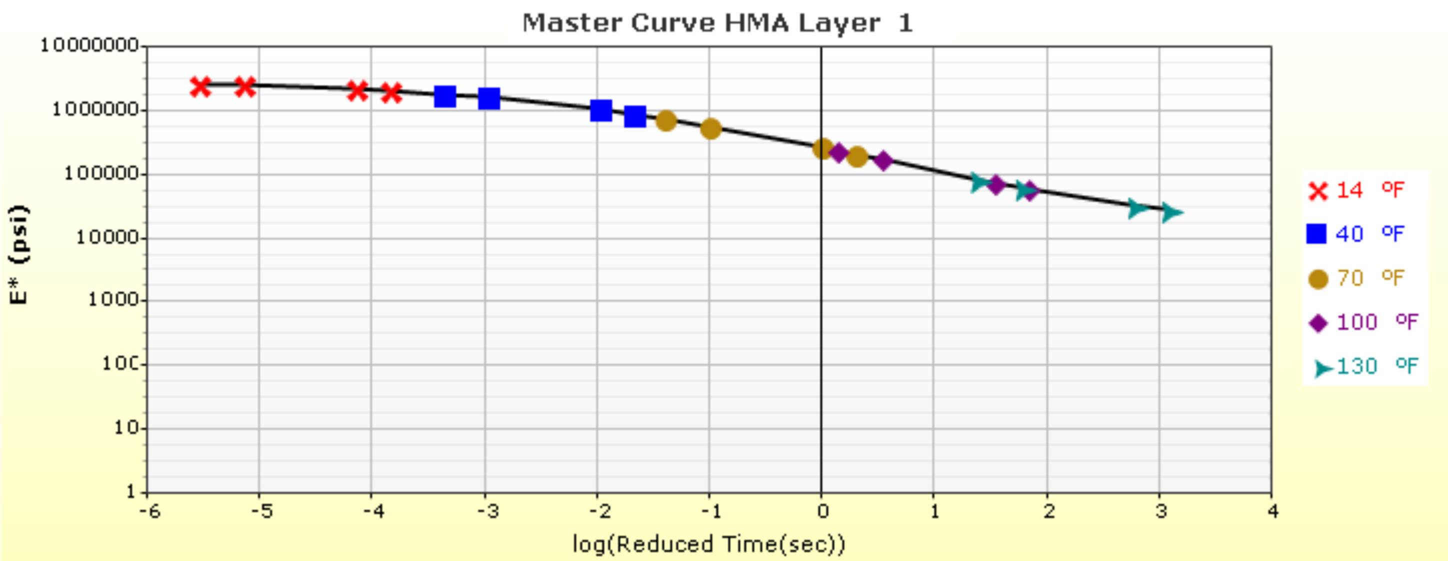
Thermal Cracking (Input Level: 1)

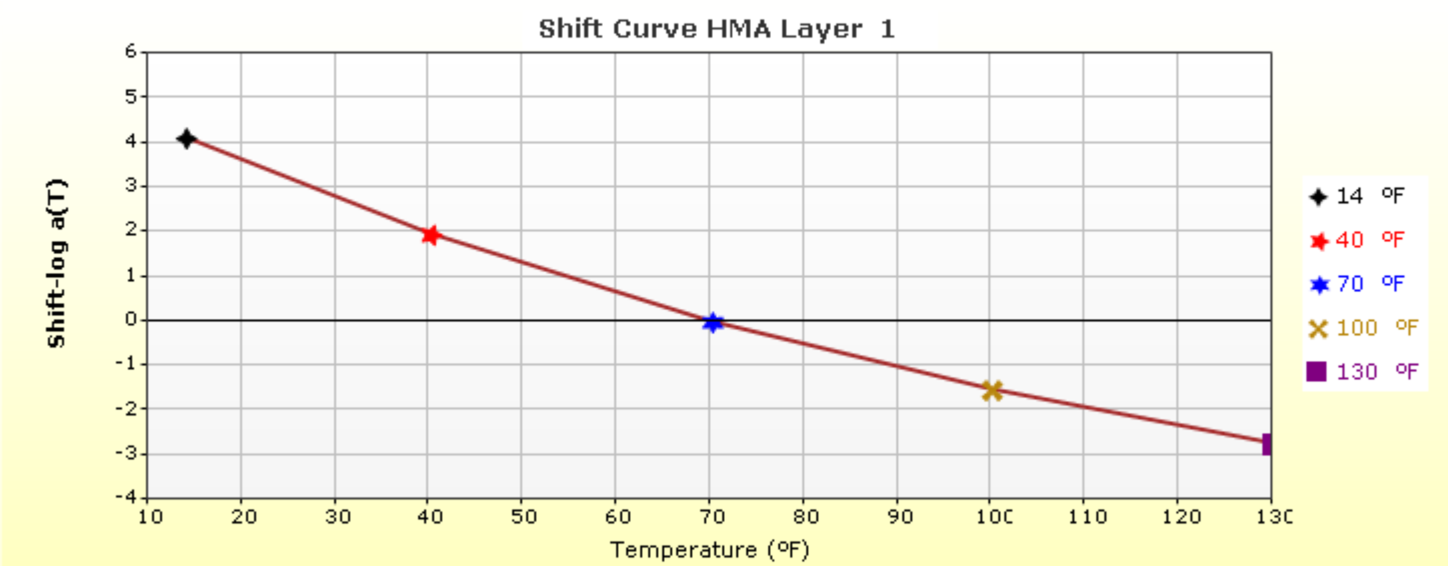
Indirect tensile strength at 14 ºF (psi)	519.00
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	16.4

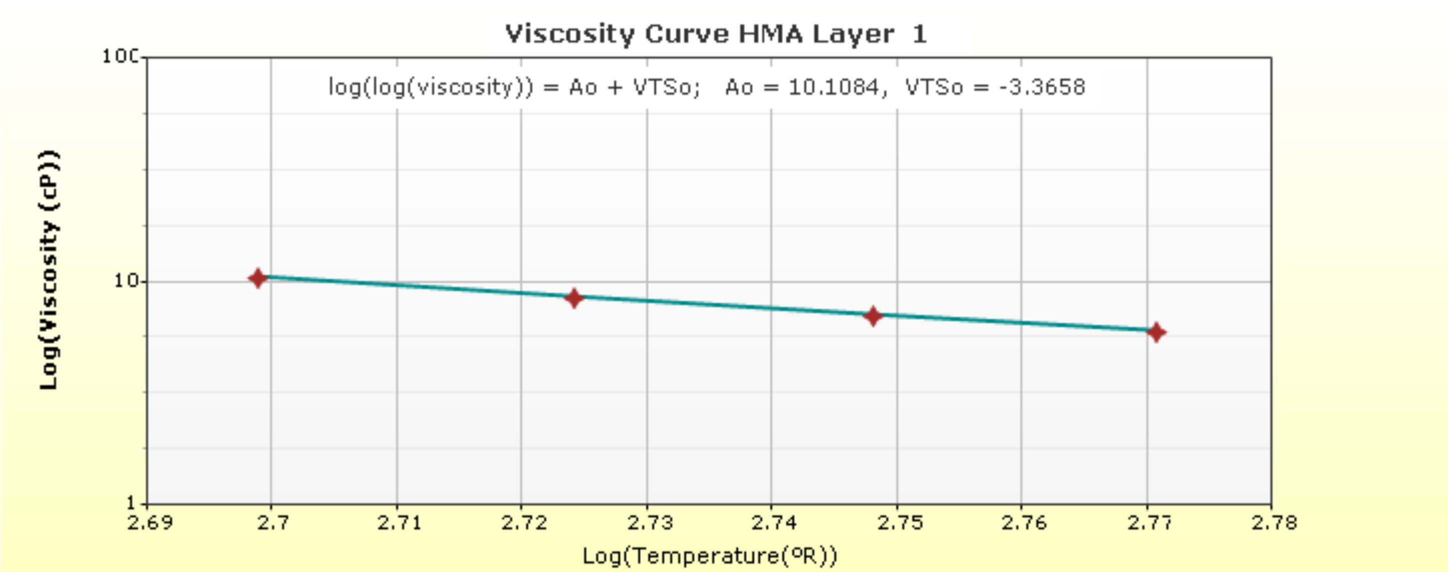
	Creep Compliance (1/psi)		
Loading time (sec)	**-4 ºF**	**14 ºF**	**32 ºF**
1	3.61e-007	4.73e-007	7.12e-007
2	4.04e-007	5.74e-007	9.97e-007
5	4.51e-007	7.35e-007	1.52e-006
10	5.11e-007	8.78e-007	1.99e-006
20	5.67e-007	1.04e-006	2.59e-006
50	6.57e-007	1.37e-006	3.75e-006
100	7.68e-007	1.66e-006	4.66e-006



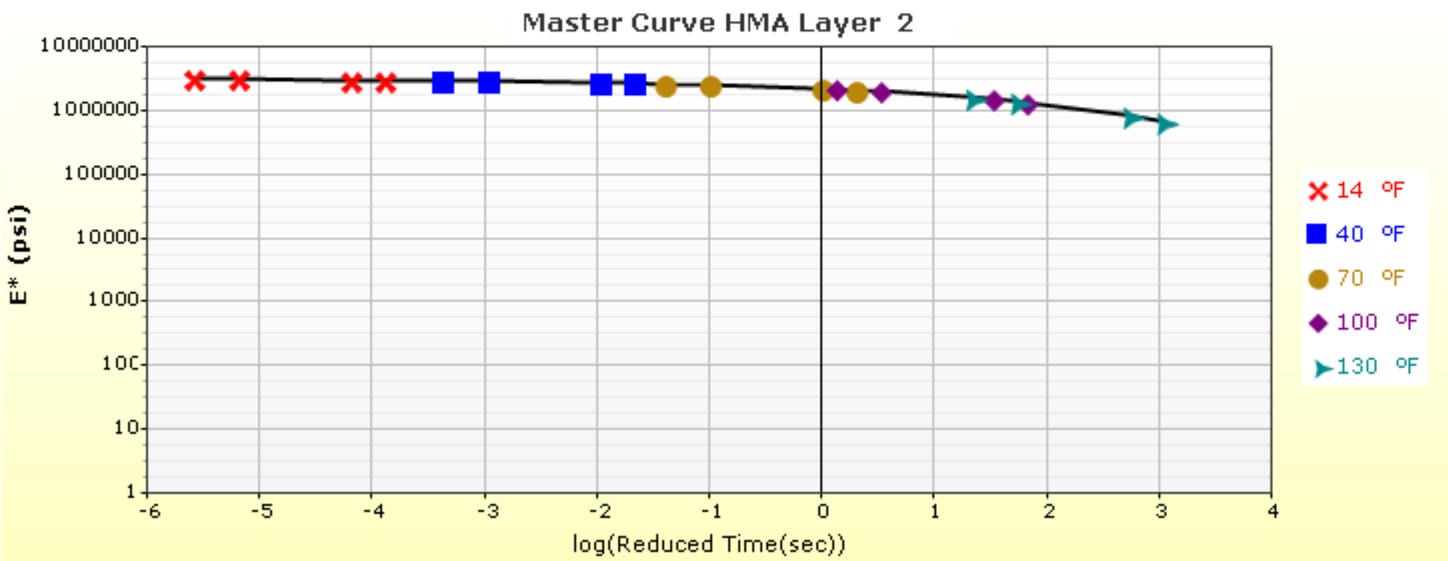
HMA Layer 1: Layer 1 Flexible : R3 Level 1 SX(100) PG 64-28

