Limited Soil Investigation
Skyline College
Slope Erosion (FMC Facility)
Slopes Surrounding FMC Facility
3300 College Drive
San Bruno, California

Prepared For
San Mateo County Community College District
C/O Swinerton Management & Consulting
3300 College Drive, Loma Chica Building
San Bruno, California

File No. 09504-Erosion
September 2009

Geotechnical and Environmental Consulting Engineers

Skyline College
FMC Facility
Slope Erosion
3300 College Drive
San Bruno, California

Submitted to
San Mateo County Community College District
C/O Swinerton Management & Consulting
3300 College Drive, Loma Chica
San Bruno, California

File No. 09504-Erosion
September 2009

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File No. 09504-Slope
September 22, 2009

San Mateo County Community College District
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San Bruno, California 94066

Attention: Mr. Edward Westland

Subject: Skyline College
Slope Erosion – FMC Facility
3300 College Drive
San Bruno, California
LIMITED SOIL INVESTIGATION

Gentlemen:

We are pleased to present herein the results our limited soil investigation performed for the slope erosion adjacent to the newly constructed FMC Facility at the Skyline College located at 3300 College drive in San Mateo, California.

The purpose of this investigation was to determine the existing soil conditions at the site of the slope erosion area and provide grading, drainage, repair recommendations based on the physical properties and the laboratory analyses of materials underlying the site.

In the proceeding sections, this report summarizes the results of our findings, conclusions and recommendations that are to be incorporated in the design process and during construction phase of the project. The conclusions and recommendations are based on the soil conditions, physical properties, laboratory analyses and the materials encountered in our exploratory borings drilled in the area.

All conclusions and recommendations presented in the proceeding sections of this report are contingent upon Advance Soil Technology, Inc. being retained to review the grading plans, field inspections and provide recommendations as deemed necessary, prior to construction and during the construction phase of the project.

Inspection and review letters are mandated to document the construction activities. Please note that it is the responsibility of the owner or his / her representative to schedule the inspections for the purpose of documentation. These conclusions and recommendations presented in this report are professional opinions derived from current standards of geotechnical practice and no warranty is intended, expressed or implied. This report is the property of Advance Soil Technology, Inc. and has been prepared for the exclusive use of our property of Advance Soil Technology, Inc. and has been prepared for the exclusive use of our client San Mateo County Community College District.

Any use of this report or presentation in any form by others without written authorization of Advance Soil Technology, Inc. shall be done at their own risk and will be subject to copyright laws.

We are pleased to be of service to you in this matter. If you have any questions or require additional information, please do not hesitate to contact our office at your convenience.

Very truly yours,
Advance Soil Technology, Inc.

Al Mirza
Project Engineer

Alex A. Kassai, PE / REA
Principal

am/aak/cj
CC:file
Copies: Addressee

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Slope Erosion

3300 College Drive
San Bruno, California

1.0 Introduction / Site Description

This report presents the results of our site reconnaissance, field sampling, and subsequent laboratory analysis of the soil samples that were collected from the shallow borings drilled in close proximity and within the existing slopes surrounding the newly constructed FMC (Facility Maintenance Center) facility at the Skyline College. Please refer to the site plan for sample locations and the slopes surrounding the newly constructed FMC Buildings and associated with this investigation.

In the proceeding sections, this report summarizes the results of our findings, conclusions and recommendations that are to be incorporated in the design process and during the construction phase of slope erosion repair. The conclusions and recommendations are based on the soil conditions, physical properties, and laboratory analyses of the materials encountered in the shallow exploratory borings drilled within and in close proximity to the location of these slopes.

For information pertaining to the location of the slope erosion and boring locations, please refer to Figures (1) through (3) and 20 through 24 in Appendix "A" of this report. The general description referred to in this report is based on our site reconnaissance and the information / site plan furnished to us by Swinerton Management and Consulting.

2.0 Scope of Services

The scope of our services for the purpose of slope erosion repair included the following:

- A field investigation / site reconnaissance of the slope area and the subject property in general. Review of available documents and existing site studies by other consultants and the studies in the vicinity of the subject property and the existing available geological maps of the area.
- Laboratory testing and analysis of the field data to determine the physical and engineering properties of the soil underlying the site, including gradation, plasticity index, and moisture content.
- Recommendations for slope stabilization.
- General site grading requirements / criteria for excavation, imported engineered fill material requirements, fill placement / spreading of the material and the compaction requirement for the materials at the site.

3.0 Existing Site Conditions

3.1 Surface Conditions

Based on the review of the existing geotechnical reports and updates by TRC, dated April 16, 2007, it is our understanding that a total of six exploratory borings were drilled at the site to the depth ranging between (6.0) to (15)-feet below the existing ground surface. Based on the findings of TRC, the soil at the site consisted of shallow layer of stiff lean clay overlying the severely weathered Franciscan Formation Greenstone. The depth of lean clay extended to a depth of (1.5) to (2.0)-feet below the existing ground surface in some of the borings. No free groundwater was encountered in the borings to the depth of (25)-feet.

Furthermore, it is our understanding that the newly constructed FMC buildings replaced the old facility maintenance buildings at the site. The proposed new building footprints extended over the existing slopes. Our site observation and review of the existing reports revealed that the buildings are surrounded by newly constructed or modified slopes. It appears that the slopes are graded away from the buildings with an approximately two-foot wide flat strip surrounding the building footprint. The rest of the area appears to be covered by landscaping, flexible and rigid pavements, and concrete walkways. Signs of erosion were observed on the slopes throughout the recently developed area. The purpose of this investigation was to determine the existing near-surface soil conditions (Exposed slope surfaces) and provide recommendations for the grading, drainage, and remedial measures to minimize further slope erosion.

3.2 Visual Observation (From Site Reconnaissance)

The following observations were made during our site reconnaissance and field investigation:

- Slope erosion surrounding the newly constructed FMC Facility.
- Soil creep / soil washouts on the north, east, and northeast corner due to saturation and water run-off on slopes.
- Roof rain-leaders discharging roof runoffs onto crushed rock beds. It appears that roof runoffs spills over the drain rock and runs onto the slope. Water seepage into the underlying soil (Below the crushed rock) was also evident.
- Surface runoffs from walkways on to the face of slopes.
- Water draining from the weep holes of the retaining walls.
- Open drain outlets (Permanent open storage area adjacent to the equipment washing area) that discharges the drain water onto the face of slope.
- Irrigations of landscaping areas on and adjacent to slopes resulting in saturation of slopes.
- Un-compacted / loose soils placed at random locations on the slopes.
- Seepage of water from upper sections of slope which is surfacing at the face of slope –cavities.
- Undermined slope toe due to water runoff – especially on north slopes.
- Decomposed vegetation and roots embedded in the slopes with concaving slope failure areas.
- Caving of utility trenches and signs of movement observed.

4.0 Field Investigation

After reconnaissance of the site, a field investigation was conducted on August 11, 2009 which included drilling of ten shallow exploratory borings within the slope area. The exploratory borings were drilled to a depth of (3 to 5)-feet below the existing ground surface and the samples were collected at various depths for visual inspection and laboratory analysis. A hand auger and sampler was utilized to collect near surface soil from each boring. Soils encountered in the borings were continuously logged in the field during this operation.

4.1 Subsurface Soil Conditions

In order to determine the near-surface soil conditions at the eroded slope areas, exploratory borings were drilled to depth of 3 to 5 feet below the existing slopes grade. The material encountered was mostly medium to yellowish brown silty sand with clay binder. At deeper depth, weathered rock fragments were encountered in the borings. These soils were loose on the top and denser at the depth of 3.5 feet below the existing surface. Please note that the soil conditions presented above are location specific and the subsurface soil conditions could vary with the change in locations from the conditions at the above boring locations. For the location of the borings, please refer to the site plan – Figure (2) in Appendix “A” of this report.

4.2 Groundwater

Free Groundwater or perched water was not encountered in the borings drilled within the slope area. However, higher moisture contents were detected on the near-surface soil with respect to deeper soil / rock strata. Seepage of moisture on the surface was evident at the locations of some of our borings. Please note that seasonal groundwater studies were beyond the scope of this investigation. However, it shall be noted that perched water condition could infiltrate the terrain and could fluctuate due to excessive irrigation, variation in rainfall or due to use of containment area for storm water disposal, geological changes, temperature, pumping water from the wells and other factors that were not evident at the time of this investigation.

5.0 Laboratory Testing and Analysis

Laboratory testing program was performed on the near soil samples for the purpose of determining the moisture condition and classifying the soils that were encountered in the borings drilled at the site. Selected soil samples were tested for moisture content, gradation and Atterberg limits Tests. The results of the laboratory testing are presented in Figures (4) through (19) and Table I in Appendix "A" of this report.

6.0 Data Description

The data needed for this slope erosion study has been subdivided into the following:

- Slope Erosion Characteristics
- Geology
- Trigger Mechanism
- Utility Impact
- Damage and Repair (Mitigation)

6.1 Slope Erosion Characteristics

6.1.1 Slope Height

The Slope Height is an estimate of the approximate elevation difference in feet, between the head and the toe of the slope, as estimated from field observation. Differences between these estimates and actual conditions may exist. The height and steepness of the slopes at the site varies. The height ranges between 11 to 20 feet and are generally steeper than 1.5 to 1 (Horizontal to Vertical).

6.1.2 Slope Erosion / Failure Type

The slope erosion consists of a general classification of each slope, even though more than one classification may have been involved at a specific location. The classification for the type of slope erosion is based on the site reconnaissance and our interpretation during our site visits. Henceforth, we classify the slope erosion / failure as shallow colluvial and seepage failure.

6.1.3 Size

The size of the slope erosion will depend upon the extent of the ground displacement. Since no topographic as built plans were available, it was difficult in estimating horizontal or vertical extent of the slope erosion. However, based on our visual observation and site reconnaissance of the area, slope erosion was identified at different elevations and at random locations. Please note that the differences between these estimates and actual conditions may exist and will be determined during actual slope erosion repair.

6.1.4 Vegetation

The vegetation describes the vegetative ground cover contained within the slope failure margins based on the field reconnaissance. The vegetation that was observed during our reconnaissance was brush, wooded, sparse cover, trees, and bare ground.

6.1.5 Topography

In general, the topography near the area of the slope erosion / failure appears to be at 1.5 to 1 (Horizontal to vertical). However we could not establish the actual slope due to lack of existing topographic information.

6.2 Geology

The soils encountered during our field investigation mostly appear to be shallow topsoil overlying the weathered bedrock.

6.3 Slope Erosion Mechanisms

Based on our site reconnaissance, it is our professional opinion that the failure appears to be due to excessive surface runoff, disturbance of soil due to general during construction activities, placement of un-compacted / loose soil to dress-up the slope, decomposed vegetation, and installation of utility lines as described below.

6.3.1 Excessive Surface Runoff

Excessive surface runoff which may have been the results of roof runoff, surface runoff due to heavy rain, irrigation of landscaping areas, broken / leaking pipes, trench backfills (Granular backfill) etc.

6.3.2 Erosion of Un-compacted / Loose Soil Due To Construction Activities

Infiltration of moisture on to loose and un-compacted soils that are covering the surface of existing slopes at some locations. The un-compacted soil may have resulted from spreading loose soil over the slope and or by utility installation.

6.3.3 Uncontrolled Roof Run-Off Discharge

Roof Runoff is discharging water onto the pockets of crushed rock and eventually seeping into the underlying soil at the locations of all downspouts and therefore saturating the slope.

6.3.4 Landscape Irrigation / Rain Water On The Upper Portion of Slopes

Irrigation of landscaping areas located on or near the slopes and general surface water introducing additional water to the slopes.

6.3.5 Discharge of Water from Open Drain Outlet

Discharge of drain water from open storage area located to the south of the project.

7.0 Typical Approaches to Improve Stability

We evaluated potential stability improvements, which could be preventive or remedial in minimizing the slope erosion / failure. In general, the methods for achieving suitable stability for a site or project include: 1) Avoiding the slope and 2) improving stability by reducing the forces that cause movement, increasing the forces that resist movement, or a combination of the two. In the following paragraphs, recommendations / measures are provided to minimize the erosion

Recommendations

7.1.1 Removal of Existing Surface and Subsurface Structures / Utilities

Prior to any grading, all existing surface and sub-surface structures that will not be incorporated in the final improvements of the slope shall be removed from the slope repair area. These objects shall be accurately located on the grading plan to assist the Soil Engineer in establishing proper control over their removal. This is to include, but not limited to any existing concrete foundation / footings, utility lines, underground pipes, tree stumps and any other miscellaneous debris. A representative from our firm shall be present during the removal operation for further recommendations as deemed necessary in the field. After the demolition / removal of the existing subsurface structures, debris, and loose soil; the slope shall be graded / tracked walked to reduce the steepness of the existing slope and fill the low areas.

7.1.2 Correction of Existing Conditions – Drainage Improvements

Roof runoff should be directed to a proper discharge facility through closed conduit to minimize water runoff onto the surface of the slopes. No water shall be allowed to flow over the slope. Continuous aerial drains / channels shall be provided adjacent to the walkways, concrete pads extending from the building. They shall be constructed such that the water generated from surface runoff is drained into the channels and from channels into proper discharge facilities. There shall be no gap between the existing concrete pads / walkways for water to seep into the soil. Concrete curb or asphalt berm could also be provided on the top to divert surface water from running to face of the slopes.

7.1.3 Slope Stabilization

The degree of slope erosion varies from one area to another at the subject property. The slope located to the north of the property facing the roadway (See picture 2) is experiencing a higher degree of erosion. Caving and sloughing of soil has been observed in this area which needs to be addressed immediately. To minimize the erosion in this area, we recommend that the loose and unstable soil from the slope be removed and slope surface shall be compacted / track walked and the area be covered with jute netting / or fabric. A base key shall be installed at the toe and along the entire length of the existing slope. The base key shall be a minimum of three feet wide and shall be excavated a minimum of three feet below the existing or proposed grade, whichever governs. The base key shall be graded inward towards the existing slope with a minimum of 2% grade. A six inch diameter perforated PVC pipe (Schedule 40 or higher) encased in fabric and gravel shall be installed as shown in figure 3. The pipe shall have a minimum of ¼ to ½-inch perforations, placed facing down with a minimum of 2% slope in the direction of the downspout location. The pipe shall be placed on a minimum of (3) inches of ½" to ¾" clean angular gravel at the bottom. The drains shall be encased in a filter fabric such as 140N or similar. Clean outs shall be provided at all major bends and every 50 feet on-center. At this time the base-key shall be backfilled with ¼ ton rip-rap as shown in Figure 3, and rip-rap shall continue all the way to the top of the slope (Please refer to figure 3). The jute netting / fabric shall be carried into the base-key and wrapped as shown on figure 3. The perforated pipe and gravel shall be extended all the way to the existing catch basin at the bottom of the hill. If trees and other plants are obstructing the site, the perforated pipe can be terminated in a new catch basin and a solid pipe from this catch basin can carry the water to the lower catch basin at the site. The lower catch basin shall be connected to the existing storm facility for proper discharge of the water as designed by the Project Civil Engineer. The open slopes shall be hydro-seeded immediately after the rip-rap is placed.

