DIGGS Data Model

MEASUREMENT

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DATA INTERCHANGE FOR GEOTECHNICAL AND GEOENVIRONMENTAL SPECIALISTS

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Measurements

- A measurement is an act or event whose results are estimates of the values of properties of the target of investigation (eg. natural ground, earthworks).
- Two measurement features in DIGGS
  - Test – measurements over a spatial domain (lab and in-situ tests)
  - Monitor – measurements over a temporal domain (monitoring activities)
- Both features are structured very similarly and results are reported in a self-describing fashion (based on OGC O&M structure) in order to support extensibility and the wide range of measurement results and procedures in the geotechnical and geoenvironmental community.
- Measurements do NOT carry RAW or solely procedural data (eg. tare weights, machine voltages, container ID's)

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Tests

- Components of a Test Feature
  - References to project, samplingFeature(s), samples, measurements
    - Inherited properties vary depending on whether in-situ or laboratory tests
  - Temporal properties (samplingTime, resultTime, validTime) (optional)
  - Test results (mandatory)
    - Spatial domain (location(s) where measurements occur)
    - Property descriptions
      - Controlled terms that define WHAT is being measured/interpreted (terms held in a standard dictionary NOT as elements within the schema)
    - Property values
      - The reported results – values of the properties described above
  - Test procedure(s) (optional)
    - Metadata about the procedure(s) followed in making the measurements
    - Measurements bound directly to the specific procedure and used to obtain the reportable results of the test
    - Equipment used, calibration dates, specifications followed

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Monitor

- Components of a Monitor Feature
  - Readings (1 or more) – each reading is from one response zone
    - Response zone location
    - Time domain (list of time instants)
    - Property descriptions
      - Controlled terms that define WHAT is being monitored (terms held in a standard dictionary NOT as elements within the schema)
    - Property values
      - The reported results – values of the properties described above
  - Sensors (optional)
    - Reference point
    - Date installed
    - Detectors
      - Detector location
      - Measurand
      - Type
      - Measurement axis bearing
      - Measurement axis inclination

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Result Properties

- propertyName
- typeData (eg. string, integer, double etc.)
- propertyClass (controlled term – must be defined in an external dictionary)
- unit of measure
- measurementAxisBearing
- measurementAxisInclination
- nullValue
- context
- sampleFraction (eg. dissolved, total, vapor, etc. – controlled list)
- correctionUsed
- measurementTechnique (eg. measured, assigned, estimated – controlled list)
- reference to detector object
- detection limits
- reportable (boolean)
- qualifiers (name-value pairs)
- curve state (eg. processed, raw, depth adjusted, etc. – controlled list from WITSML)