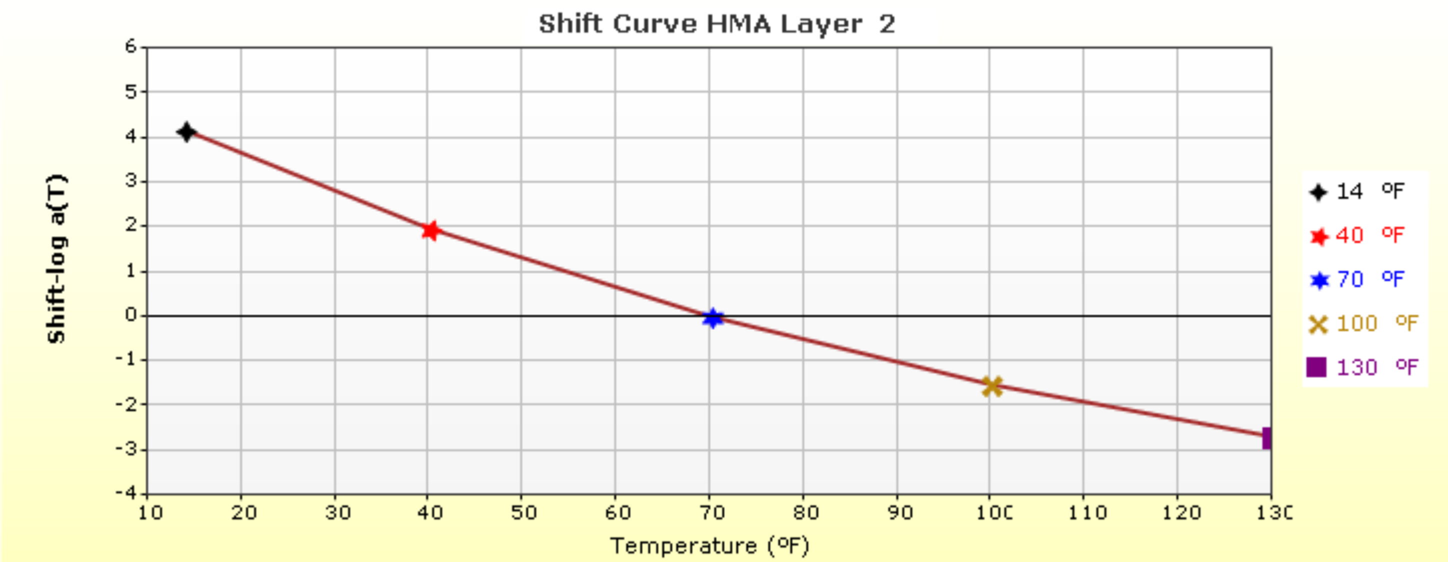


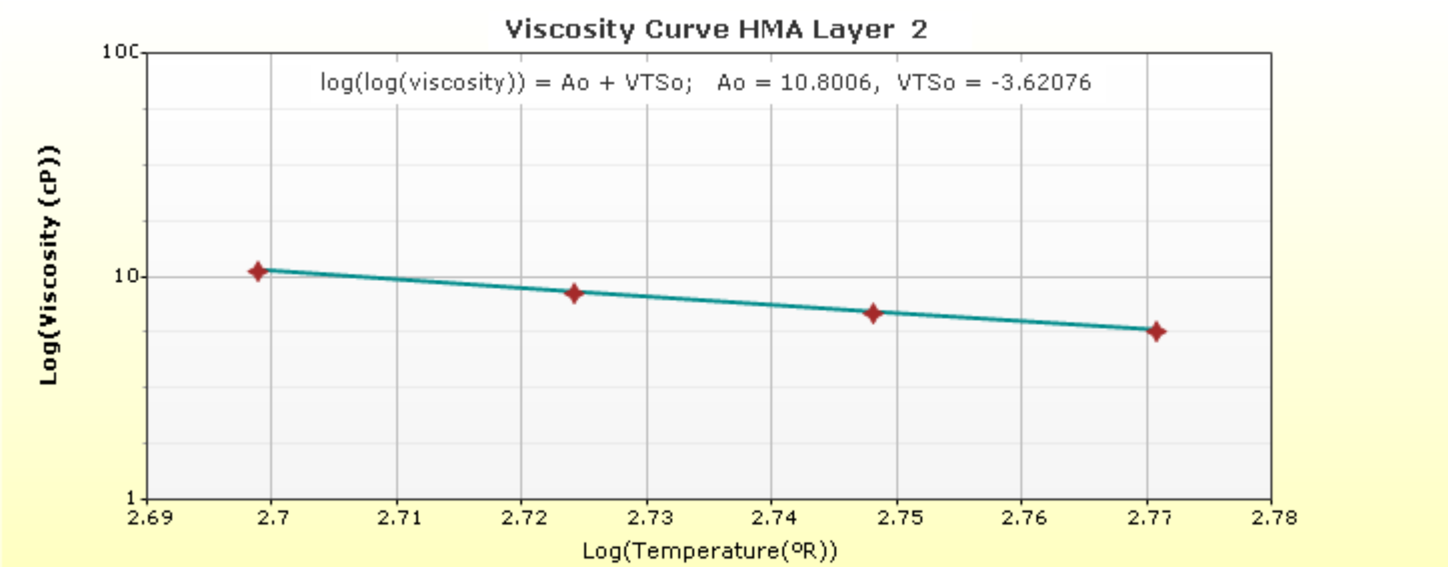




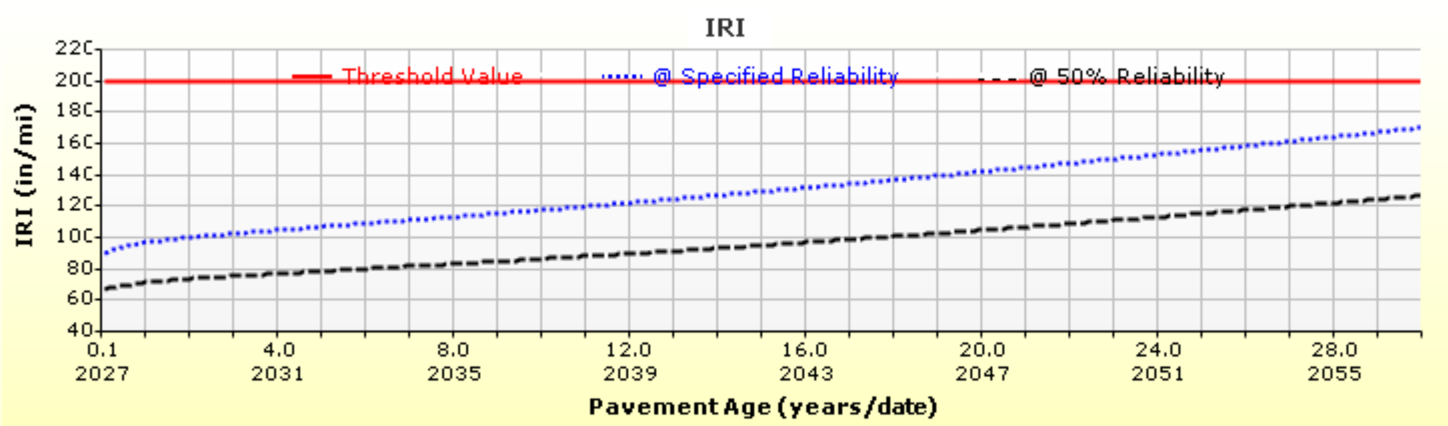
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