Please note that this operation shall be performed during dry weather condition.

In general, on-site granular soil generated from the excavation with an organic content less than 3% by volume and free of any vegetation or hazardous substances may be used as engineered fill to achieve the proposed grades. Any import fill material shall comply with the following:

Resistance R-Value	Not less than 25
Plasticity Index	20 or less
Liquid Limit	30% or less
Expansion Index	20% or less
Percent Passing Sieve #200	between 10 and 20%
Maximum rock size	(3) inches

All fill material shall be approved by the Project Soil Engineer, prior to hauling it to the site. All grading work shall be observed and approved by the Soil Engineer. The Soil Engineer shall prepare a final report upon completion of the grading operations. It is recommended that the grading plan shall be reviewed by Advance Soil Technology, Inc. to ensure conformance / compliance with the requirements of this report. The Soil Engineer shall be notified at least two days, prior to commencement of any grading operations so that he may coordinate the work in the field with the contractor.

8.0 General Maintenance Consideration For Drainage

The following section of this report provides a general field procedure to minimize erosion of the existing slope, areas adjacent to the buildings foundations / slabs and general improvement to the drainage.

8.1.1 Subsurface Water Seepage

Drainage measures usually are most effective when they intercept groundwater at the contact between the relatively permeable soil and the underlying less permeable soil. The application of an interceptor trench sub-drain and a springhead drain, both improve stability by intercepting the water seepage in a potentially unstable slope area, thereby reducing the driving forces and increasing the soil strength. The springhead drain is used to collect water that emerges from the slope in a concentrated area, thereby reducing erosion potential and improving stability. Trench sub-drains generally are applicable to slopes where the contact with the underlying low permeability material is relatively shallow. An interceptor trench sub-drain is installed on the upper section across the slope along the road to intercept the water seepage before it reaches the road / slope face. Another type of trench sub-drain, called a finger drain, it is similar in construction to an interceptor trench sub-drain, except that it is installed along the slope fall line (perpendicular to slope contours).

8.1.2 Utilities

Buried utilities can affect the stability of the slopes they are built on, into, or adjacent to. The presence of a buried utility can act either to enhance or reduce stability. For example, a utility trench could be designed and built to act as a trench sub-drain that would remove groundwater from a slope, thereby improving the stability. The same utility trench, if not properly graded, covered, or drained, could provide a conduit to rapidly convey surface and/or groundwater to a critical portion of a slope, and then infiltrate the water at that location.

For another example, low permeability pavements typically inhibit infiltration of surface water into the groundwater, thereby improving stability. However, if the storm water system is inadequate or not present, then uncontrolled, concentrated surface water runoff can discharge onto a slope and reduce its stability. This section presents recommendations and typical design concepts for using buried utilities and streets to improve stability. For instances where stability improvements are not practical, this section makes recommendations for minimizing the destabilizing effects.

We recommend the following consideration of these types of improvements when building a new street, performing maintenance, or when rebuilding an existing street. The following sections provide typical details and design recommendations regarding these improvements.

8.1.3 Reduce Infiltration

Most paved areas have low permeability asphalt concrete or Portland cement concrete. As such, paved areas tend to reduce infiltration into the subsurface. Where reducing infiltration could improve stability, we recommend adopting the following measures:

1. Use low permeability pavements. Do not use pavement materials that are designed to allow rapid infiltration of surface water.

2. Design the pavement section for a high degree of reliability and long service life to reduce deterioration and cracking that would increase the permeability of the pavement surface.

3. The performance of a pavement depends largely on the condition of the subgrade. Therefore, subgrade improvements should be made where practical, such as with new streets or major renovations and repairs. Subgrade improvements include over excavating soft, loose, and compressible soil until undisturbed, firm, and unyielding native soil is exposed. Any backfill or embankment fill materials should be placed and compacted in accordance with the ASTM Standard Specifications; except that all fill material should be compacted to at least 95 percent of the maximum dry density (American Society for Testing and Materials Procedure [ASTM] D 1557.

4. Perform regular inspections and maintenance to detect and seal significant cracks, if necessary. Evaluate the subgrade in areas of chronic cracking. Correct soft or loose subgrade conditions that lead to poor drainage and/or cracking, if found to be needed.

5. Provide adequate storm water drainage system. Grade pavement surfaces as may be found needed to promote rapid runoff and to prevent ponding.

8.1.4 Storm Water Runoff Control

Storm water runoff from structures, walkways and other low permeability surfaces, including areas of low-permeability soil, is sometimes a contributing factor to landslides. The following measures can be used to reduce the flow of storm water from streets onto or adjacent to slopes:

1. Provide curbs and / or lined storm water ditches to prevent runoff onto or adjacent to slopes. Curbs or ditches should be designed to contain and convey all runoff to a storm sewer or other

appropriate facility. In some cases, curbs that are higher than normally built could be effective in controlling runoff in landslide-prone areas. The capacity of the ditch or curb should take into account the design storm, and reasonable allowances for reductions in capacity from debris and/or melting snow or ice.

2. AST does not recommend constructing unlined ditches to convey storm water runoff in slope eroded -prone areas.
3. Grade streets to drain into storm catch basins. Provide curbs and berms as needed to ensure proper runoff into the catch basins.
4. Educate and enlist the assistance of maintenance staff regarding storm drainage facilities. They could perform simple surface cleaning of debris.
5. Regularly inspect and maintain curbs, ditches, and storm drains.

8.1.5 Subsurface Drainage

Subsurface drainage can be incorporated during construction and / or renovation of streets and adjacent storm water ditches. In general, subsurface drainage associated with streets would fall into two general categories: trench sub-drains built under or adjacent to a street and a drained pavement base course. A drained pavement base course can intercept shallow groundwater and surface water that infiltrates through the pavement surface. It can improve stability of slopes below the road to the extent that groundwater is intercepted and infiltration is reduced. Usually, this type of shallow drainage will have the greatest benefit in improving the stability of roadway embankment fills. However, in areas of shallow groundwater, drainage in the base course can effectively drain natural slopes. While not related to slope stability, well-drained pavements generally perform better and have a longer service life. A drained pavement base course is constructed in the same manner as a normal base course, with the following exceptions:

1. Grade the pavement subgrade to drain into a perforated or slotted collector pipe. The collector pipe should be constructed in the same manner as a trench sub-drain.
2. The collector pipe should be graded to drain to a suitable discharge point, such as a storm sewer. It should not be allowed to discharge directly onto the surface.
3. Cleanout points should be provided for the collector pipe, and a regular cleaning and maintenance program adopted.
4. The base course aggregate should meet the requirements Cal-Tran Standard Specifications with the following additional requirements.
5. The aggregate should not have more than 3 percent passing the No. 200 mesh sieve, based on the minus 3/4-inch fraction in a wet sieve analysis (ASTM D 422).
6. The aggregate should also meet filter criteria with respect to the underlying subgrade soil. A non-woven filter fabric could be placed between the subgrade and the drainage base course layer in lieu of using a base course aggregate.

Trench sub-drains associated with roadway / drive thru area would not be substantially different in their application and construction from those mentioned in the above sections. Roadways / drive thru areas in slope failure-prone areas are generally parallel to the slope. As such, they are well suited for constructing a groundwater cutoff trench sub-drain, either in or adjacent to the street. A groundwater cutoff trench sub-drain could be particularly effective in improving the stability of an embankment fill that was placed over a soil with relatively low permeability, such as clay or a fine-grained colluvium. It could also effectively dewater relatively permeable colluvium that overlies clay or other low permeable soil.

A trench sub-drain could be built either in the roadway, and then paved over, or on the upslope side of the roadway. If a storm water drainage ditch is being excavated next to the roadway, a trench sub-drain could be incorporated. The trench would be excavated to the depth needed for the sub-drain. The trench sub-drain materials would be placed and then covered with a low permeability liner material for the storm water ditch. As with all subsurface drainage, the collector pipes should discharge to a suitable location, such as a storm sewer. The system should include provisions for periodic inspection and cleaning. The district should adopt a regularly scheduled program for inspecting, cleaning and maintaining of the subsurface drainage.

9.0 Utility Trench Considerations

In most cases, buried utilities are placed in trenches that are subsequently backfilled to restore the original grades. For these cases, slope stability improvements are mostly limited to subsurface drainage as described in the previous section. However, in certain circumstances, grading improvements could be made in conjunction with placing utilities. In most cases, grading improvements would be made when desirable for maintaining stability of the proposed utility installation. For example, excavations could be made at the top of a slope to reduce the driving forces of a marginally stable slope in conjunction with installing a pipeline. Lightweight fill materials can be effective in improving stability or reducing adverse effects when a fill is needed mid slope or at the top of a slope. As mentioned previously, the stability of any fills or excavations should be evaluated to demonstrate that the stability both above and below the proposed grading is not adversely affected. Large utility excavations that extend below a landslide failure surface or potential failure surface could be backfilled with compacted angular aggregate to form a shear key.

9.1.1 Buried Utilities

Buried utilities, such as water, irrigation lines, sewer, and storm drainage pipes and electrical and communication lines, could be used to improve the stability of a slope by providing subsurface drainage. In some cases, grading changes could be made when a buried utility is installed that could also improve stability. In some cases, buried utilities have triggered landslides. These cases include pipe leaks and breaks, and possibly when groundwater is conveyed to a marginally stable slope in the trench backfill. The following sections describe methods to improve slope stability associated with buried utilities, including:

- Subsurface drainage
- Groundwater control methods
- Old buried utilities
- Grading improvements
-

9.1.2 Subsurface Drainage

A buried utility trench could also be used as a trench sub-drain. In general, the use and design of a trench sub-drain that is associated with a buried utility is the same as discussed above. The utility location limits where drainage can be installed. Therefore, the potential effectiveness of such drainage as well as the possibility for conveying groundwater into an inappropriate location should be carefully evaluated. In addition to the above-mentioned recommendations, we recommend that trench sub-drains constructed in conjunction with a planned buried utility include the following elements:

1. The trench sub-drain should extend all the way through saturated or potentially saturated soil. Portions of the utility trench that are excavated in permeable, unsaturated soil should be backfilled with clay or another low permeability material. The collector pipe should be connected to a tight line through such permeable trench sections. If a perforated pipe was placed in unsaturated permeable soil, water could flow from the perforated pipe into the soil it was intended

to drain. Under these circumstances, the trench sub-drain could actually reduce the stability of a slope.

2. A slotted or perforated collector pipe should be included as part of the trench sub-drain system. It should be designed with sufficient capacity to convey the anticipated groundwater inflow.
3. Concrete or clay dams should be built wherever perforated pipes are connected to tight lines. The concrete or clay dams will force the water into the tight line and prevent water from moving along the outside of the tight line.
4. The trench and the collector pipe should be continuously graded to drain so there are no low spots where water would tend to pond.
5. The trench backfill, collector pipe and native soil should be compatible with respect to filter criteria to prevent piping of fines that could cause loss of ground or clogging of the collector pipe.
6. Provide cleanouts and provisions for maintaining the collector pipe.
7. Install piezometers along the utility trench to verify that the trench sub-drain is functioning as intended. The monitoring wells should be used to determine when maintenance is required.

9.1.3 Groundwater Controls

Some slope failures have been attributed to buried utilities. Usually, these instances involve a pipe leak or break in a water, sewer, or storm drainage line. The following section provides recommendations for constructing pipes in landslide prone areas. The utility bedding and / or trench backfill can also provide a path for groundwater to migrate to a slope failure area. In such cases, bedding and trench backfill for utilities should be made in a manner that either does not change the drainage characteristics of the soil, or in a way that inhibits groundwater migration to the slope. This section provides recommendations for constructing buried utilities to prevent groundwater migration to potential slope failure zones.

Buried utilities can provide an adverse path for groundwater migration under the following circumstances:

1. The backfilled trench passes through saturated soil, i.e., a groundwater source, and then into an area of unsaturated permeable soil that is marginally stable.
2. The pipe bedding and / or trench backfill is more permeable than the native soil, but is not sufficiently well-drained to maintain groundwater levels in the backfill that are below the groundwater level in the adjacent native ground.
3. The trench is not continuously graded, so there are low areas where water can infiltrate from the pipe bedding or trench backfill into the native ground.
4. The trench backfill is not covered with a low permeability soil at the surface, thereby allowing surface water to infiltrate into the permeable backfill.

Water can migrate along a buried utility either in a permeable backfill material, or along small voids between the pipe and the backfill material. The latter process, piping, can also result in ground loss by erosion of the backfill material around the pipe. The following measures can reduce the potential for undesirable groundwater migration along a buried utility.

1. When possible, always backfill the trench with native soil to a minimum of 95% relative compaction. This should result in a trench backfill that is hydraulically similar to the undisturbed ground.
2. Backfill the upper 1 to 2 feet of a utility trench with low permeability soil to reduce surface infiltration. In landscaped areas, mound the backfill soil over the trench and grade the surrounding area to promote runoff away from the trench and to reduce the possibility of ponding.

3. Install concrete or clay dams at intervals along the pipe to prevent groundwater flow in the pipe bedding and/or backfill. Concrete or clay dams can also reduce the potential for piping.

4. Pervious granular bedding material is often required for certain types of pipes. In these cases, consider alternate pipe materials or install a sufficient number of concrete or clay dams to prevent groundwater migration into sensitive areas. If possible, collect water from behind the concrete or clay dams with a tight line.