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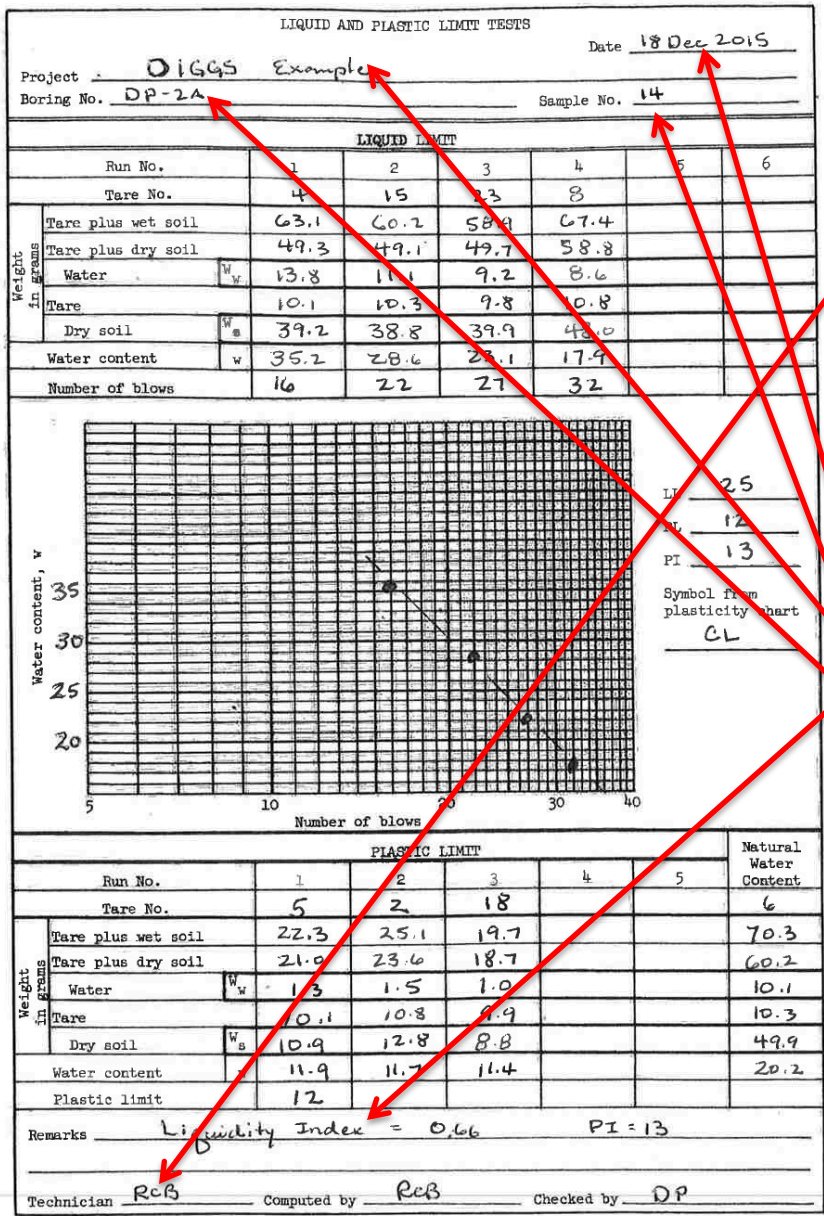
Example – Atterberg Limits



LIQUID AND PLASTIC LIMIT TESTS

Date 18 Dec 2015

Project DiGGS Example

Boring No. DP-2A Sample No. 14

LIQUID LIMIT

	Run No.	1	2	3	4	5	6
	Tare No.	4	15	23	8		
Weight in grams	Tare plus wet soil	63.1	60.2	58.9	67.4		
	Tare plus dry soil	49.3	49.1	49.7	58.8		
	Water W_w	13.8	11.1	9.2	8.6		
	Tare	10.1	10.3	9.8	10.8		
	Dry soil W_s	39.2	38.8	39.9	48.0		
	Water content w	35.2	28.6	23.1	17.9		
	Number of blows	16	22	27	32		

Water content, w — 35, 30, 25, 20

Number of blows — 5, 10, 20, 30, 40

LL 25

PL 12

PI 13

Symbol from plasticity chart CL

PLASTIC LIMIT

	Run No.	1	2	3	4	5	Natural Water Content
	Tare No.	5	2	18			6
Weight in grams	Tare plus wet soil	22.3	25.1	19.7			70.3
	Tare plus dry soil	21.9	23.6	18.7			60.2
	Water W_w	1.3	1.5	1.0			10.1
	Tare	10.1	10.8	8.9			10.3
	Dry soil W_s	10.9	12.8	8.8			49.9
	Water content w	11.9	11.7	11.4			20.2
	Plastic limit	12					

Remarks Liquidity Index = 0.66 PI = 13

Technician RCB Computed by RCB Checked by DP

```
<measurement>
  <Test gml:id="atterberg">
    <gml:name>Atterberg Limits Test</gml:name>
    <role>
      <Role>
        <rolePerformed>Technician</rolePerformed>
        <businessAssociate>RCB</businessAssociate>
      </Role>
    </role>
    <role>
      <Role>
        <rolePerformed>Computed by</rolePerformed>
        <businessAssociate>RCB</businessAssociate>
      </Role>
    </role>
    <role>
      <Role>
        <rolePerformed>Checked by</rolePerformed>
        <businessAssociate>DP</businessAssociate>
      </Role>
    </role>
    <remark>
      <Remark>
        <content>Liquidity Index = 0.66; PI = 13</content>
      </Remark>
    </remark>
    <investigationTarget>Natural Ground</investigationTarget>
    <projectRef xlink:href=#DiggsExample"/>
    <relatedSamplingFeatureRef xlink:href="#DP-2A"/>
    <sampleRef xlink:href="#s14"/>
    <resultTime>
      <TimeInterval gml:id="t3">
        <start>2015-12-18</start>
      </TimeInterval>
    </resultTime>
    <outcome>
```