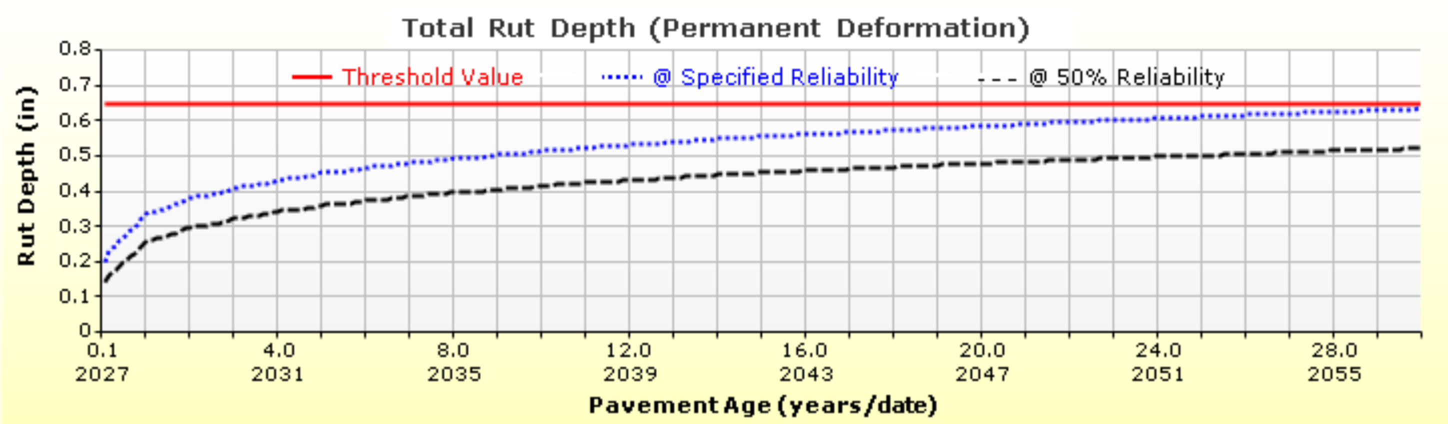


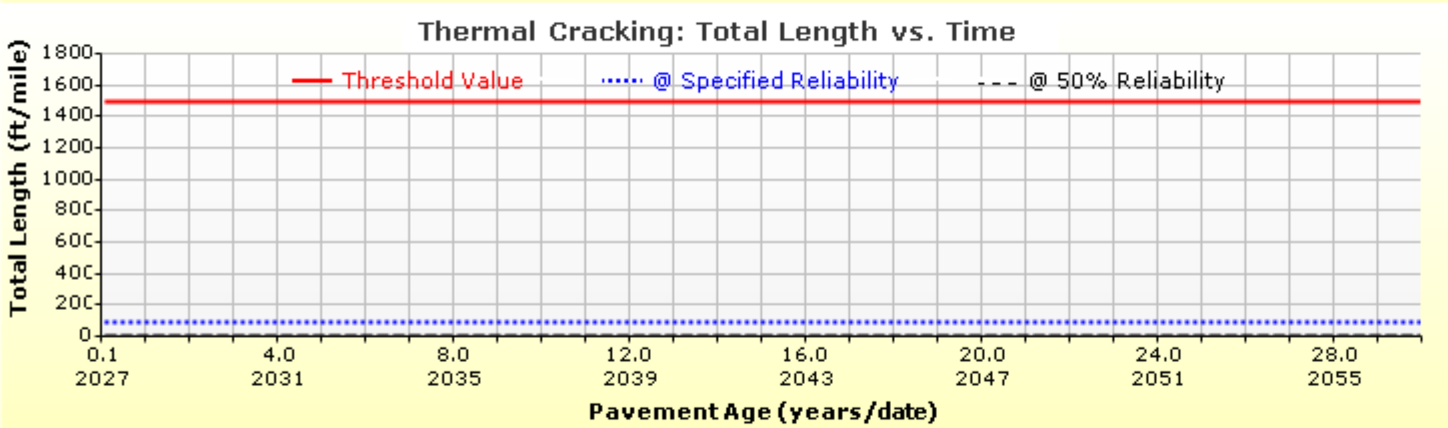


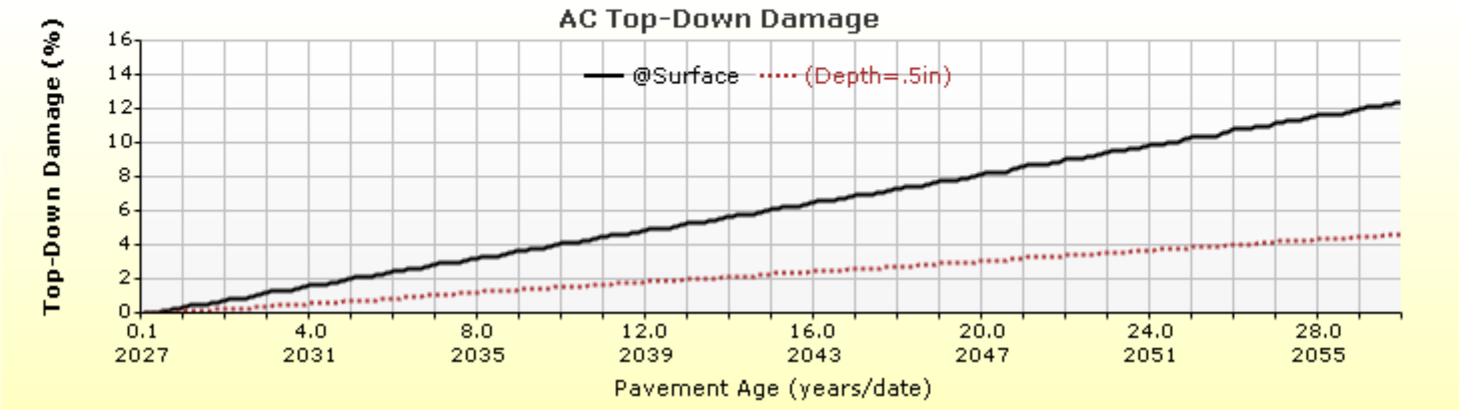


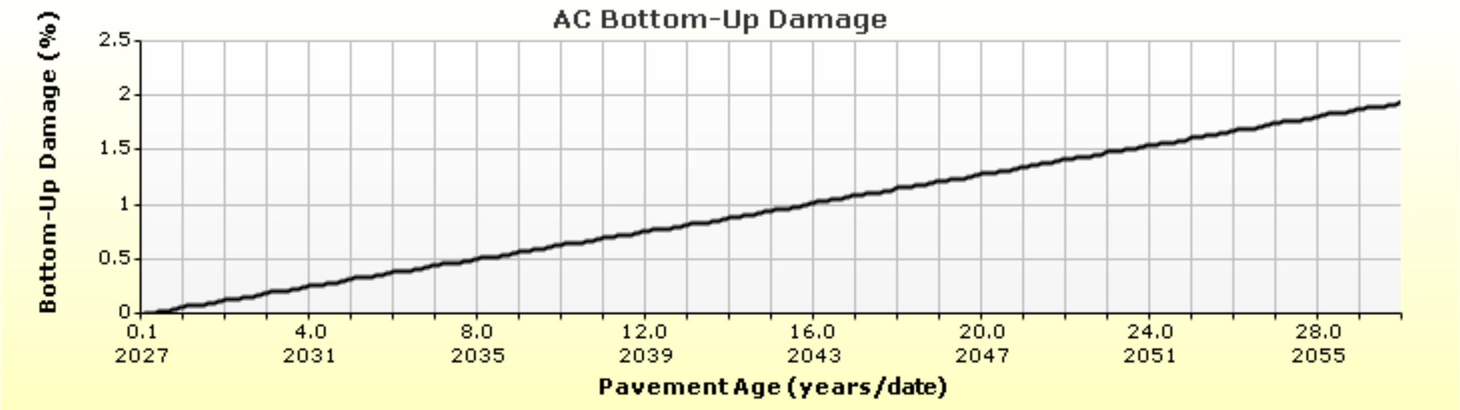
Analysis Output Charts

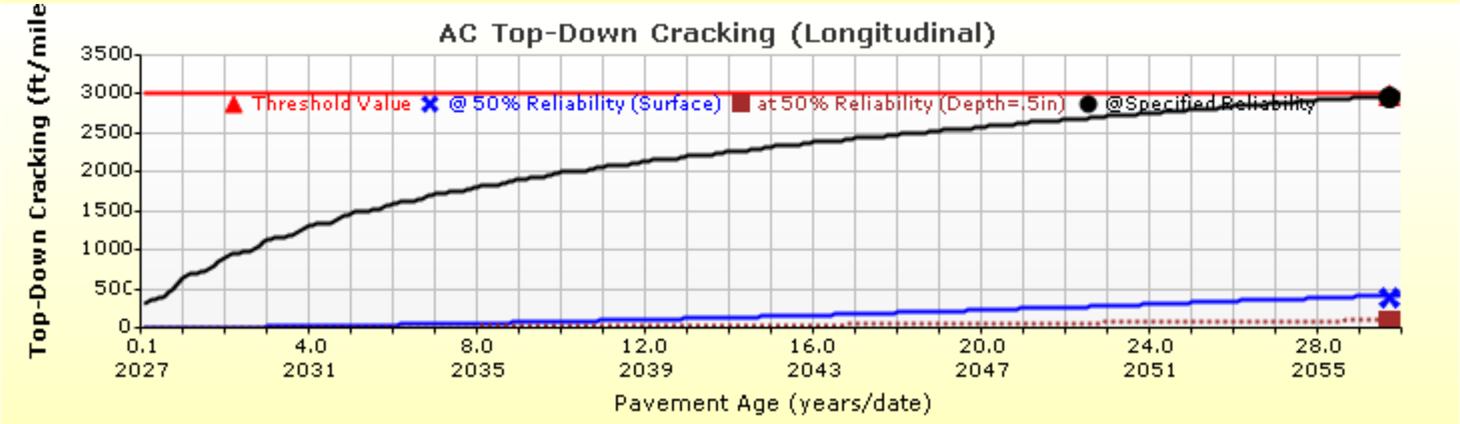


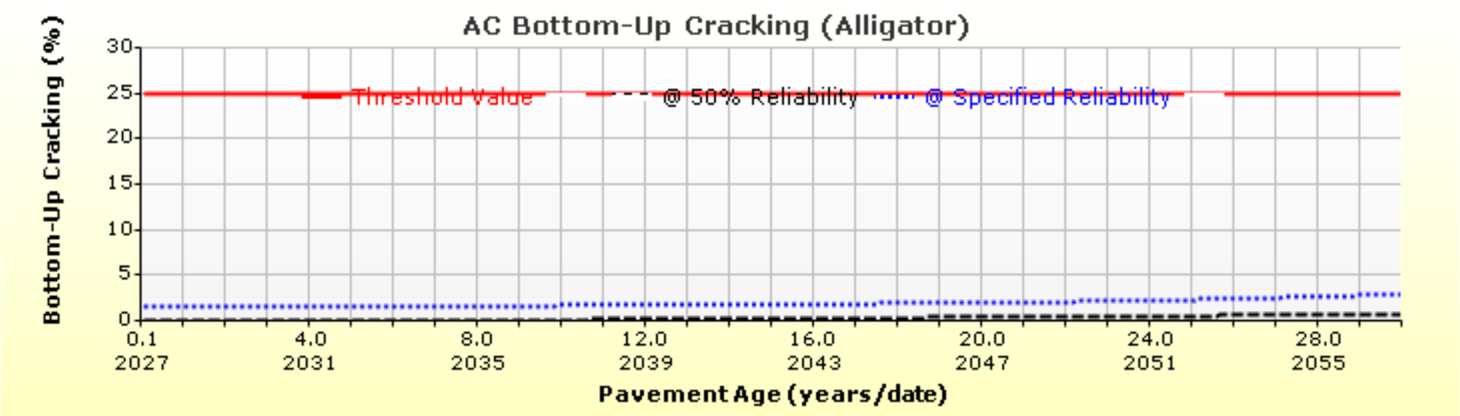