5. Install utilities above ground.

6. Provide subsurface drainage at key points. For example, a trench sub-drain could be installed where saturated soil is encountered in the utility excavation. A concrete or clay dam should be installed at the end of the trench sub-drain section to force the groundwater into the collector pipe and to prevent further groundwater migration along the buried utility.

9.1.4 Old Buried Utilities

Old buried utilities / existing pipelines and especially irrigation lines or lines constructed using bedding with placement of pipe in pea gravel at the bottom of the trench or around the pipe could contribute to the slope instability. This pea gravel bedding material has a relatively high permeability that provides the capacity to convey potentially large volumes of water. If water is conveyed out of a potentially unstable slope, the stability of the slope is improved. However, the opposite can also occur and that is, pea gravel pipe bedding can act as a conduit to rapidly convey water into an unstable slope, thereby reducing the stability of the slope. We recommend establishing a program to evaluate buried utilities that are in or adjacent to slope failure-prone areas. Those that may have pervious bedding and / or backfill material, and especially pea gravel pipe bedding, should be further evaluated to determine if they have the potential to adversely affect slope stability. For buried utilities that could adversely affect slope stability, we recommend the following:

1. If the utility is old and close to its design life, consider early replacement. The replacement utility should be designed to improve subsurface drainage and to prevent adverse groundwater migration. If this alternative is selected, the old buried utility should be excavated to remove pervious bedding and / or backfill materials.

2. Install concrete or clay dams at key locations to prevent water migration along the pervious bedding and / or backfill material. If possible, drainage should be installed at each concrete or clay dam location to collect and convey the water to a suitable discharge location.

3. Install adjacent drainage to intercept water that the buried utility may convey into a marginally stable slope. Such drainage could include trench sub-drains that are located down gradient from the buried utility.

4. Grout the pipe bedding and/or backfill to reduce the permeability. While this alternative may be technically feasible, it is also relatively expensive. Therefore, we anticipate that it would be used only for relatively short sections where other alternatives are not practical.

10.0 Other Considerations

Slope Failure prone areas pose a breaking or rupture hazard to buried utilities. Water and irrigation lines, sewers, and storm drains that are damaged by ground movement can cause leaks that further exacerbate the unstable conditions. Therefore, before installing new buried utilities, the utility route should avoid areas where ground movement is likely. Where these areas cannot be avoided, several alternatives could be considered as may be appropriate to reduce the likelihood of damage. These include:

1. Install the utilities above ground. Above ground installations generally are less susceptible to damage from relatively small ground movements. Also, they can be readily inspected for damage. Storm drainage and communication lines are particularly well suited to above ground installations.

2. Use materials that are more tolerant to ground motion. For example, bell and spigot concrete pipe is sensitive to relatively small movement as compared to HDPE pipe that has fused joints.

3. Install flexible connections and joints that also allow for some extension or compression.

11.0 Special Construction Requirements

The final exterior grade adjacent to the proposed structures shall be such that the surface drainage will flow away from the structures. Rainwater discharge at down spouts must be directed on to pavement sections or other acceptable facilities, which will prevent erosion in the soil adjacent to the foundations. Surface water should not be permitted to pond or flow adjacent to the slopes. One way to alleviate this condition is to grade the ground surface (with a minimum of 2% slope) adjacent to the proposed structures such that water flows away from the foundation and the slabs. In addition, roof down spouts and surface interceptor drains shall be provided to carry off all excess waters to a proper discharge facility. It is very important that all future occupants properly maintain drainage systems. In landscape areas, to minimize moisture changes in the natural soils and fills, we recommend the usage of drought resistant plants and / or a drip irrigation watering system. In addition, the plants for landscaping, including trees shall be planted at a minimum distance of one-half the anticipated mature height of the tree from slabs or pavements.

12.0 Limitation and Uniformity of Conditions

The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed at the locations of the borings drilled at the site. In the event that any unusual conditions not covered by the special provisions of this report are encountered during any phase of the construction, or if the proposed construction differs from that covered in the report, our office should be notified so that supplemental recommendations can be provided.

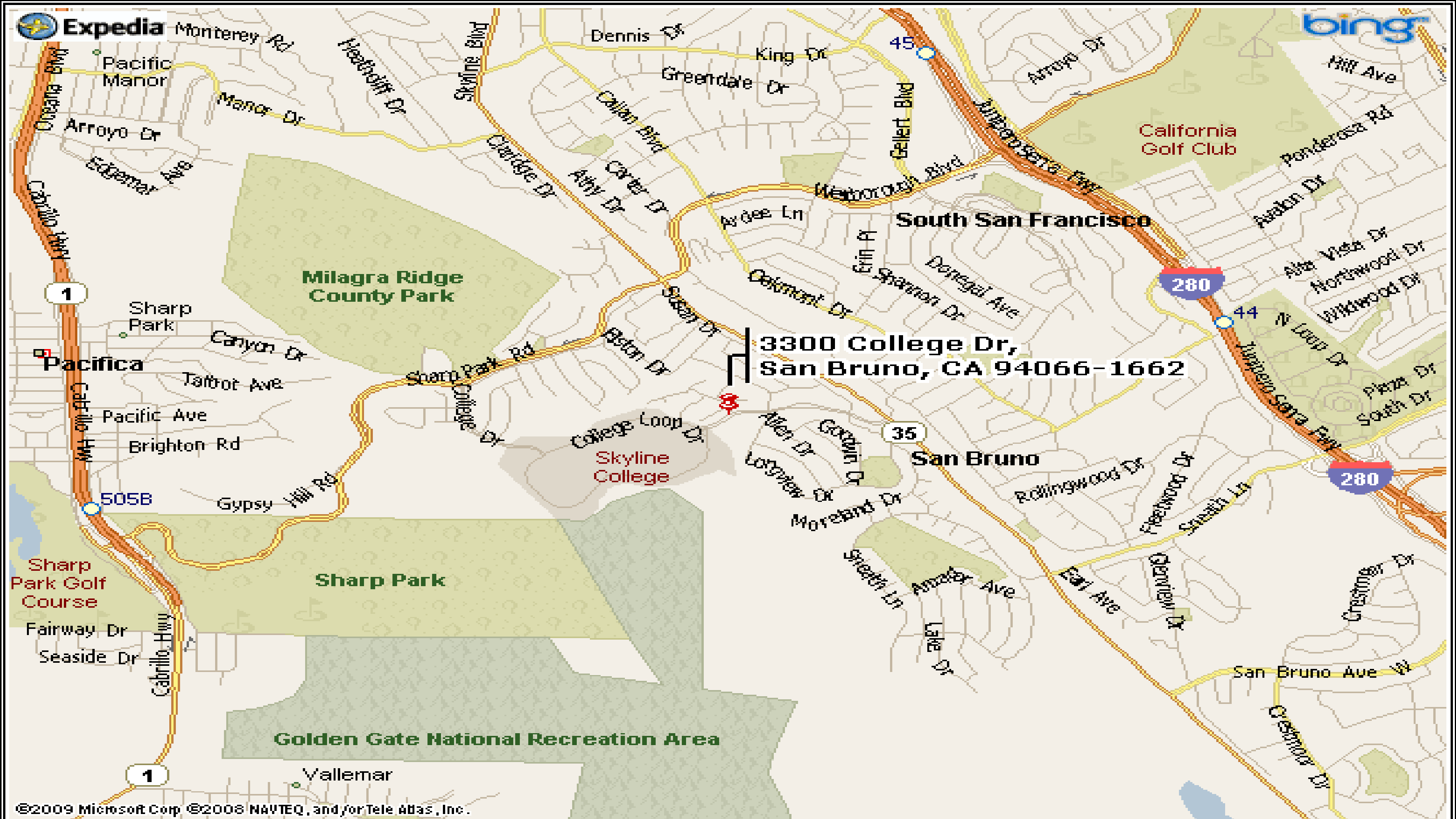
This report is issued with the understanding that it is the responsibility of the owner or of his representative, to ensure that the information and recommendations of this report be incorporated into the plans by the architects and engineers for the project, and that the necessary steps are taken to assure that the contractors and sub-contractors carry out such recommendations in the construction of the project.

The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they may be due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated, wholly or partially, by changes outside our control. This report should therefore be reviewed in the light of future planned construction and the current applicable codes.

The conclusions and recommendations presented in this report are professional opinions derived from current standards of geotechnical practice and no warranty is intended, expressed or implied. This report is the property of Advance Soil Technology, Inc. and has been prepared for the exclusive use of our client San Mateo County Community College District.

APPENDIX "A"

Vicinity Map
Site Plan
Cross Section – Slope Erosion Repair
Laboratory Gradation Test Results
Table I – Moisture / Atterberg Limits Test
Pictures



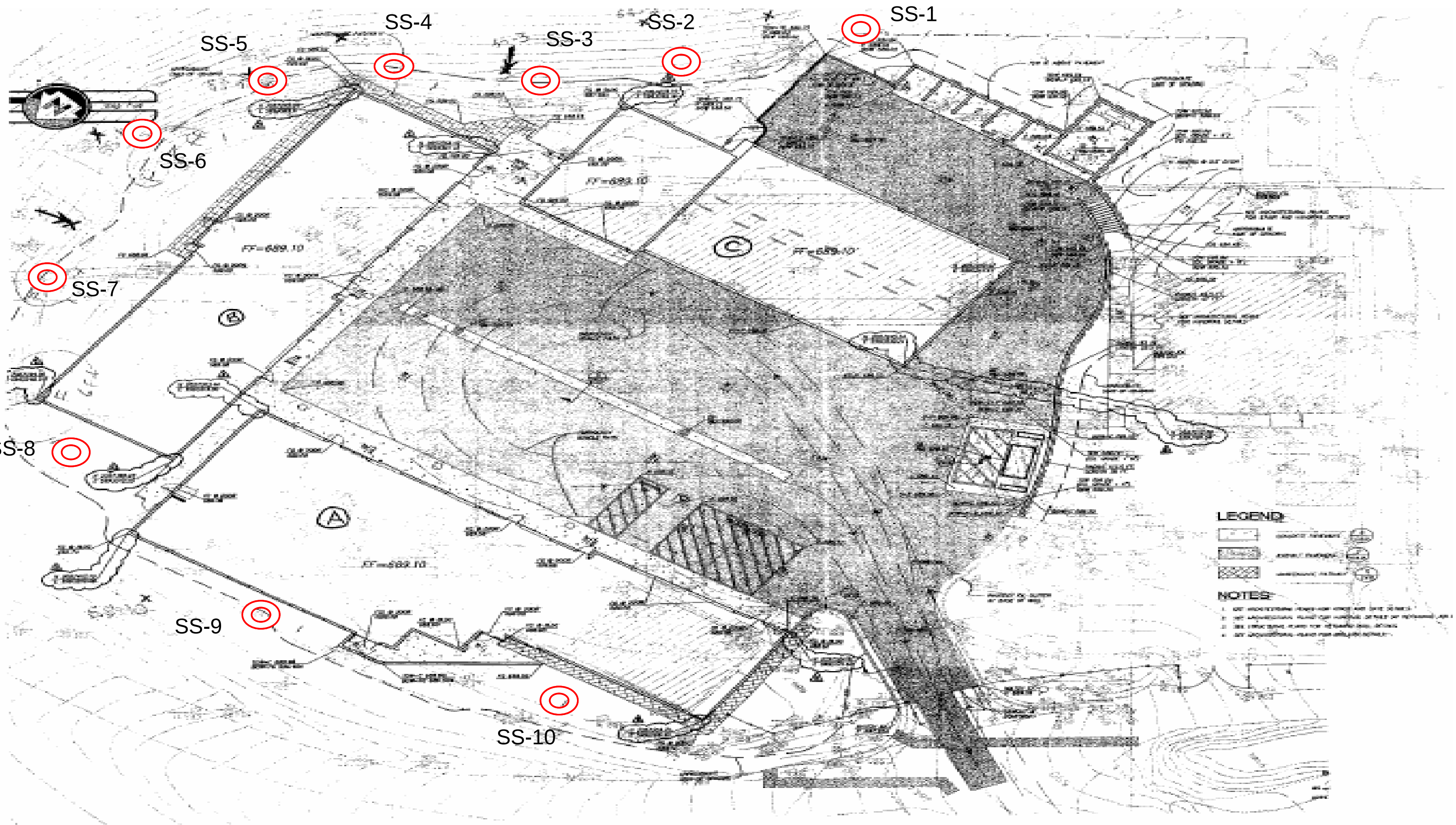
VICINITY MAP

ADVANCE SOIL TECHNOLOGY, INC.