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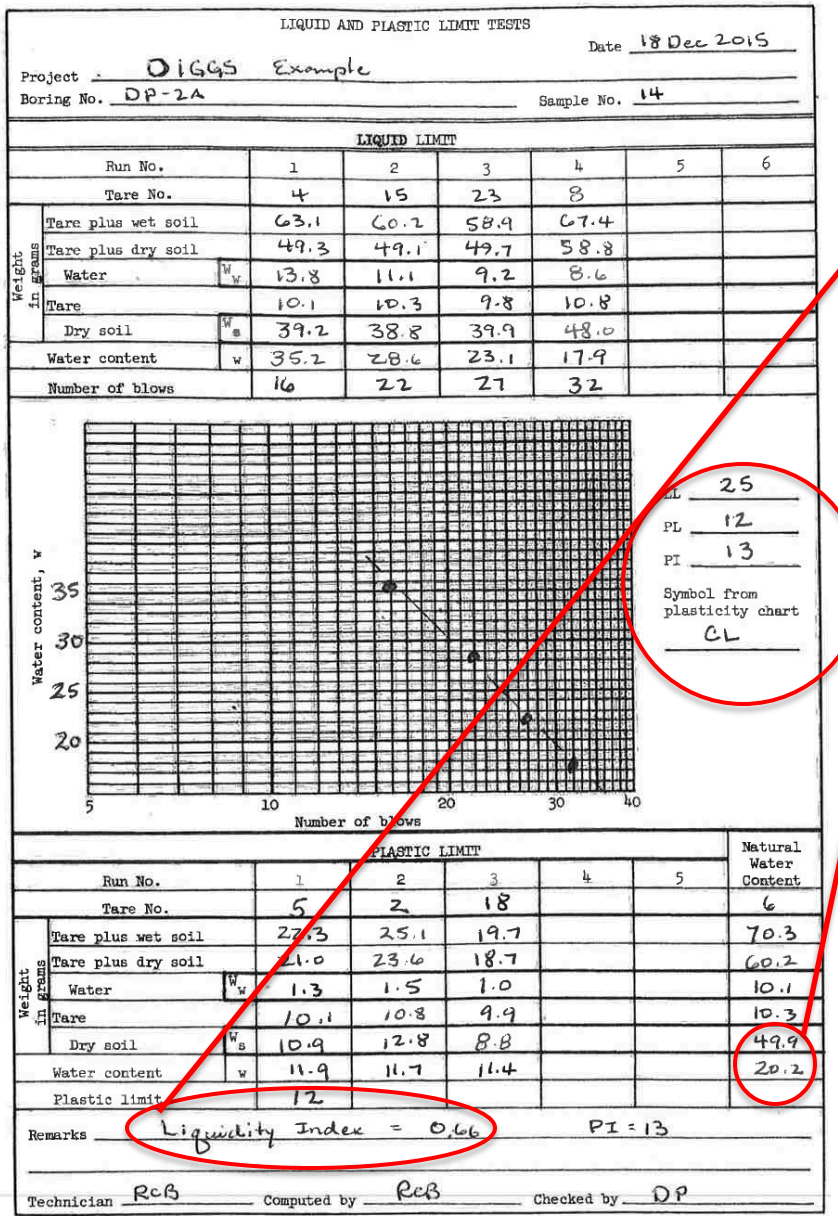
Example – Atterberg Limits



LIQUID AND PLASTIC LIMIT TESTS

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Project DIGGS Example

Boring No. DP-2A Sample No. 14

LIQUID LIMIT

	Run No.	1	2	3	4	5	6
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Weight in grams	Tare plus wet soil	63.1	60.2	58.9	67.4		
	Tare plus dry soil	49.3	49.1	49.7	58.8		
	Water W_w	13.8	11.1	9.2	8.6		
	Tare	10.1	10.3	9.8	10.8		
	Dry soil W_s	39.2	38.8	39.9	48.0		
Water content	w	35.2	28.6	23.1	17.9		
Number of blows		16	22	27	32		