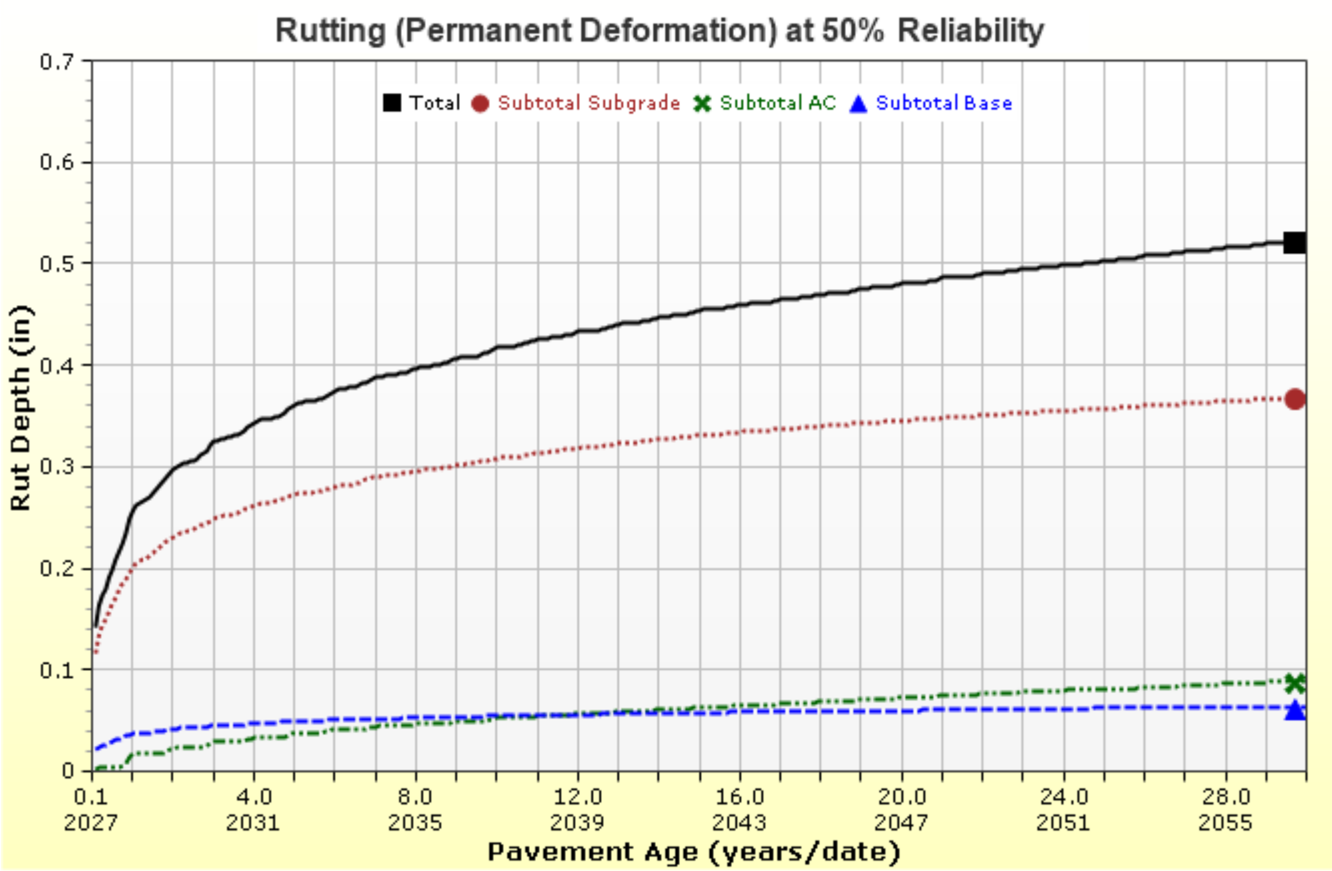


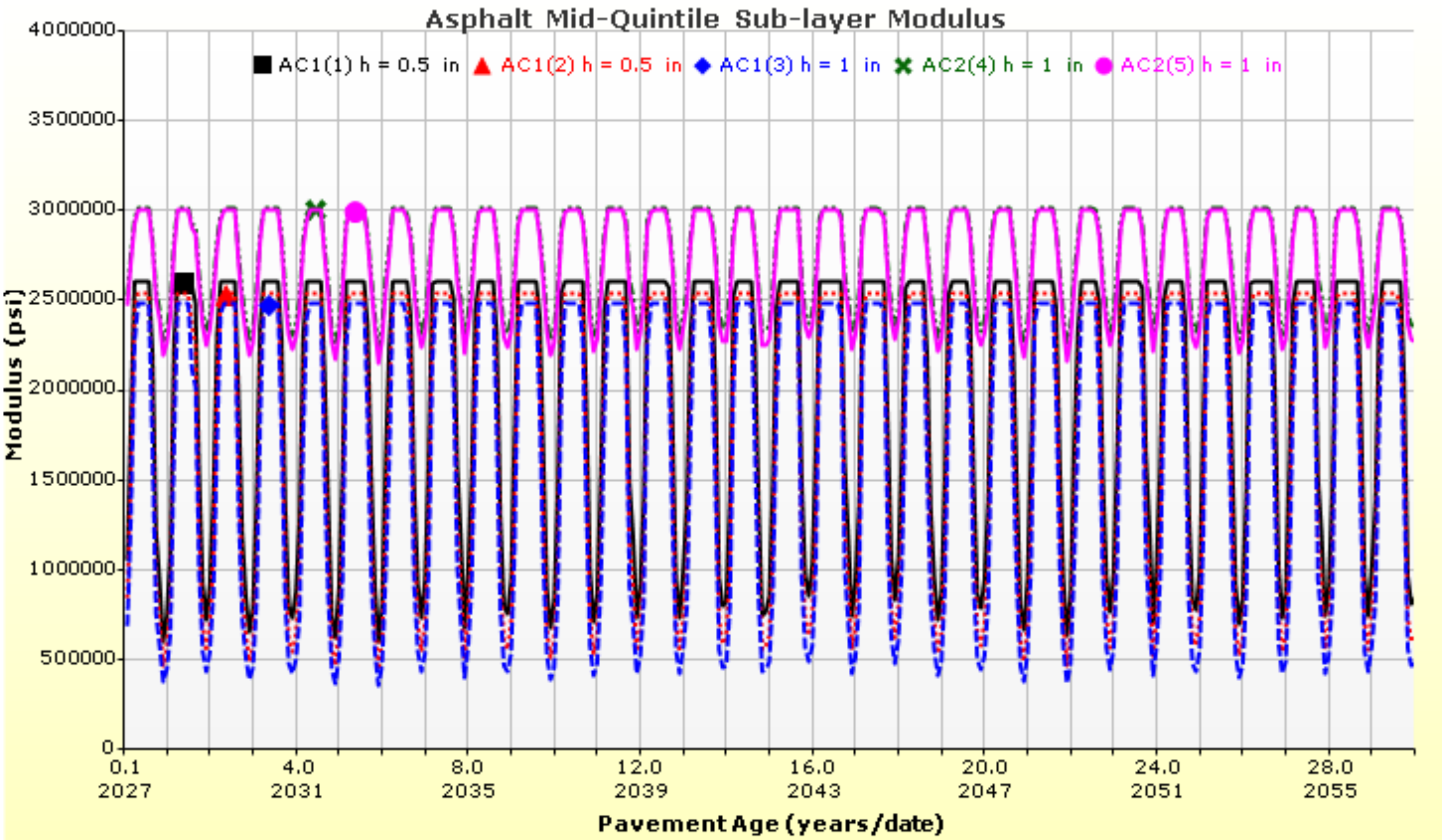

AC Top-Down Damage
@Surface
(Depth=.5in)
Top-Down Damage (%)
Pavement Age (years/date)

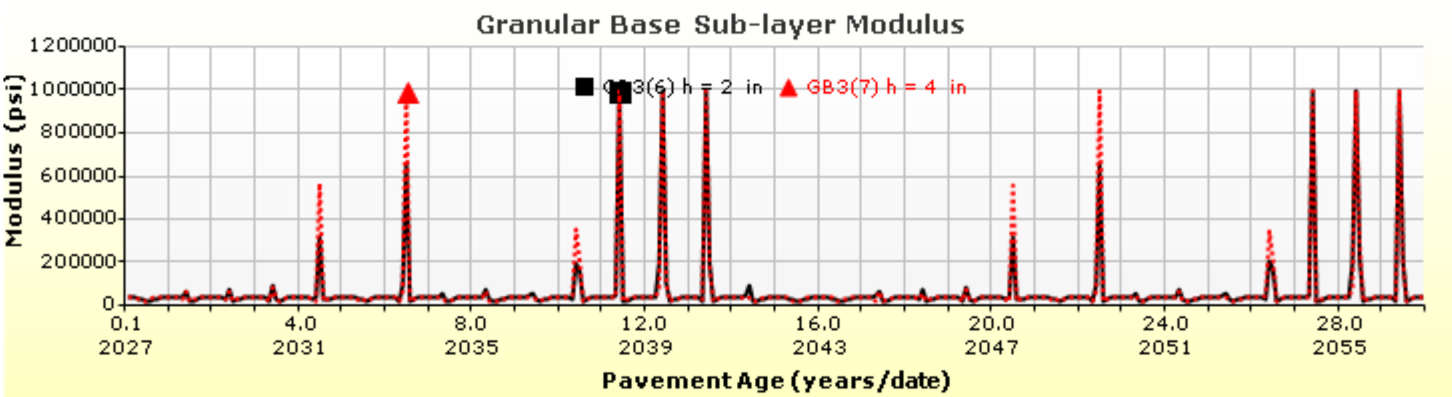

AC Bottom-Up Damage
Bottom-Up Damage (%)
Pavement Age (years/date)