Date: September 2009	N.T.S.	Figure: 1	File No. 09504-Slope

Skyline College - FMC Facility

3300 College Drive -San Bruno, California



Base Plan: SANDIS

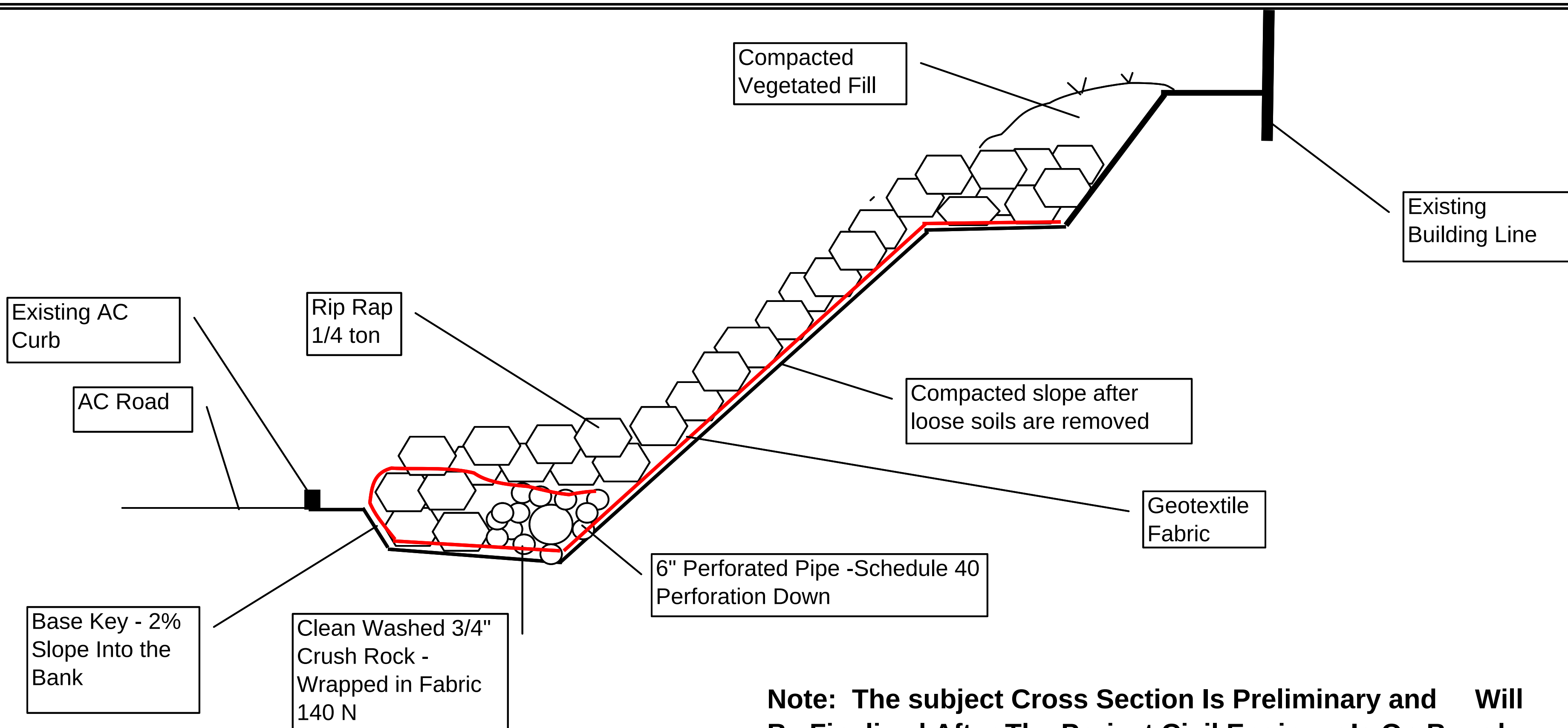
Approximate Locations Of Soil Samples

ADVANCE SOIL TECHNOLOGY, INC.

Date: August 2009	N.T.S.	Figure 2: Site Plan File No. 09504-Erosion

FMC FACILITY - SKYLINE COLLEGE

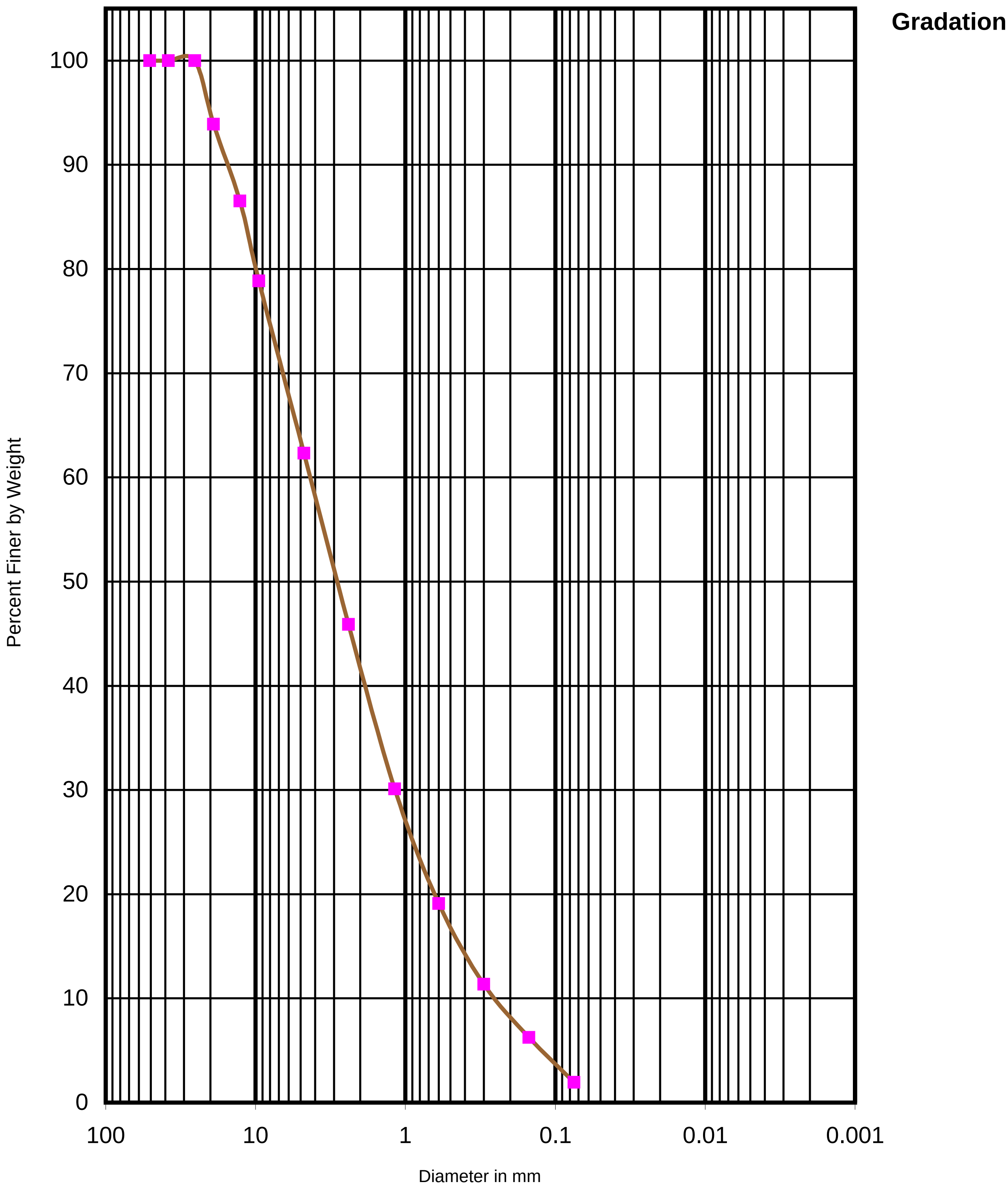
3300 College Drive, San Bruno, California



Note: The subject Cross Section Is Preliminary and Will Be Finalized After The Project Civil Engineer Is On Board and Civil Engineering Issues Are Discussed In Detail.

FIGURE 3- CROOS SECTION

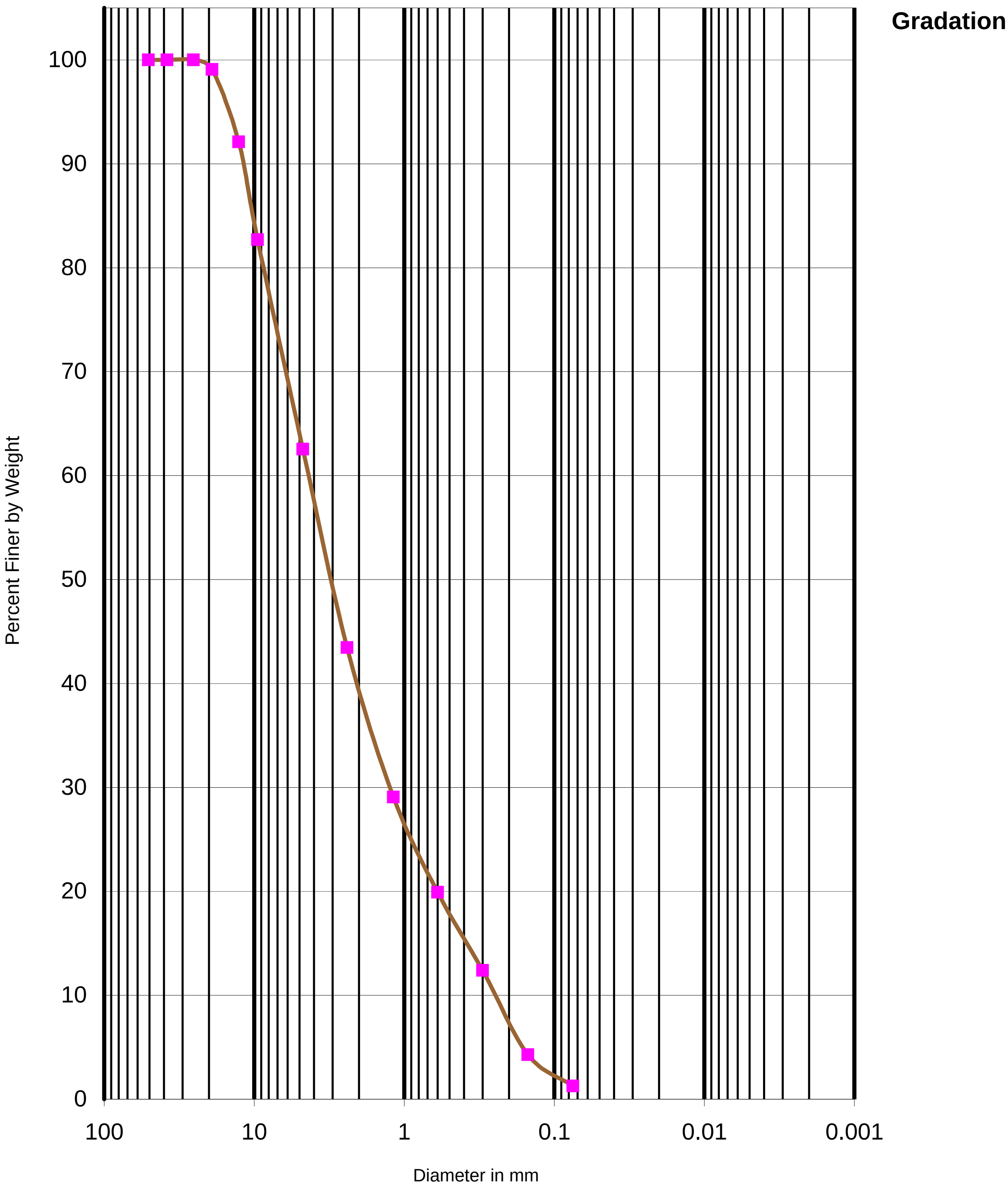
ADVANCE SOIL TECHNOLOGY, INC.		
Date: August 2009	N.T.S.	File No. 09504-Erosion
FMC Facility - Skyline College 3300 College Drive - San Bruno, California		



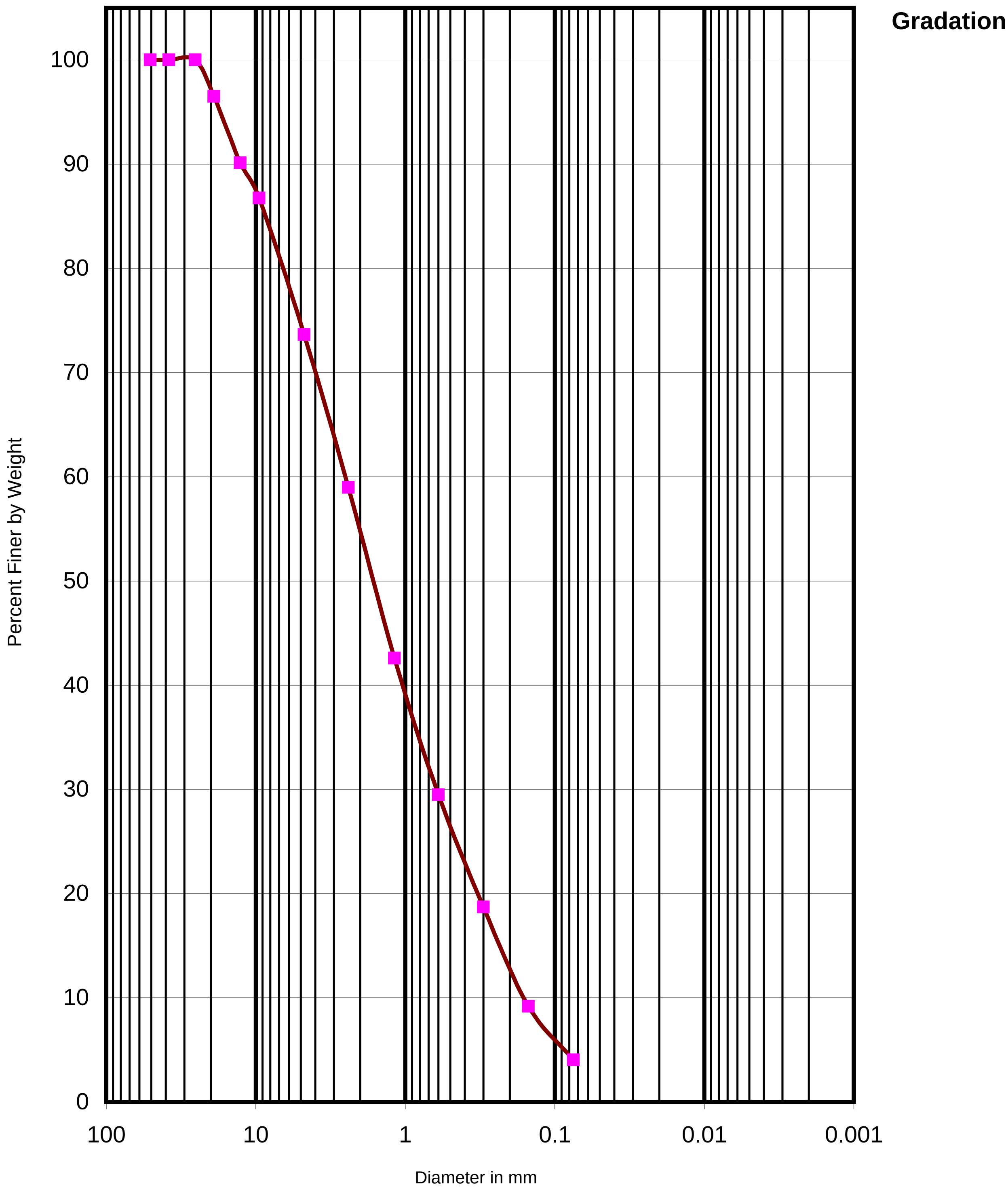
GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

SS-1 / 1-1(Surface 0-12 inches)	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 4	File. 09504-Erosion