Water content, w: 35, 30, 25, 20

Number of blows: 5, 10, 20, 30, 40

LL 25

PL 12

PI 13

Symbol from plasticity chart CL

PLASTIC LIMIT

	Run No.	1	2	3	4	5	Natural Water Content
	Tare No.	5	2	18			6
Weight in grams	Tare plus wet soil	27.3	25.1	19.7			70.3
	Tare plus dry soil	21.0	23.6	18.7			60.2
	Water W_w	1.3	1.5	1.0			10.1
	Tare	10.1	10.8	9.9			10.3
	Dry soil W_s	10.9	12.8	8.8			49.9
Water content	w	11.9	11.7	11.4			20.2
Plastic limit		12					

Remarks Liquidity Index = 0.66 PI = 13

Technician RCB Computed by RCB Checked by DP

Test Result Properties

- liquid_limit
- liquid_limit_oven_dried
- liquidity_index
- consistency_index
- natural_water_content
- plastic_limit
- plasticity_index
- shrinkage_limit
- shrinkage_ratio
- volumetric_shrinkage
- uscs_symbol

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```
<outcome>
  <TestResult gml:id="altr1">
    <location>
      <PointLocation gml:id="pl2" srsDimension="1" srsName="#sr123">
        <gml:pos>32</gml:pos>
      </PointLocation>
    </location>
    <results>
      <ResultSet>
        <parameters>
          <PropertyParameters gml:id="pp">
            <properties>
              <Property index="1" gml:id="p1">
                <propertyName>LL</propertyName>
                <typeData>integer</typeData>
                <propertyClass codeSpace="http://diggsml.org/terms/DIGGSTestPropertyDefinitions.xml#liquid_limit">liquid limit</propertyClass>
              </Property>
              <Property index="2" gml:id="p2">
                <propertyName>PL</propertyName>
                <typeData>integer</typeData>
                <propertyClass codeSpace="http://diggsml.org/terms/DIGGSTestPropertyDefinitions.xml#plastic_limit">plastic limit</propertyClass>
              </Property>
              <Property index="3" gml:id="p3">
                <propertyName>PI</propertyName>
                <typeData>integer</typeData>
                <propertyClass codeSpace="http://diggsml.org/terms/DIGGSTestPropertyDefinitions.xml#plasticity_index">plasticity index</propertyClass>
              </Property>
              <Property index="4" gml:id="p4">
                <propertyName>Symbol from plasticity chart</propertyName>
                <typeData>string</typeData>
                <propertyClass codeSpace="http://diggsml.org/terms/DIGGSTestPropertyDefinitions.xml#uscs_symbol">uUSCS symbol</propertyClass>