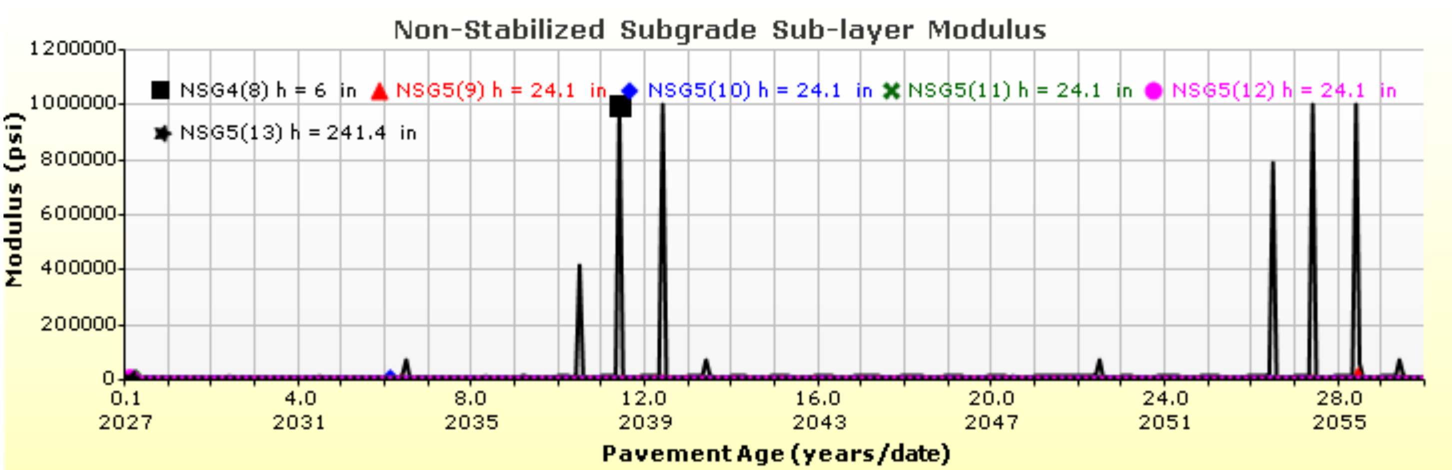

AC Top-Down Cracking (Longitudinal)
Threshold Value
@ 50% Reliability (Surface)
at 50% Reliability (Depth=.5in)
@Specified Reliability
Top-Down Cracking (ft/mile
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Threshold Value
@ 50% Reliability
@ Specified Reliability
Bottom-Up Cracking (%)
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal Subgrade
Subtotal AC
Subtotal Base
Rut Depth (in)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1 2027
4.0 2031
8.0 2035
12.0 2039
16.0 2043
20.0 2047
24.0 2051
28.0 2055
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
Modulus (psi)
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(6) h = 2 in
GB3(7) h = 4 in
Modulus (psi)
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(8) h = 6 in
NSG5(9) h = 24.1 in
NSG5(10) h = 24.1 in
NSG5(11) h = 24.1 in
NSG5(12) h = 24.1 in
NSG5(13) h = 241.4 in
Modulus (psi)
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R3 Level 1 SX(100) PG 64-28

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1687360	2134249	2493389	2608869
40	697463	1127680	1612900	1802220
70	173403	334774	616373	765125
100	54259	93163	175106	227742
130	27890	38645	60413	74657

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
147.2	3051	81.6
158	1495	83.1
168.8	772	85

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	10.7
Air voids (%)	5.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R3 Level 1 SX(100) PG 64-28
Description of object	Mix ID # FS1959
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Crushed gravel

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
25000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Crushed gravel
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	6.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	127.7
Saturated hydraulic conductivity (ft/hr)	False	5.054e-02
Specific gravity of solids	False	2.7
Water Content (%)	False	7.4

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	7.2555
bf	1.3328
cf	0.8242
hr	117.4000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	8.7
#100	
#80	12.9
#60	
#50	
#40	20.0
#30	
#20	
#16	
#10	33.8
#8	
#4	44.7
3/8-in.	57.2
1/2-in.	63.1
3/4-in.	72.7
1-in.	78.8
1 1/2-in.	85.8
2-in.	91.6
2 1/2-in.	
3-in.	
3 1/2-in.	97.6

Layer 4 Subgrade : A-1-b

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
10942.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-1-b
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	11.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	124.2
Saturated hydraulic conductivity (ft/hr)	False	2.303e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	9.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.8206
bf	0.4621
cf	3.8497
hr	126.8000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	13.4
#100	
#80	20.8
#60	
#50	
#40	37.6
#30	
#20	
#16	
#10	64.0
#8	
#4	74.2
3/8-in.	82.3
1/2-in.	85.8
3/4-in.	90.8
1-in.	93.6
1 1/2-in.	96.7
2-in.	98.4
2 1/2-in.	
3-in.	
3 1/2-in.	99.4

Layer 5 Subgrade : A-1-b

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
10942.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-1-b
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	11.0
Plasticity Index	1.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	123.7
Saturated hydraulic conductivity (ft/hr)	False	2.303e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	9.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.8206
bf	0.4621
cf	3.8497
hr	126.8000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	13.4
#100	
#80	20.8
#60	
#50	
#40	37.6
#30	
#20	
#16	
#10	64.0
#8	
#4	74.2
3/8-in.	82.3
1/2-in.	85.8
3/4-in.	90.8
1-in.	93.6
1 1/2-in.	96.7
2-in.	98.4
2 1/2-in.	
3-in.	
3 1/2-in.	99.4

Calibration Coefficients

AC Fatigue

$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2 \beta_{f2}} \left(\frac{1}{E}\right)^{k_3 \beta_{f3}}$	k1: 0.007566
	k2: 3.9492
$C = 10^M$	k3: 1.281
	Bf1: 1
$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$	Bf2: 1
	Bf3: 1

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_a^2 + 2.4868 * H_a - 17.342$$

$$C_2 = 0.0172 * H_a^2 - 1.7331 * H_a + 27.428$$

Where:

H_{ac} = total AC thickness(in)

ε_p = plastic strain(in/in)
ε_r = resilient strain(in/in)
T = layer temperature(°F)
N = number of load repetitions

AC Rutting Standard Deviation	0.24 * Pow(RUT,0.8026) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.4791	Br1:1 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

C_f = observed amount of thermal cracking(ft/500ft)
k = refression coefficient determined through field calibration
$N()$ = standard normal distribution evaluated at()
σ = standard deviation of the log of the depth of cracks in the pavments
C = crack depth(in)
h_{ac} = thickness of asphalt layer(in)
ΔC = Change in the crack depth due to a cooling cycle
ΔK = Change in the stress intensity factor due to a cooling cycle
A, n = Fracture parameters for the asphalt mixture
E = mixture stiffness
σ_M = Undamaged mixture tensile strength
β_t = Calibration parameter

Level 1 K: 1.5	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 1.5	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1}\left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

N_f = number of repetitions to fatigue cracking
σ_s = Tensile stress(psi)
M_r = modulus of rupture(psi)

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^\beta} \right|$$

δ_a = permanent deformation for the layer
N = number of repetitions
ε_v = average veritcal strain(in/in)
$\varepsilon_0, \beta, \rho$ = material properties
ε_r = resilient strain(in/in)

Granular		Fine	
k1: 2.03	Bs1: 1	k1: 1.35	Bs1: 1
Standard Deviation (BASERUT) 0.1477 * Pow(BASERUT,0.6711) + 0.001		Standard Deviation (BASERUT) 0.1235 * Pow(SUBRUT,0.5012) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1+e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10 (TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1+e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D*100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 1	c2: 1	c3: 6000

AC Cracking Bottom Standard Deviation

1.13 + 13/(1+exp(7.57-15.5*LOG10 (BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1+e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 40	C2: 0.4	C3: 0.008	C4: 0.015

APPENDIX J

PAVEXPRESS FLEXIBLE PAVEMENT OUTPUT SHEETS

Project: City of GJ Recycling Center

New Asphalt Pavement Design

AASHTO '93/'98: Flexible Pavement Design

Pavement Diagram

Layer Thicknesses (in)

Recommended Surface: 4.00 in

Aggregate Base: 6.00 in

Total SN: 2.41 (Required minimum design SN: 2.20)

Details

Scenario: New Asphalt Pavement Design

Created By: Alexander Walt, walt@rocksol.com

Last Modified: December 2, 2025 11:49:03 am

Design Parameters

Design Period: 30 years

Reliability Level (R): 90%

Combined Standard Error (S_0): 0.44

Initial Servicability Index (p_i): 4.5

Terminal Servicability Index (p_t): 2

Delta Servicability Index (ΔPSI): 2.5

Total Design ESALs (W_{18}): 514,000

Layers

Recommended Surface - Asphalt

Thickness: 4.00 in

Aggregate Base - Base

Thickness: 6.00 in

Structural Coefficient: 0.12

Drainage Coefficient: 0.9

APPENDIX K

PAVEMENT M-E DESIGN
RIGID PAVEMENT OUTPUT SHEETS

PMED Concrete Design

File Name: C:\Users\RSGeoTech\Desktop\PMED Projects\803.64\PMED Concrete Design.dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	39.134, -108.538
Design Type:	JPCP	Pavement construction:	May, 2027		
		Traffic opening:	August, 2027		

Design Structure

Layer type	Material Type	Thickness (in)
PCC	R4 Level 1 Lawson	7.0
NonStabilized	Crushed stone	6.0
Subgrade	A-1-b	6.0
Subgrade	A-1-b	Semi-infinite

Joint Design:	
Joint spacing (ft)	12.0
Dowel diameter (in)	1.00
Slab width (ft)	12.0

Traffic

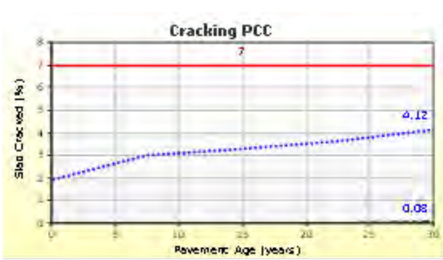
Age (year)	Heavy Trucks (cumulative)
2027 (initial)	40
2042 (15 years)	226,989
2057 (30 years)	471,611

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	117.62	90.00	100.00	Pass
Mean joint faulting (in)	0.20	0.02	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	4.12	90.00	98.60	Pass