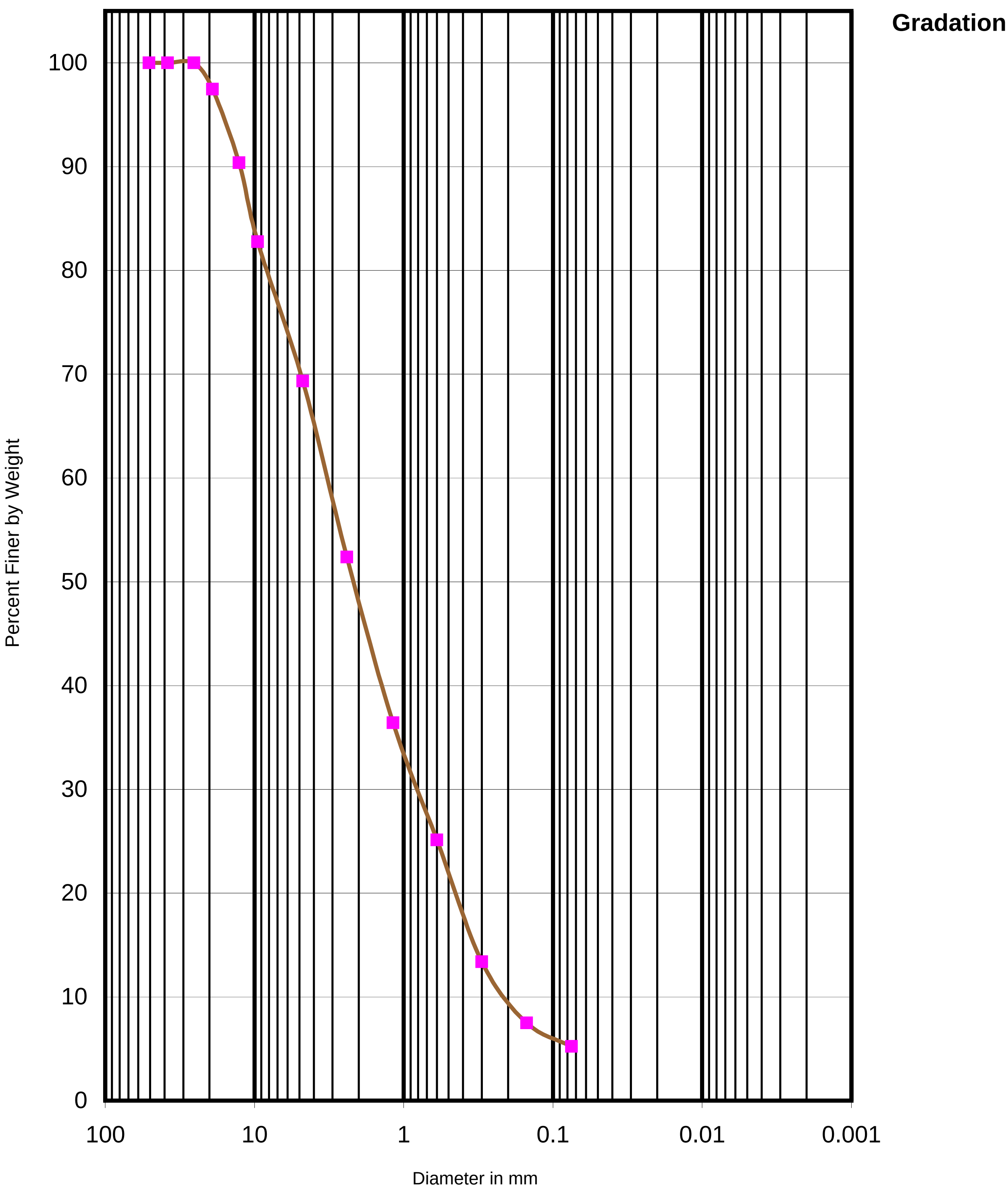
GRADATION CURVE			
FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca			
SS-1 / 1-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 5	File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

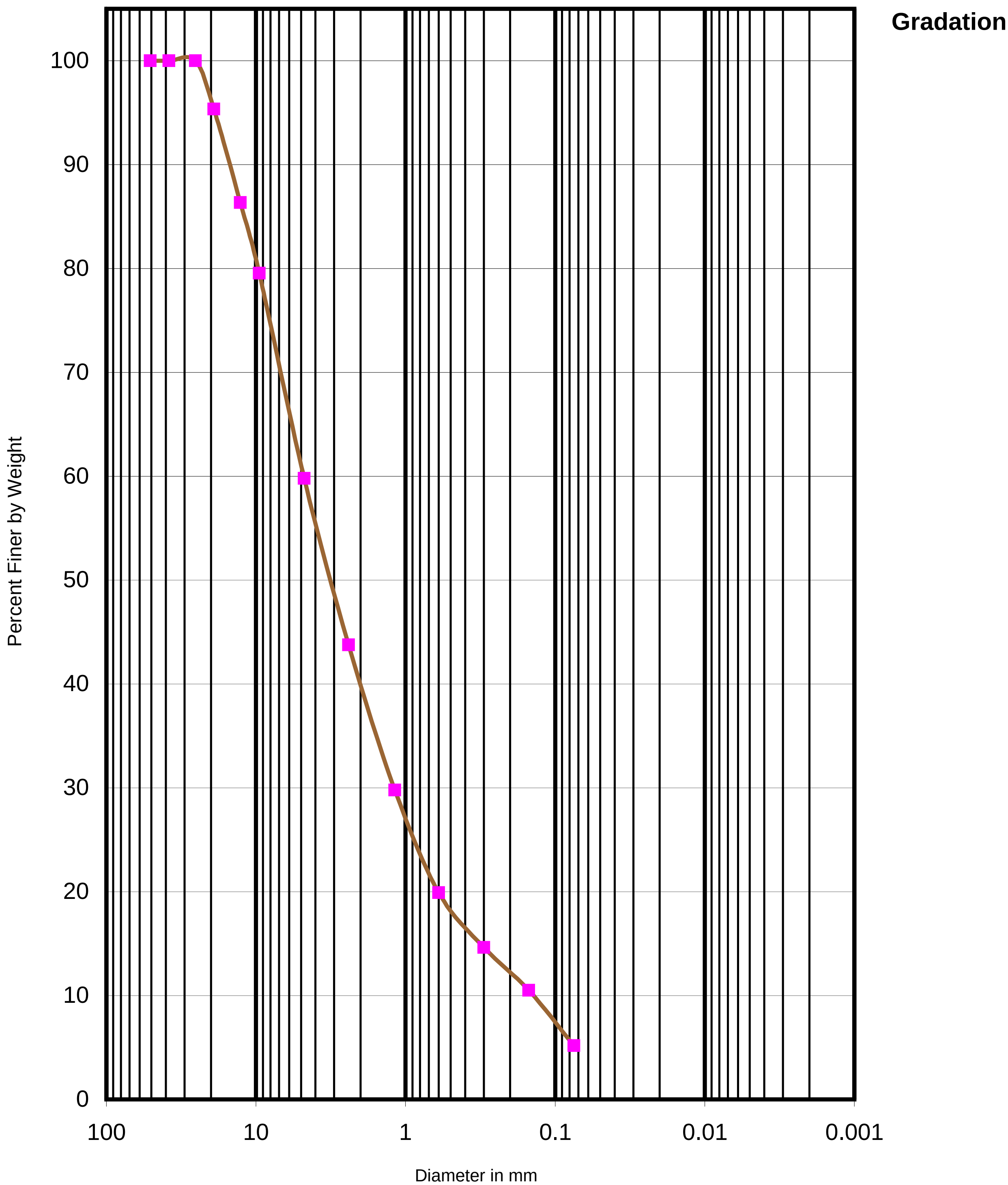
SS-2 / 1-1 (Surface 0-12")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 6	File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

SS-3 / 1-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.
	Date: August 2009 / Figure: 7 / File. 09504-Erosion



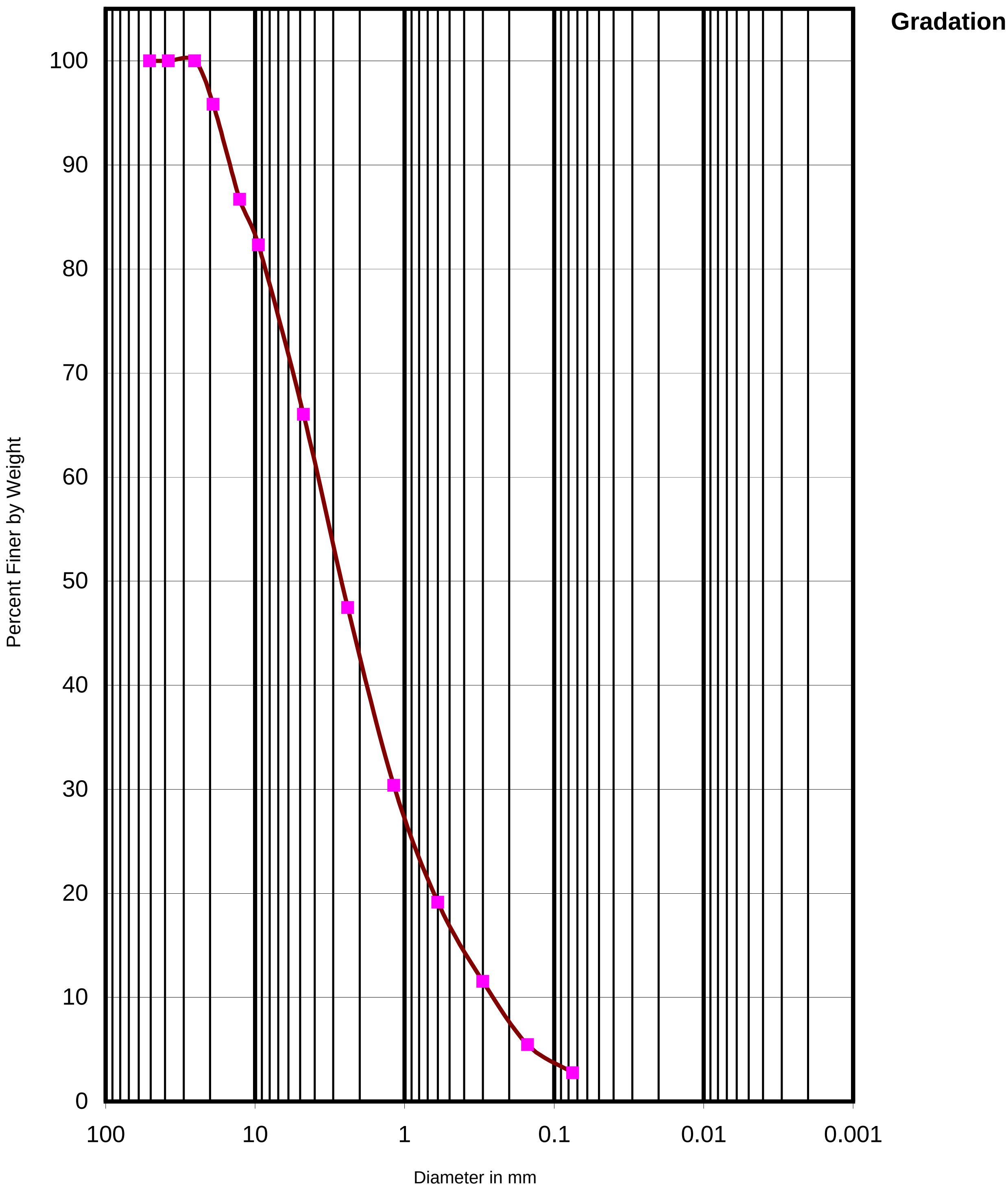
GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

SS-4 / 1-1 (Surface 0-12")

ADVANCE SOIL TECHNOLOGY, INC.

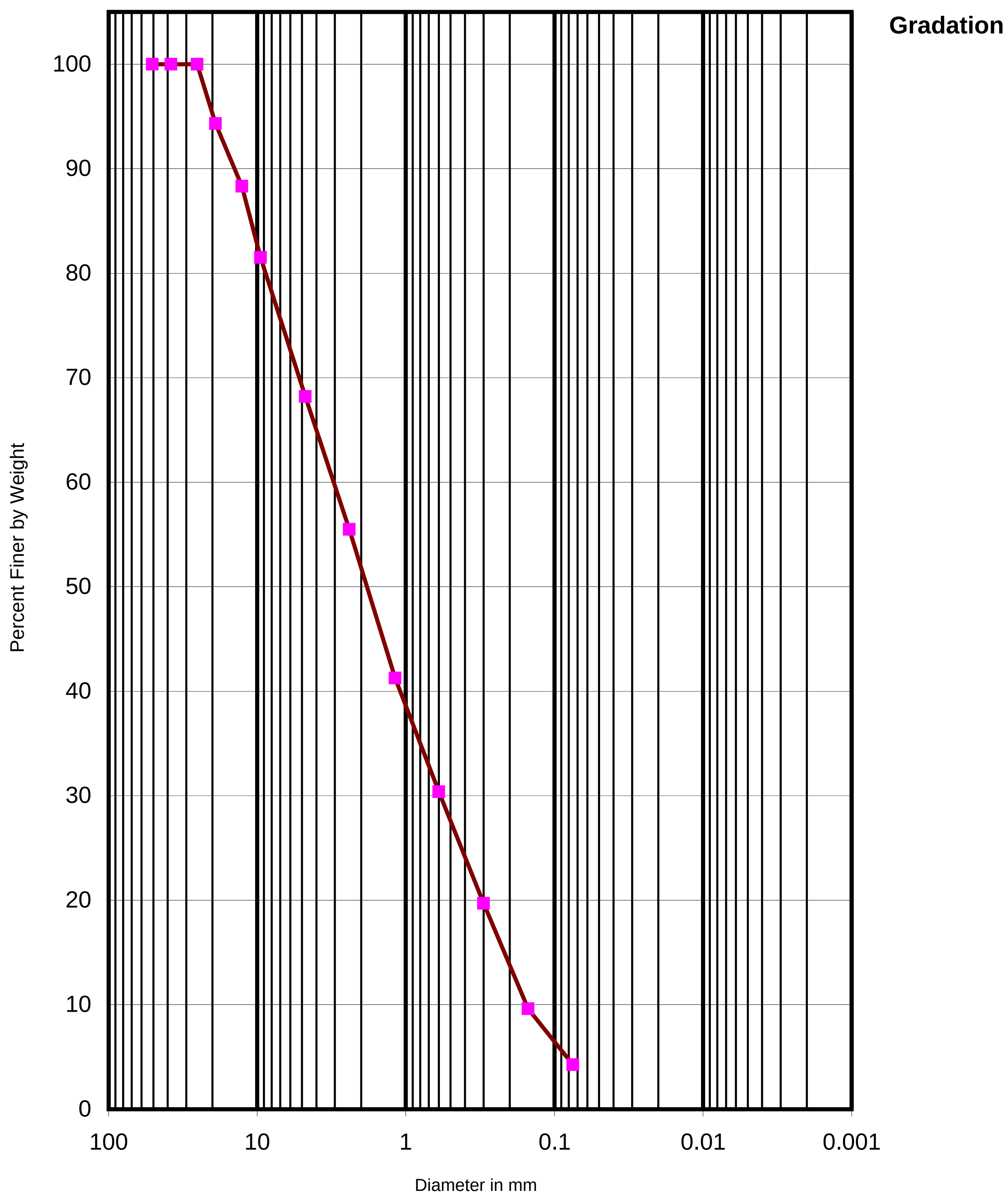
Date: August 2009 | Figure: 8 | File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

SS-4 / 1-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 9	File. 09504-Erosion

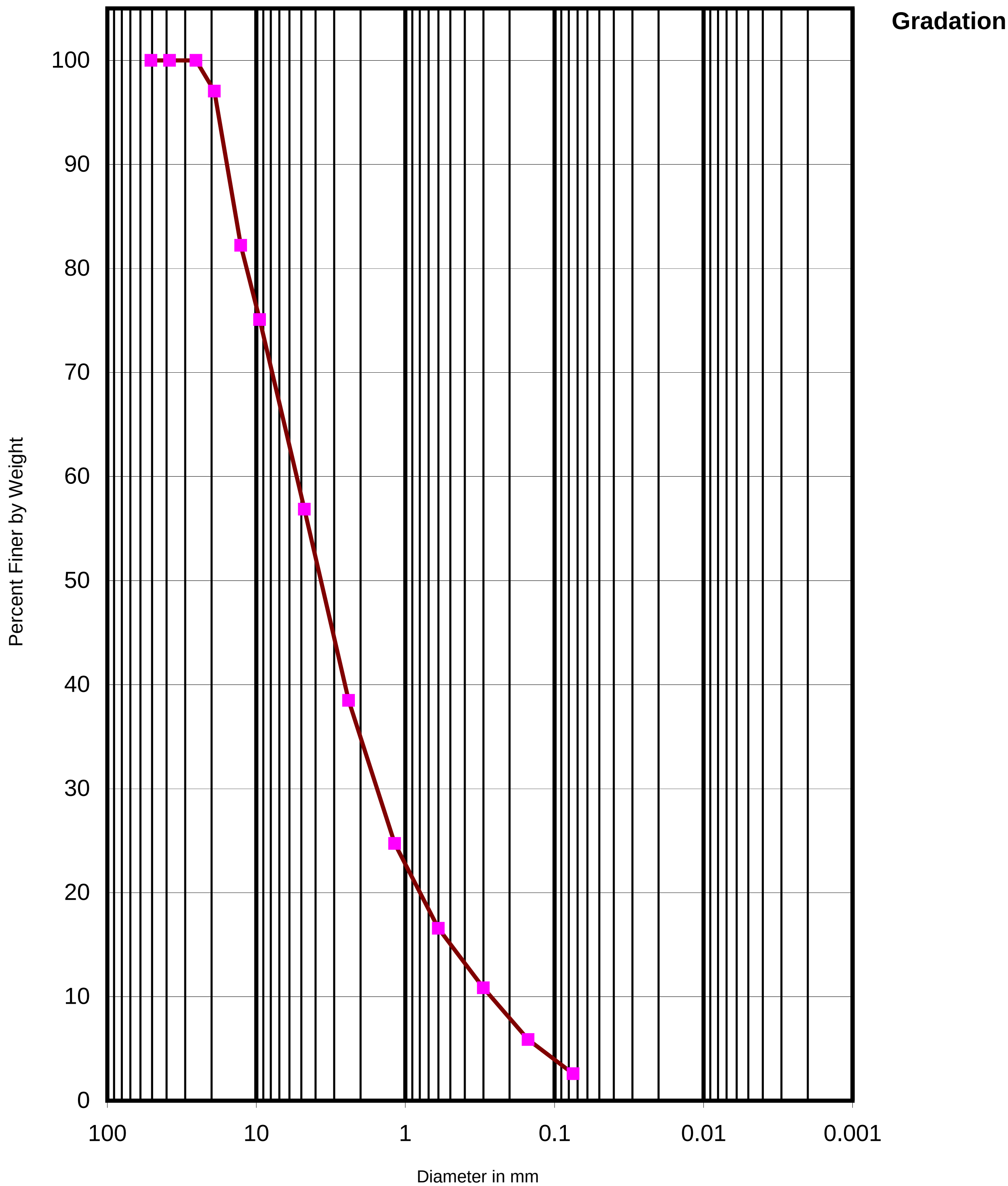


GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

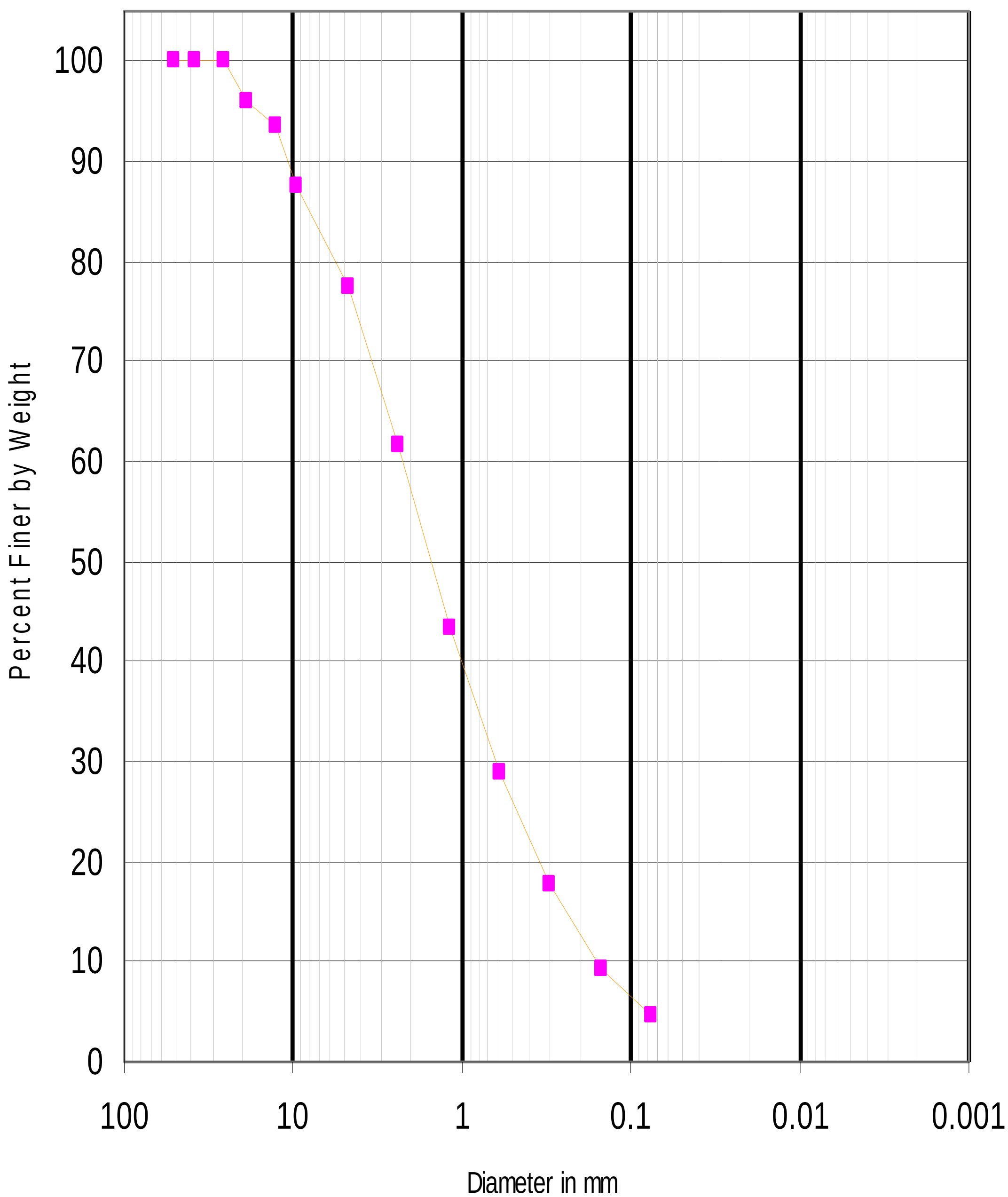
SS-5 (Surface 0-12")	ADVANCE SOIL TECHNOLOGY, INC.
	Date: August 2009 | Figure: 10 | File. 09504-Erosion

Advance Soil Technology, Inc.



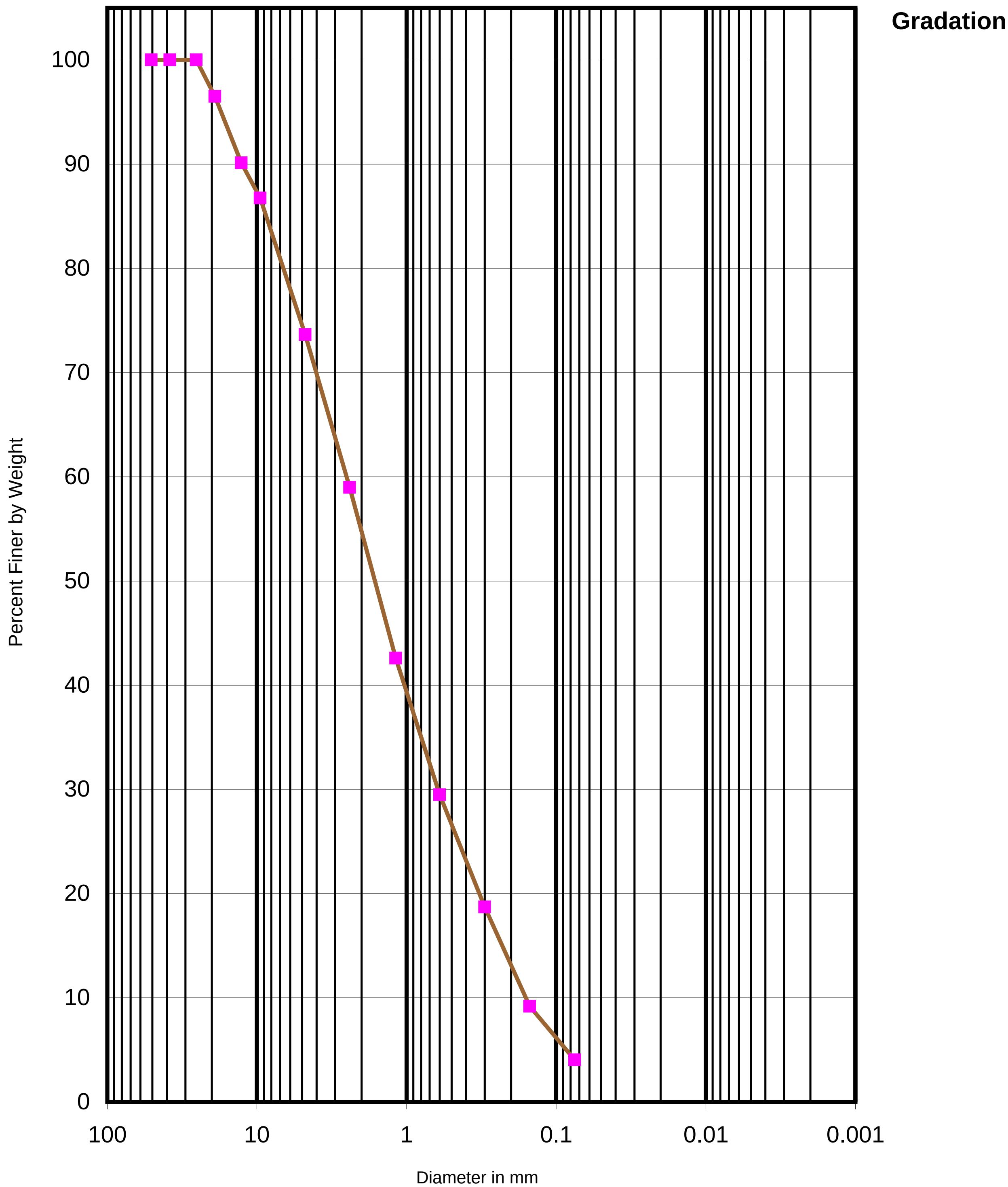
GRADATION CURVE			
FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca			
SS-5 / 5-2(24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 11	File. 09504-Erosion