Distress Charts

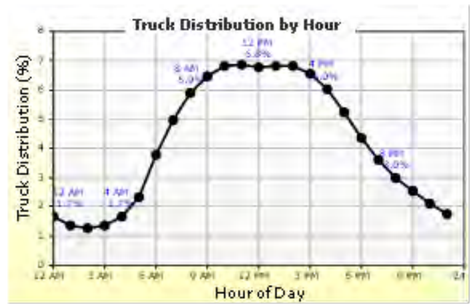


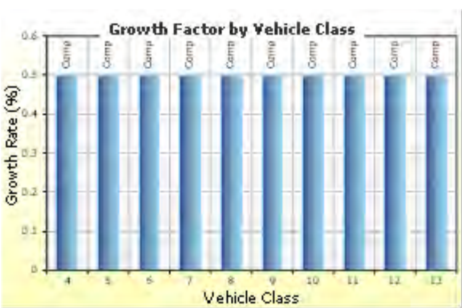
Threshold Value ····· @ Specified Reliability - - - @ 50% Reliability

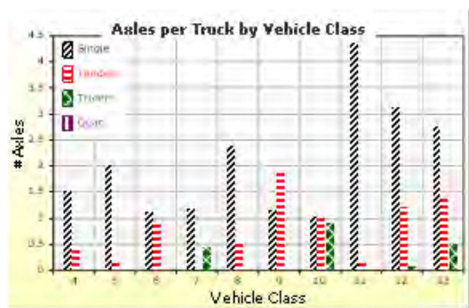
Traffic Inputs

Graphical Representation of Traffic Inputs

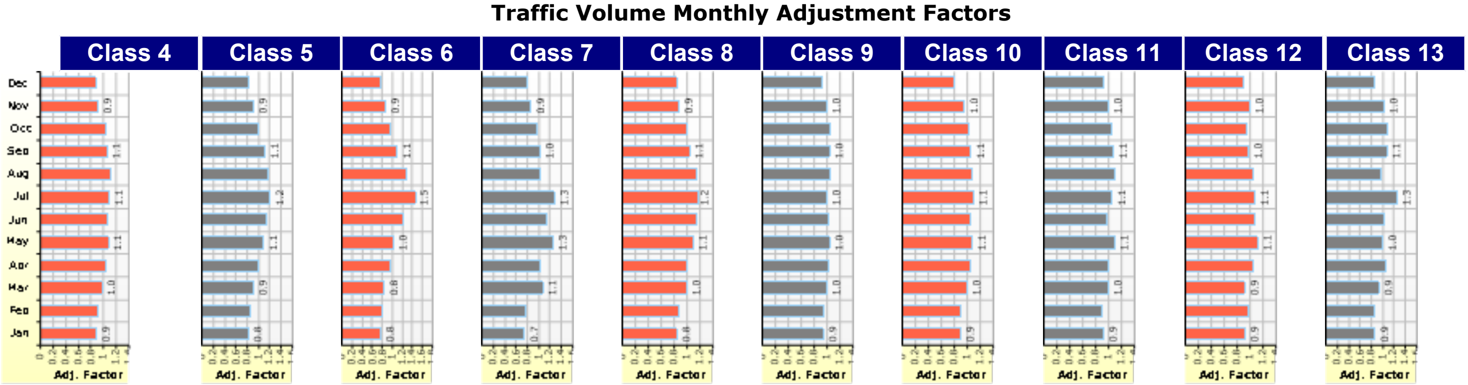
Initial two-way AADTT:	40	Percent of trucks in design direction (%):	100.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	25.0







Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	0%	0.5%	Compound
Class 5	0%	0.5%	Compound
Class 6	30%	0.5%	Compound
Class 7	0%	0.5%	Compound
Class 8	0%	0.5%	Compound
Class 9	70%	0.5%	Compound
Class 10	0%	0.5%	Compound
Class 11	0%	0.5%	Compound
Class 12	0%	0.5%	Compound
Class 13	0%	0.5%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

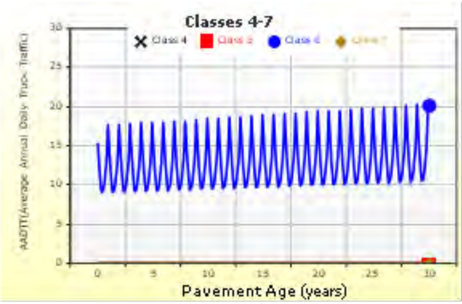
Wheelbase			
Value Type / Axle Type	Short	Medium	Long
Average spacing of axles (ft)	12.0	15.0	18.0
Percent of Trucks (%)	17.0	22.0	61.0

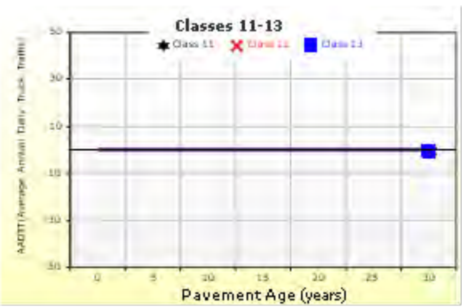
Number of Axles per Truck

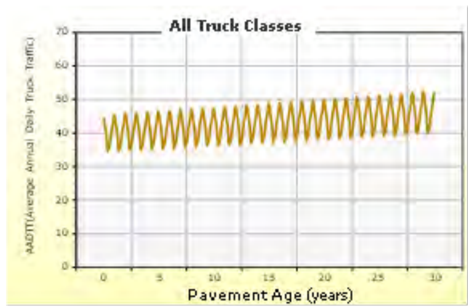
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

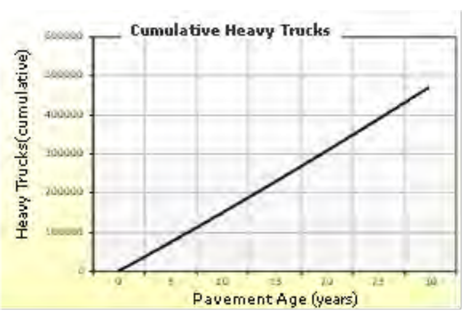
AADTT (Average Annual Daily Truck Traffic) Growth

*** Traffic cap is not enforced**





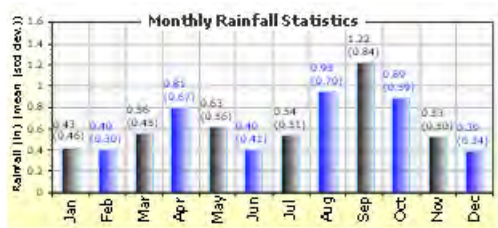




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
GRAND JUNCTION, CO	39.13400 -108.53800 4839

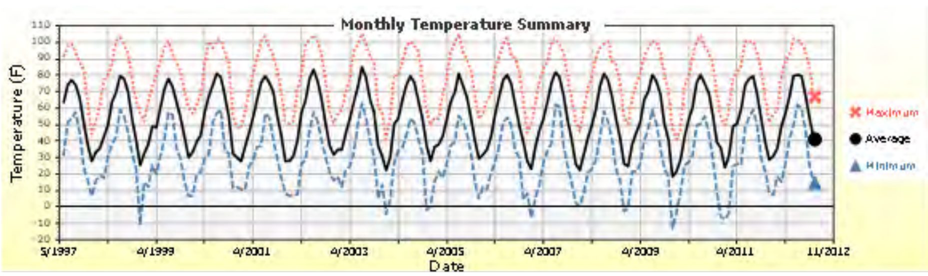


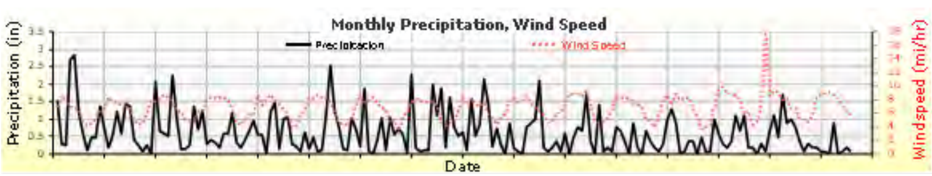
Annual Statistics:

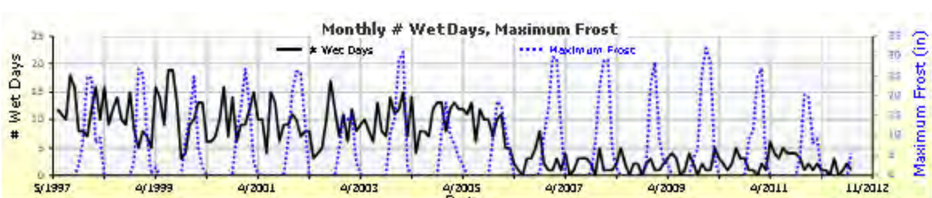
Mean annual air temperature (ºF)	53.51
Mean annual precipitation (in)	7.75
Freezing index (ºF - days)	399.81
Average annual number of freeze/thaw cycles:	111.77

Water table depth (ft) 10.00

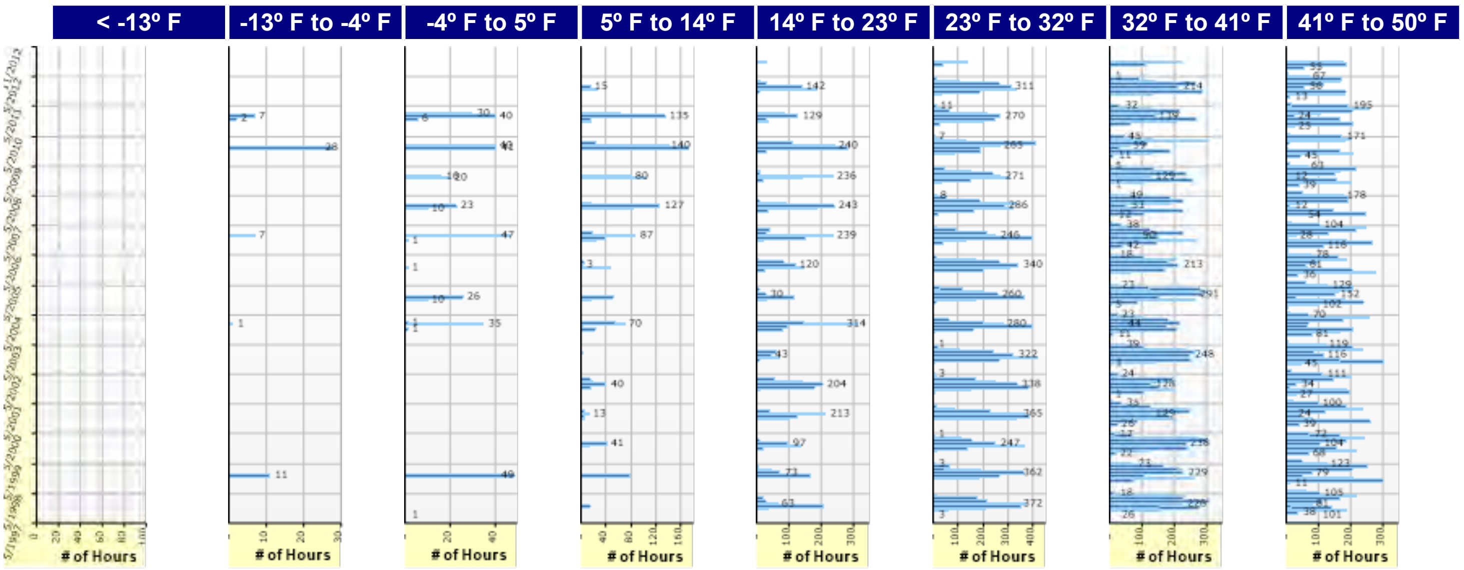
Monthly Climate Summary:

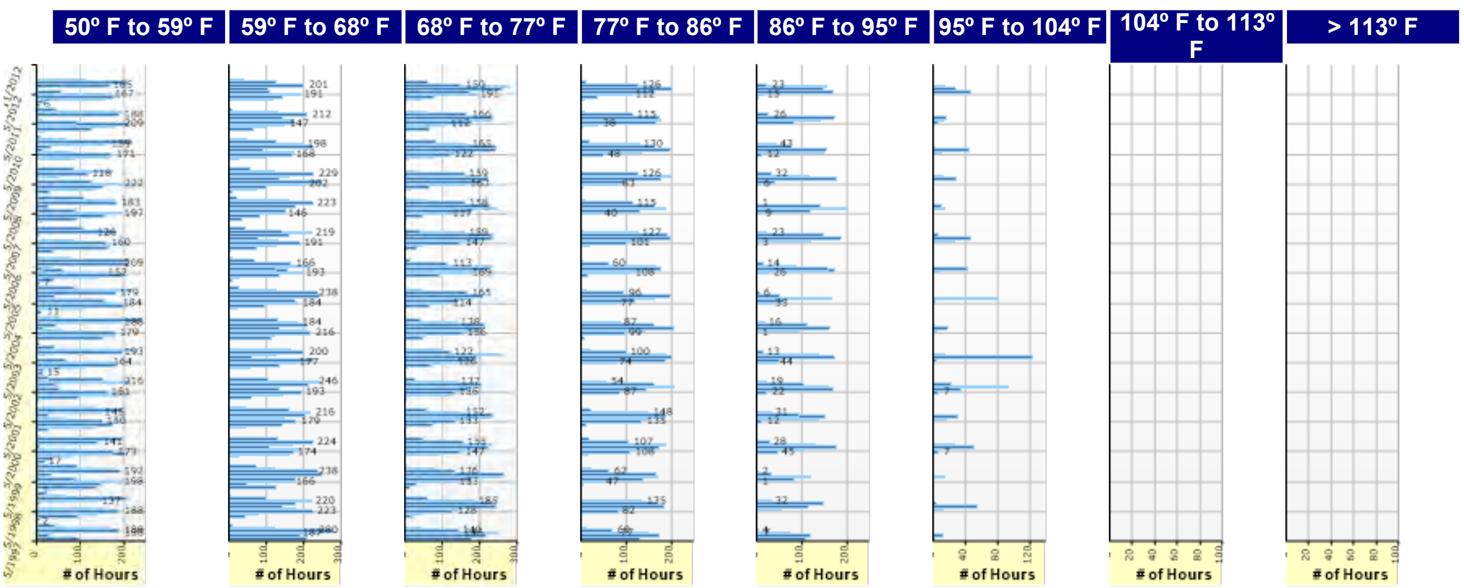






Hourly Air Temperature Distribution by Month:





Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.00
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	True
Load transfer efficiency (%)	50.00

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	12.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

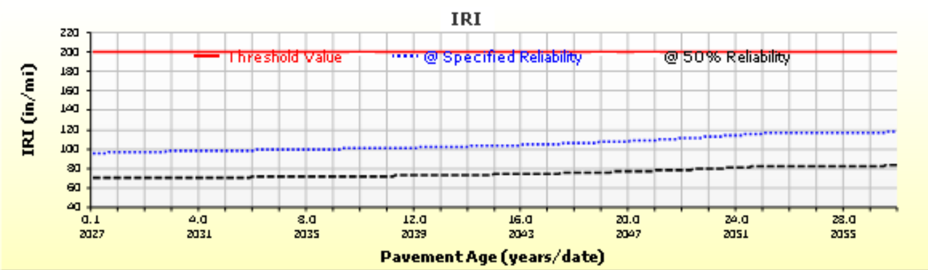
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	360.00

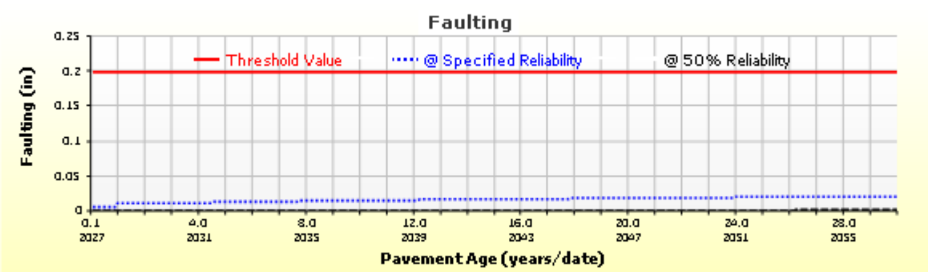
Sealant type	Other(Including No Sealant... Liquid... Silicone)

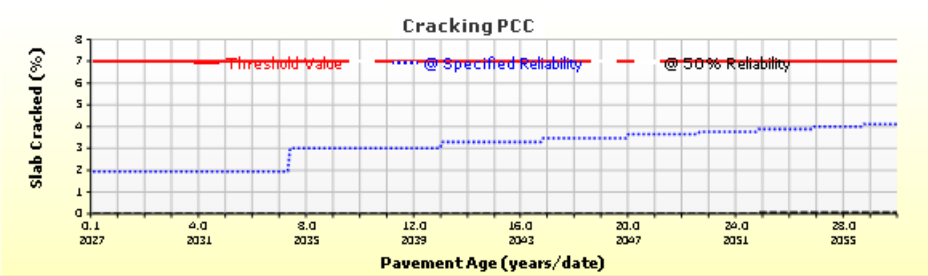
Erodibility index	4

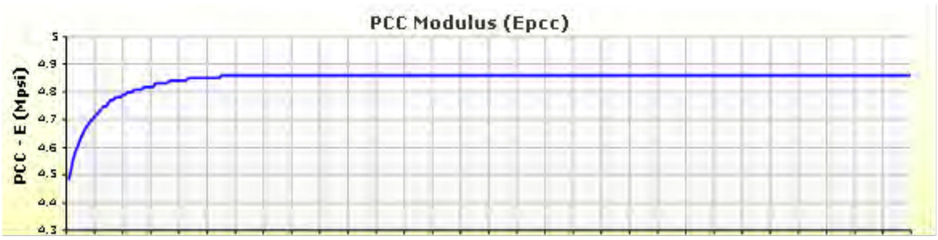
Permanent curl/warp effective temperature difference (ºF)	-10.00

Analysis Output Charts

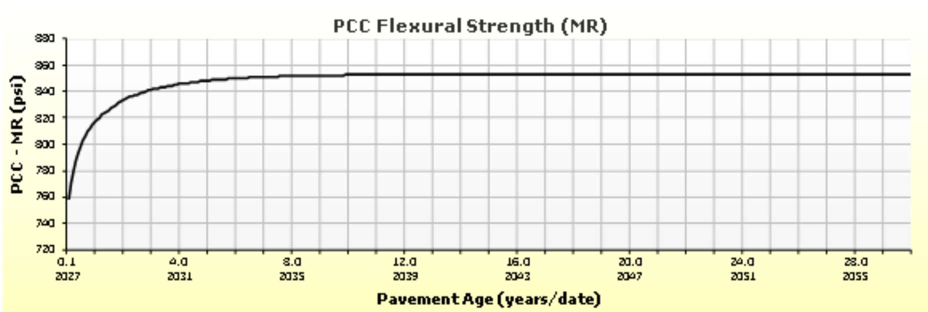




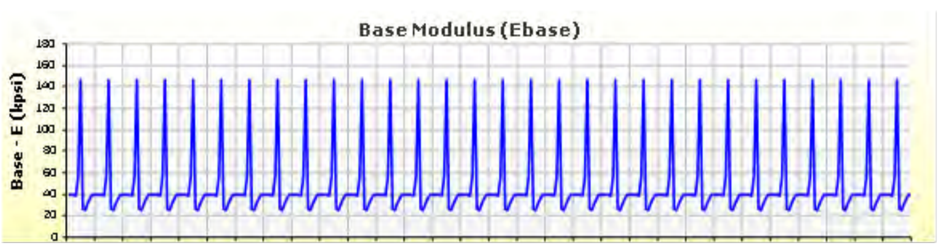




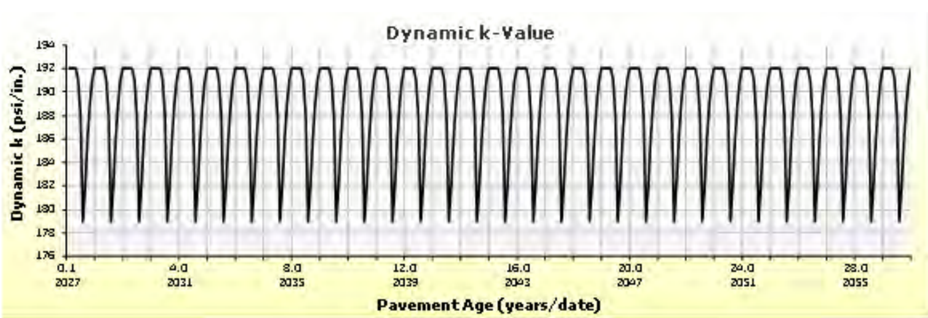
PCC Modulus (Epcc)
PCC - E (Mpsi)