Gradation



GRADATION CURVE
FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

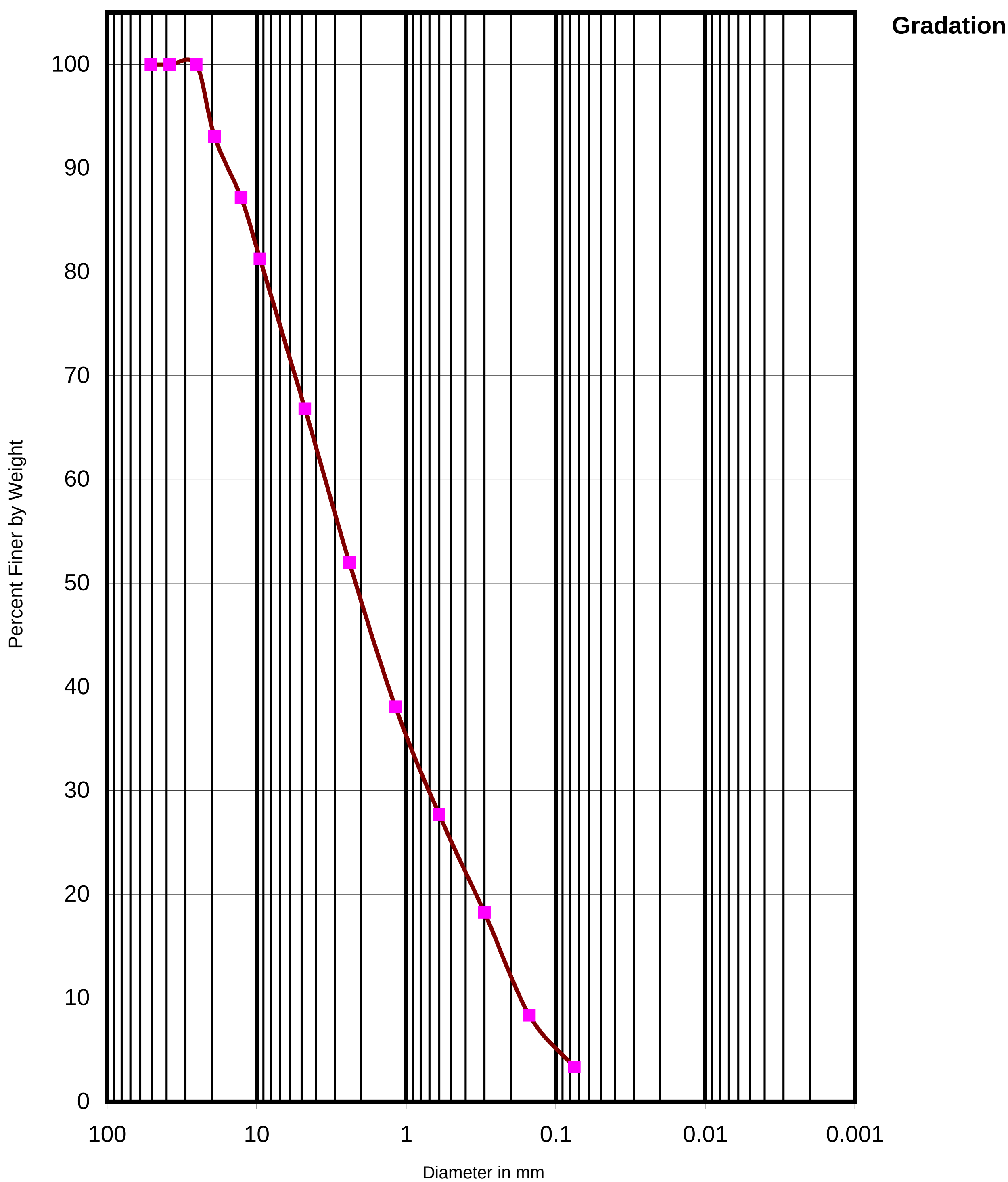
SS-6 / 6-1(surface 0-12")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 12	File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

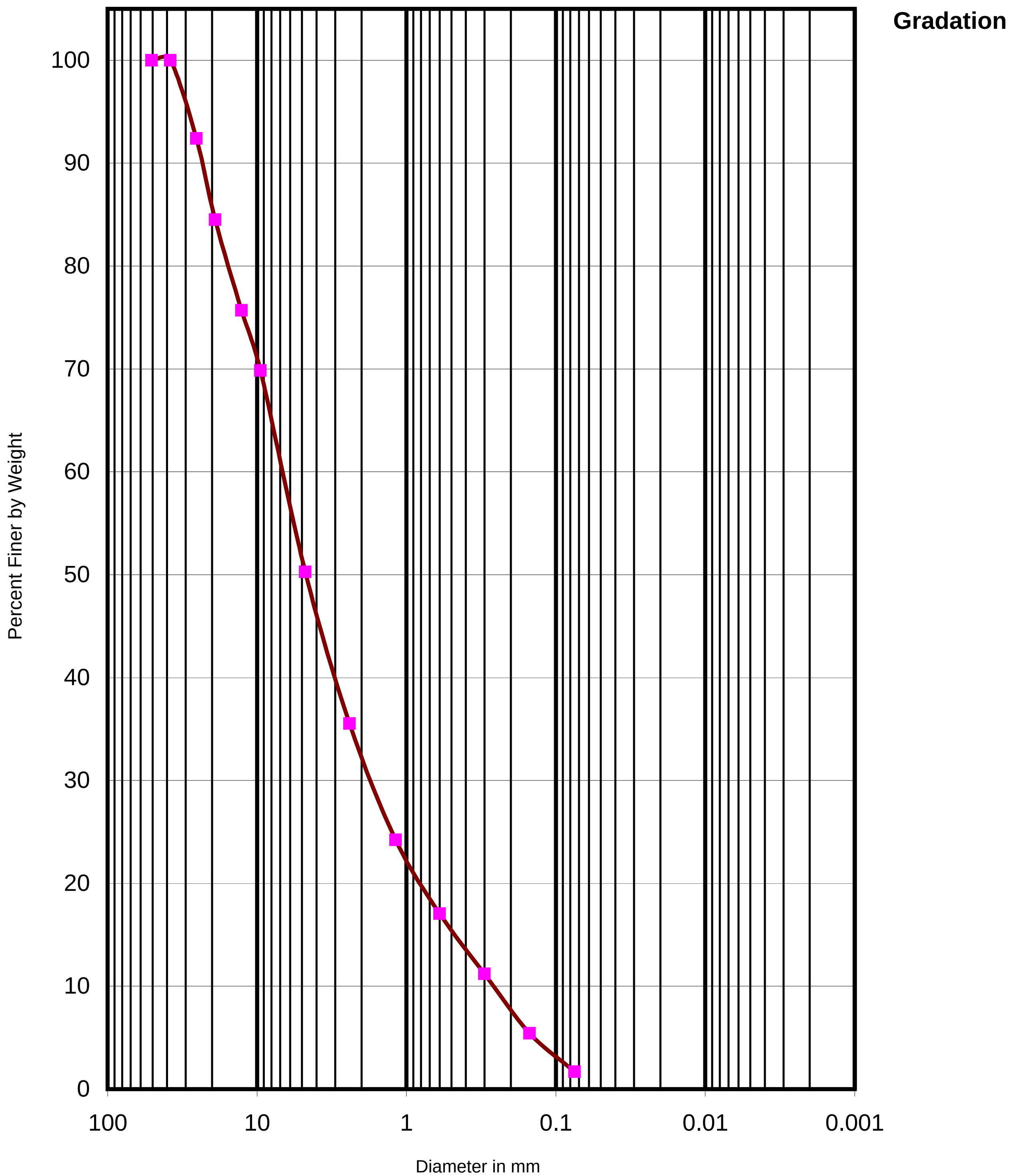
SS-6 / 6-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.
	Date: August 2009 | Figure: 13 | File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

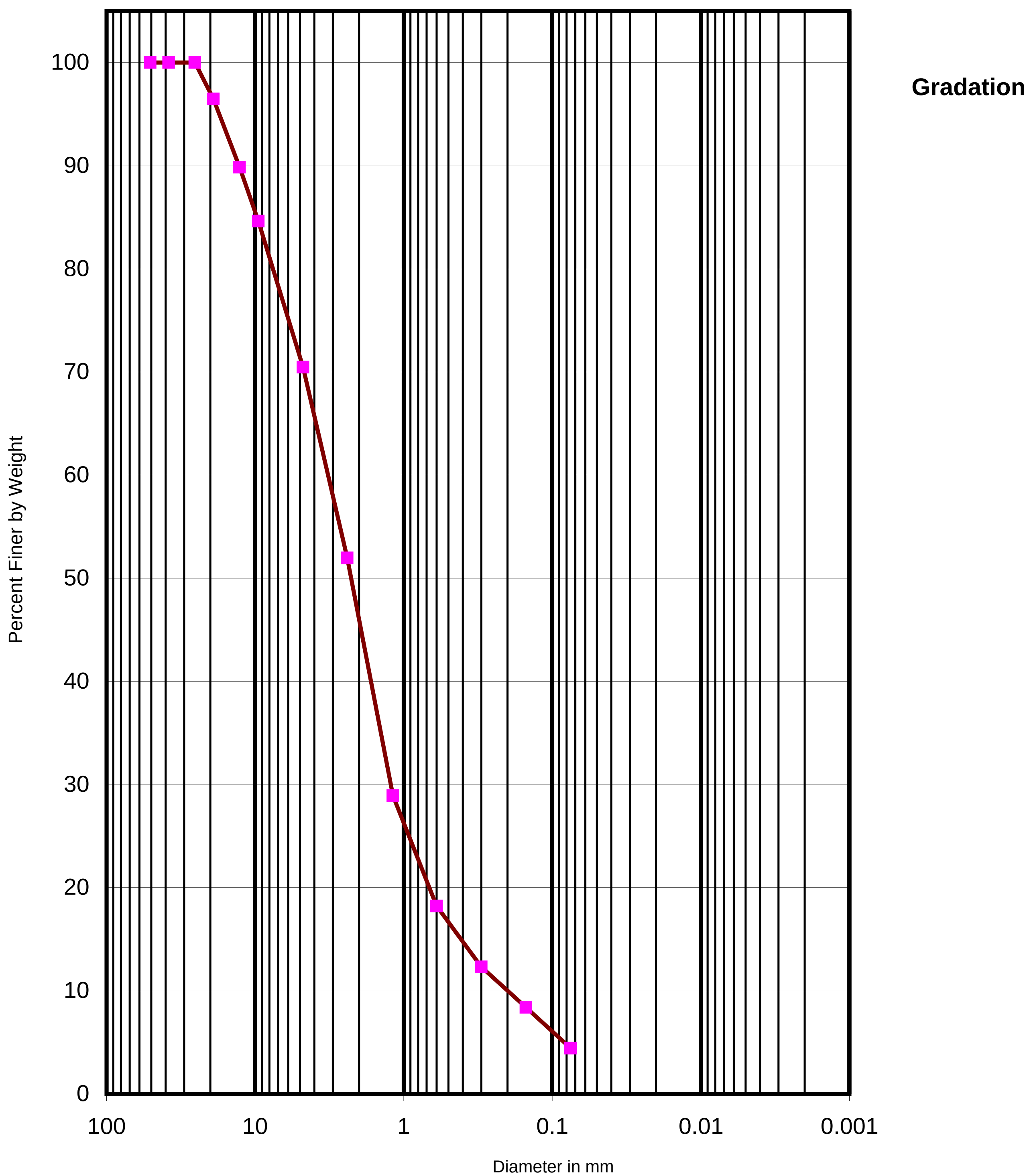
SS-7 / 7-1(Surface 0-12")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 14	File. 09504-Erosion



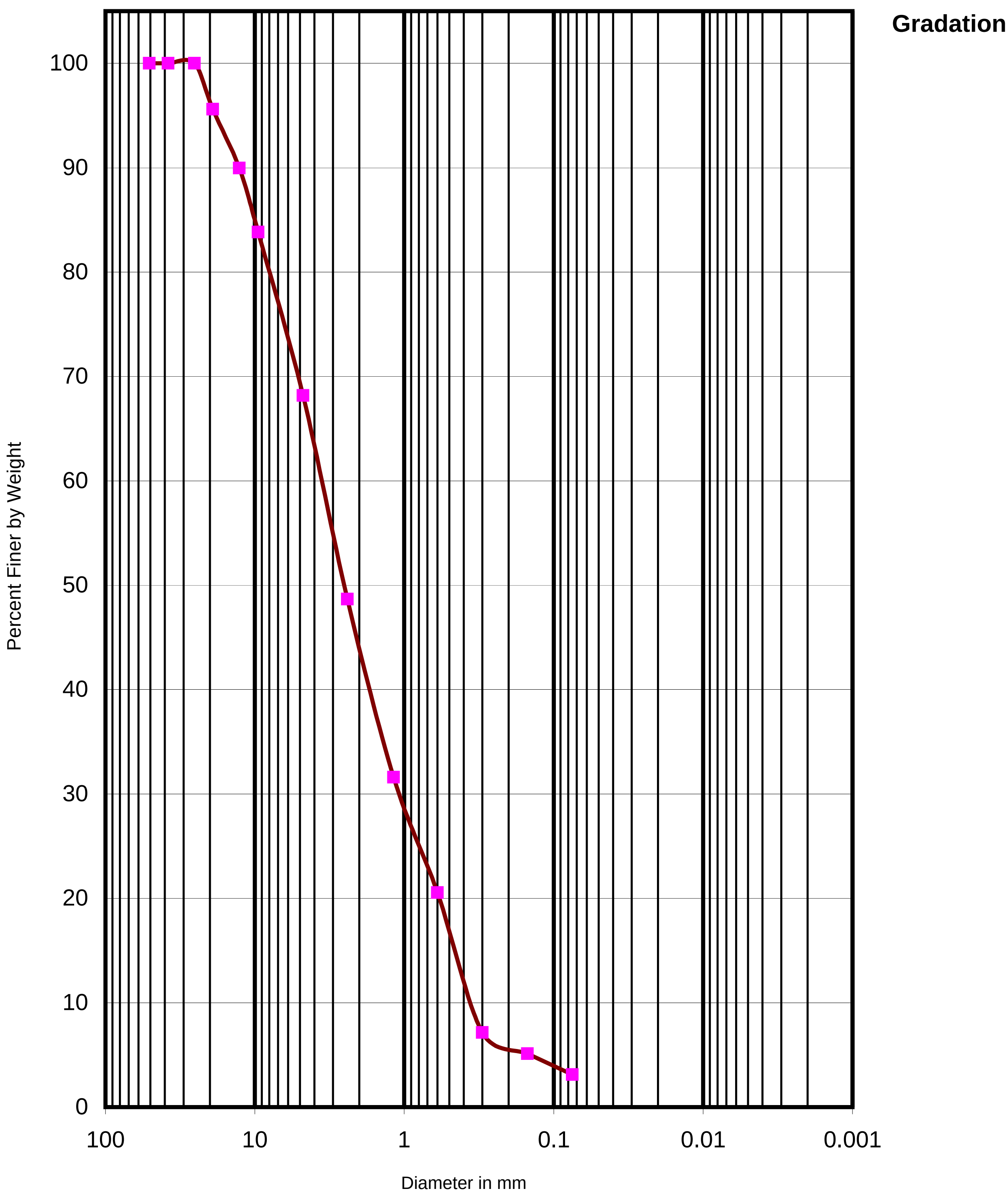
GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