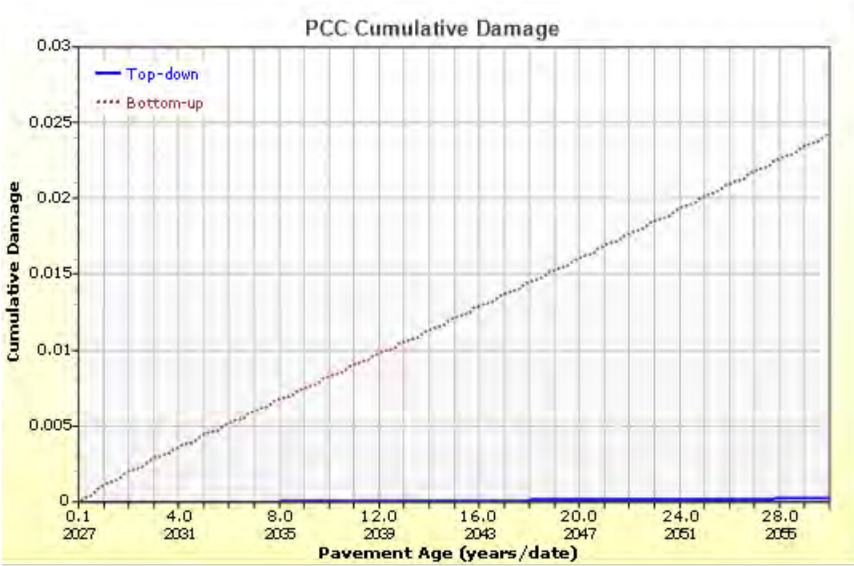
PCC Flexural Strength (MR)
PCC - MR (psi)
Pavement Age (years/date)



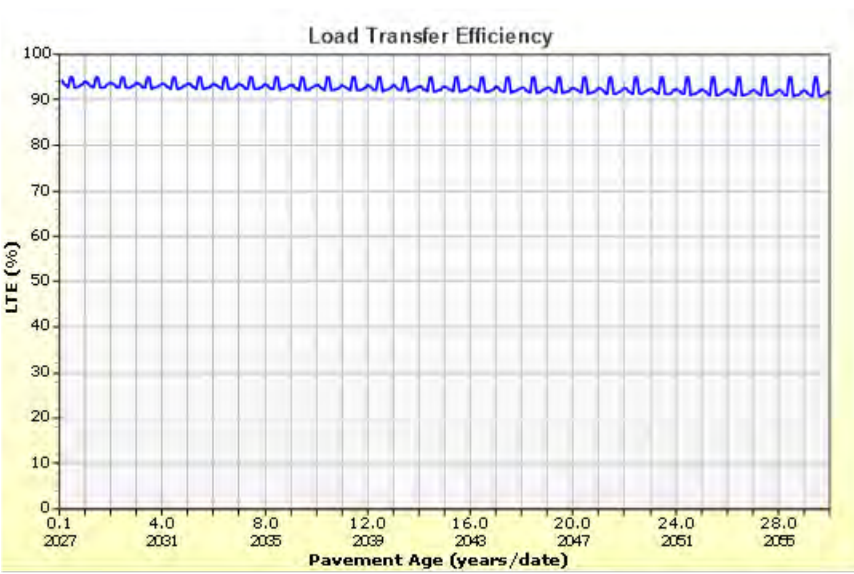
Base Modulus (Ebase)
Base - E (kpsi)



Dynamic k-Value
Dynamic k (psi/in.)
Pavement Age (years/date)



PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1
2027
4.0
2031
8.0
2035
12.0
2039
16.0
2043
20.0
2047
24.0
2051
28.0
2055
Pavement Age (years/date)



Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2027
4.0
2031
8.0
2035
12.0
2039
16.0
2043
20.0
2047
24.0
2051
28.0
2055
Pavement Age (years/date)

Layer Information

Layer 1 PCC : R4 Level 1 Lawson

PCC	
Thickness (in)	7.0
Unit weight (pcf)	140.6
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.86
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		563
Water to cement ratio		0.36
Aggregate type		Dolomite (2)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	90.7
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	516.0
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 1)

Time	Modulus of rupture (psi)	Elastic modulus (psi)
7-day	560	3230000
14-day	620	3500000
28-day	710	4030000
90-day	730	4240000
20-year/28-day	1.2	1.2

Identifiers

Field	Value
Display name/identifier	R4 Level 1 Lawson
Description of object	Mix ID # 2009105
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	Region 4/1/6
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Crushed stone

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
25000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Crushed stone
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	6.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	127.7
Saturated hydraulic conductivity (ft/hr)	False	5.054e-02
Specific gravity of solids	False	2.7
Water Content (%)	False	7.4

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	7.2555
bf	1.3328
cf	0.8242
hr	117.4000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	8.7
#100	
#80	12.9
#60	
#50	
#40	20.0
#30	
#20	
#16	
#10	33.8
#8	
#4	44.7
3/8-in.	57.2
1/2-in.	63.1
3/4-in.	72.7
1-in.	78.8
1 1/2-in.	85.8
2-in.	91.6
2 1/2-in.	
3-in.	
3 1/2-in.	97.6

Layer 3 Subgrade : A-1-b

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
10615.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-1-b
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	11.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	124.2
Saturated hydraulic conductivity (ft/hr)	False	2.303e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	9.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.8206
bf	0.4621
cf	3.8497
hr	126.8000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	13.4
#100	
#80	20.8
#60	
#50	
#40	37.6
#30	
#20	
#16	
#10	64.0
#8	
#4	74.2
3/8-in.	82.3
1/2-in.	85.8
3/4-in.	90.8
1-in.	93.6
1 1/2-in.	96.7
2-in.	98.4
2 1/2-in.	
3-in.	
3 1/2-in.	99.4

Layer 4 Subgrade : A-1-b

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
10615.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-1-b
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	11.0
Plasticity Index	1.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	123.7
Saturated hydraulic conductivity (ft/hr)	False	2.303e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	9.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.8206
bf	0.4621
cf	3.8497
hr	126.8000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	13.4
#100	
#80	20.8
#60	
#50	
#40	37.6
#30	
#20	
#16	
#10	64.0
#8	
#4	74.2
3/8-in.	82.3
1/2-in.	85.8
3/4-in.	90.8
1-in.	93.6
1 1/2-in.	96.7
2-in.	98.4
2 1/2-in.	
3-in.	
3 1/2-in.	99.4

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_s}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400

PCC Reliability Faulting Standard Deviation

0.0831*Pow(FAULT,0.3426) + 0.00521

IRI-jpcp

C1 - Cracking	C1: 0.8203	C2: 0.4417
C2 - Spalling	C3: 1.4929	C4: 25.24
C3 - Faulting	**Reliability Standard Deviation**	
C4 - Site Factor	5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$

$$CRK = \frac{100}{1 + C4\, FD^{C5}}$$

Fatigue Coefficients		Cracking Coefficients	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05

PCC Reliability Cracking Standard Deviation

Pow(57.08*CRACK,0.33) + 1.5

APPENDIX L

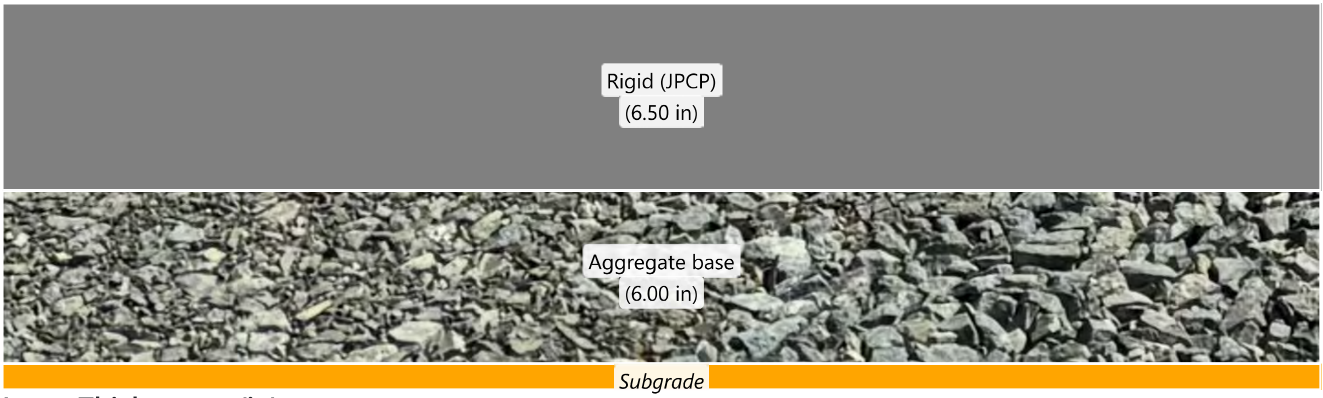
PAVEXPRESS RIGID PAVEMENT OUTPUT SHEETS

Project: City of GJ Recycling Center

New Rigid Pavement Design

AASHTO '93/'98: Rigid Pavement Design

Pavement Diagram



Layer Thicknesses (in)

Rigid (JPCP): 6.50 in
Base: 6.00 in

Calculation Details

Effective positive temperature differential
TD
5.062 °F

Ratio of stress with friction to stress with bond
f
1.11

Radius of relative stiffness l
l
30.89 in

Log of slope of TD effect on stress
log(b)
-1.45

Stress due to load
$sigma_L$
314.1 PSI

Total stress due to load and temperature
$sigma_t$
411.3 PSI

**Note: calculated design thicknesses will be rounded to the nearest 0.5" for constructability reasons.*

Details

Scenario: New Rigid Pavement Design

Created By: Alexander Walt, walt@rocksol.com

Last Modified: December 2, 2025 12:16:38 pm

Design Parameters

Layers

Rigid (JPCP) - Concrete
Thickness: 6.50 in

Aggregate base - Base
Thickness: 6.00 in

Subgrade - Subgrade

Design Period: 30 years

Reliability Level (R): 90%

Combined Standard Error (S_0): 0.44

Initial Servicability Index (p_i): 4.5

Terminal Servicability Index (p_t): 2

Delta Servicability Index (ΔPSI): 2.5

Total Design ESALs (W_{18}): 796,000

Thickness: 0.00 in