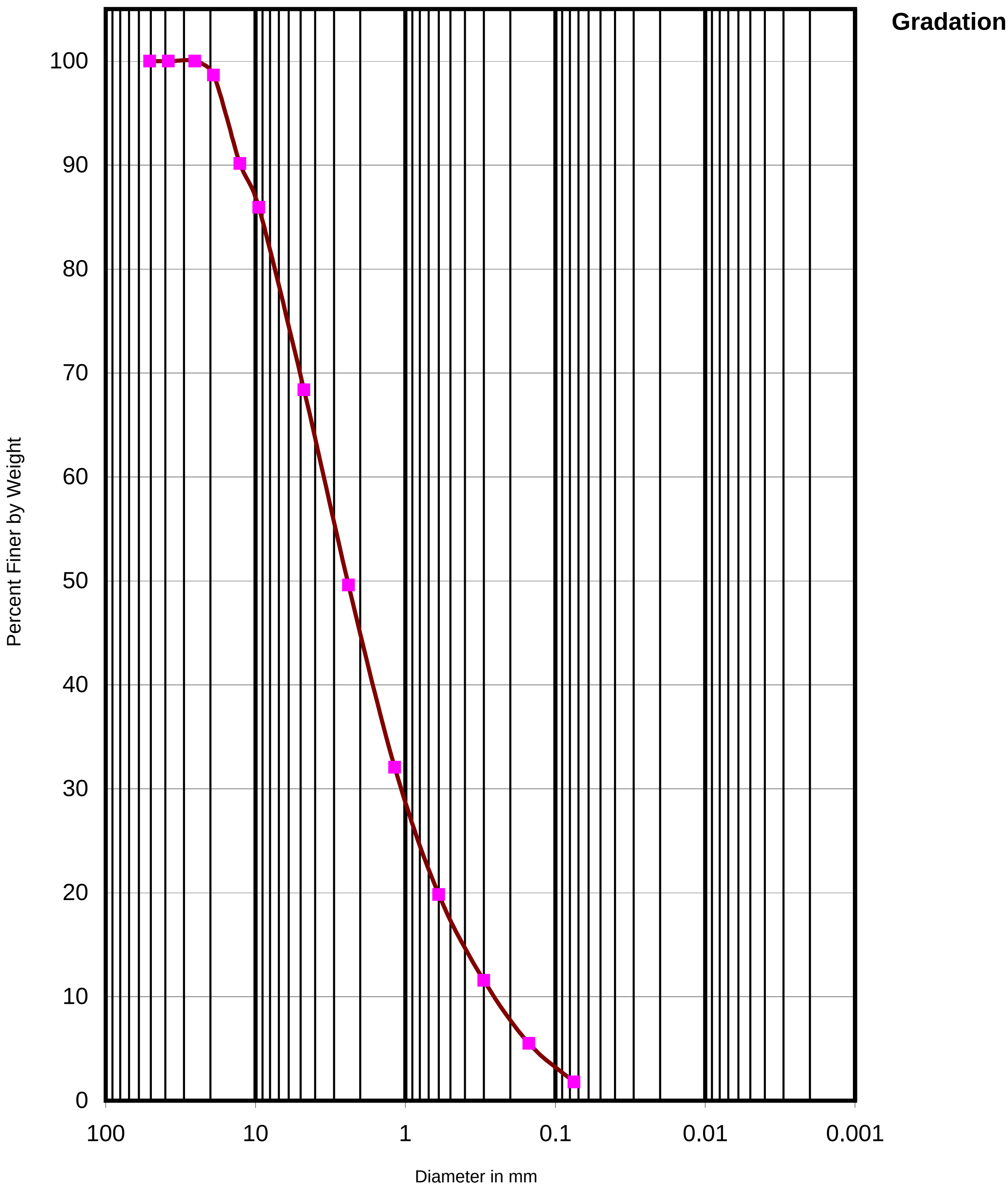
SS-7 / 7-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 15	File. 09504-Erosion



GRADATION CURVE			
FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca			
SS-8 / 8-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 16	File. 09504-Erosion



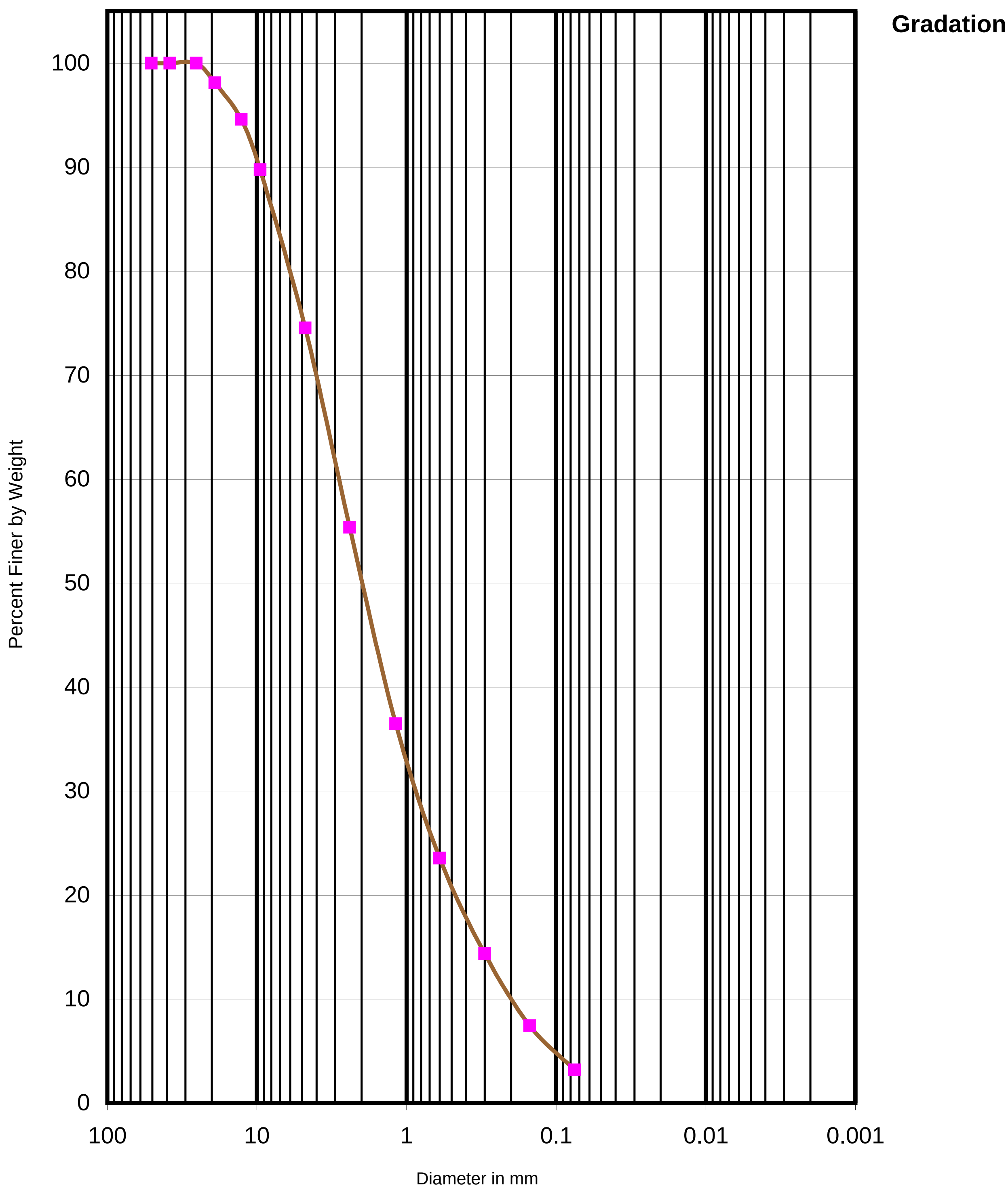
GRADATION CURVE			
FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca			
SS-9 / 9-1(Surface 0-12")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 17	File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

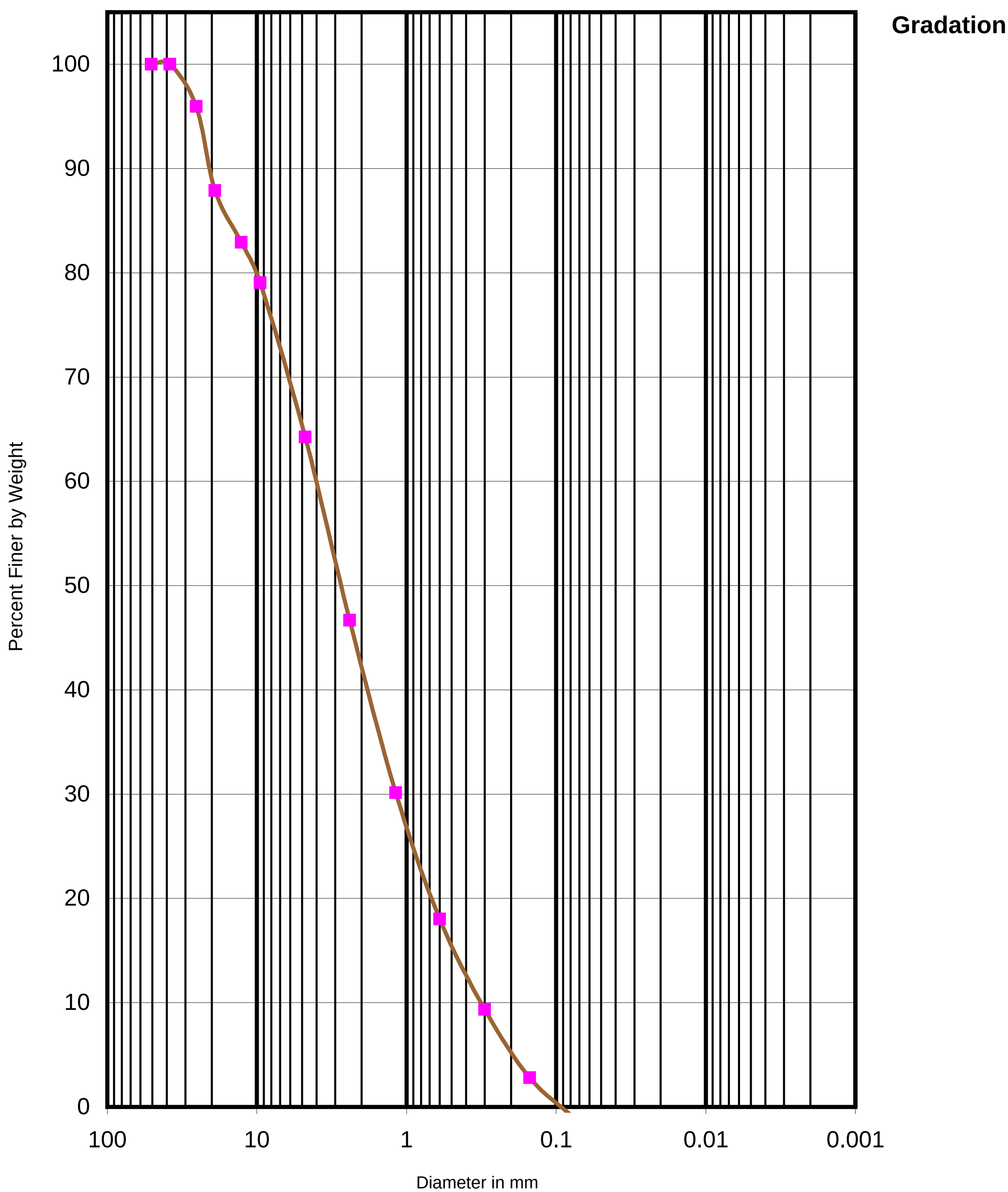
SS-9 / 9-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 18	File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

SS-10 / 10-1(Surface 0-12")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 19	File. 09504-Erosion



GRADATION CURVE

FMC Facility, Slope Erosion - Skyline College, San Bruno, Ca

SS-10 / 10-2 (24"-36")	ADVANCE SOIL TECHNOLOGY, INC.		
	Date: August 2009	Figure: 20	File. 09504-Erosion

File No. 09504-Erosion

TABLE I
Moisture, Plasticity Index

Boring / Sample No.	Moisture %	Liquid Limit	Plasticity Index
SS-1			
1-1	7.7	28	3
1-2	7.6		
SS-2			
2-1	9.6		
2-2	12.3		
SS-3			
3-1	9.0	31	8
3-2	10.7		
SS-4			
4-1	9.2		
4-2	13.0		
SS-5			
5-1	7.6		
5-2	7.4		
SS-6			
6-1	11.1	39	10
6-2	23.4		
SS-7			
7-1	9.5		
7-2	8.2		
SS-8			
8-1	15.8		
8-2	12.7		
SS-9			
9-1	8.1		
9-2	9.2		
SS-10			
10-1	9.8	25	9
10-2	10.6		


1- Equipment wash area


2- Drain from equipment washing area


3- Drain outlet (Washing Area) - Soil Erossion


4- Soil Erossion - North Side


5- Soil Erossion - North Side - Caving


6- Roof drain box - North Slope

SKYLINE COLLEGE - FMC FACILITY

PICTURES

ADVANCE SOIL TECHNOLOGY, INC.

Date: August 2009	Figure: 21	File No. 09504-Slope


7- Slope to the north


8- Drain from equipment washing area


9- Drain outlet (Washing Area) - Soil Erossion


10- Soil Erossion - North Side


11- Soil Erossion - North Side - Caving


12- Roof drain box - North Slope

SKYLINE COLLEGE - FMC FACILITY

PICTURES

ADVANCE SOIL TECHNOLOGY, INC.

Date: August 2009	Figure:22	File No. 09504-Slope

13- Catch Basin On The North Side

14- Soil erosion on the north slope

15- Loose and uncompacted soil on the south slope

16- Soil erosion-drain outlet - east slope

17- Soil erossion - east side

18- loose, uncompacted soil on the north slope

SKYLINE COLLEGE - FMC FACILITY

PICTURES

ADVANCE SOIL TECHNOLOGY, INC.

Date: August 2009	Figure: 23	File No. 09504-Slope

19- Caving of utility trenches - Erosion

20- Utility trench erosion

21- Loose soil adjacent to the building

22- Erosion of utility trenches

23- Slope erosion on the east

24- Slope erosion south - east of the property

SKYLINE COLLEGE - FMC FACILITY

PICTURES

ADVANCE SOIL TECHNOLOGY, INC.

Date: August 2009	Figure:24	File No. 09504-Slope