              </Property>
              <Property index="5" gml:id="p5">
                <propertyName>LI</propertyName>
                <typeData>double</typeData>
                <propertyClass codeSpace="http://diggsml.org/terms/DIGGSTestPropertyDefinitions.xml#liquidityy_index">liquidity index</propertyClass>
              </Property>
              <Property index="6" gml:id="p6">
                <propertyName>Natural M/C</propertyName>
                <typeData>double</typeData>
                <propertyClass codeSpace="http://diggsml.org/terms/DIGGSTestPropertyDefinitions.xml#water_content_natural">natural water content</propertyClass>
                <uom>%</uom>
              </Property>
            </properties>
          </PropertyParameters>
        </parameters>
        <dataValues cs="," decimal="." ts=" ">25,12,13,"CL",0.66,20.2</dataValues>
      </ResultSet>
    </results>
  </TestResult>
</outcome>
```

liquid_limit
plastic_limit
plasticity_index
uscs_symbol
liquidity_index
natural_water_
content

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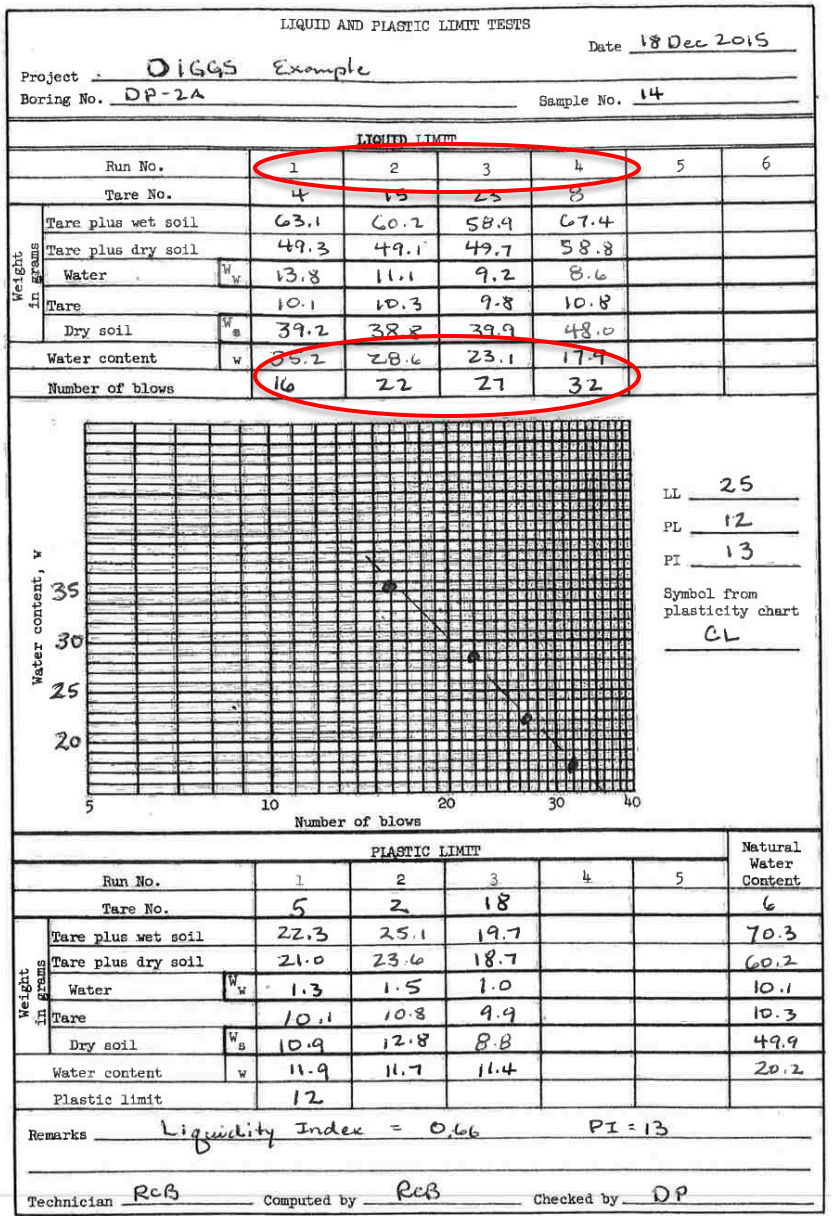
Example – Atterberg Limits



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Water content, w: 35, 30, 25, 20

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	Plastic limit	12					

Remarks Liquidity Index = 0.66 PI = 13

Technician RCB Computed by RCB Checked by DP

```
<procedure>
    <diggs_geo:AtterbergLimitsTest gml:id="atterberg-procedure">
      <diggs_geo:liquidLimitTrial>
        <diggs_geo:CasagrandeTrial gml:id="tr1">
          <diggs_geo:trialNo>1</diggs_geo:trialNo>
          <diggs_geo:isManual>true</diggs_geo:isManual>
          <diggs_geo:blowCount>16</diggs_geo:blowCount>
          <diggs_geo:waterContent uom="%">35.2</diggs_geo:waterContent>
        </diggs_geo:CasagrandeTrial>
      </diggs_geo:liquidLimitTrial>
      <diggs_geo:liquidLimitTrial>
        <diggs_geo:CasagrandeTrial gml:id="tr2">
          <diggs_geo:trialNo>2</diggs_geo:trialNo>
          <diggs_geo:isManual>true</diggs_geo:isManual>
          <diggs_geo:blowCount>22</diggs_geo:blowCount>
          <diggs_geo:waterContent uom="%">28.6</diggs_geo:waterContent>
        </diggs_geo:CasagrandeTrial>
      </diggs_geo:liquidLimitTrial>
        …
```

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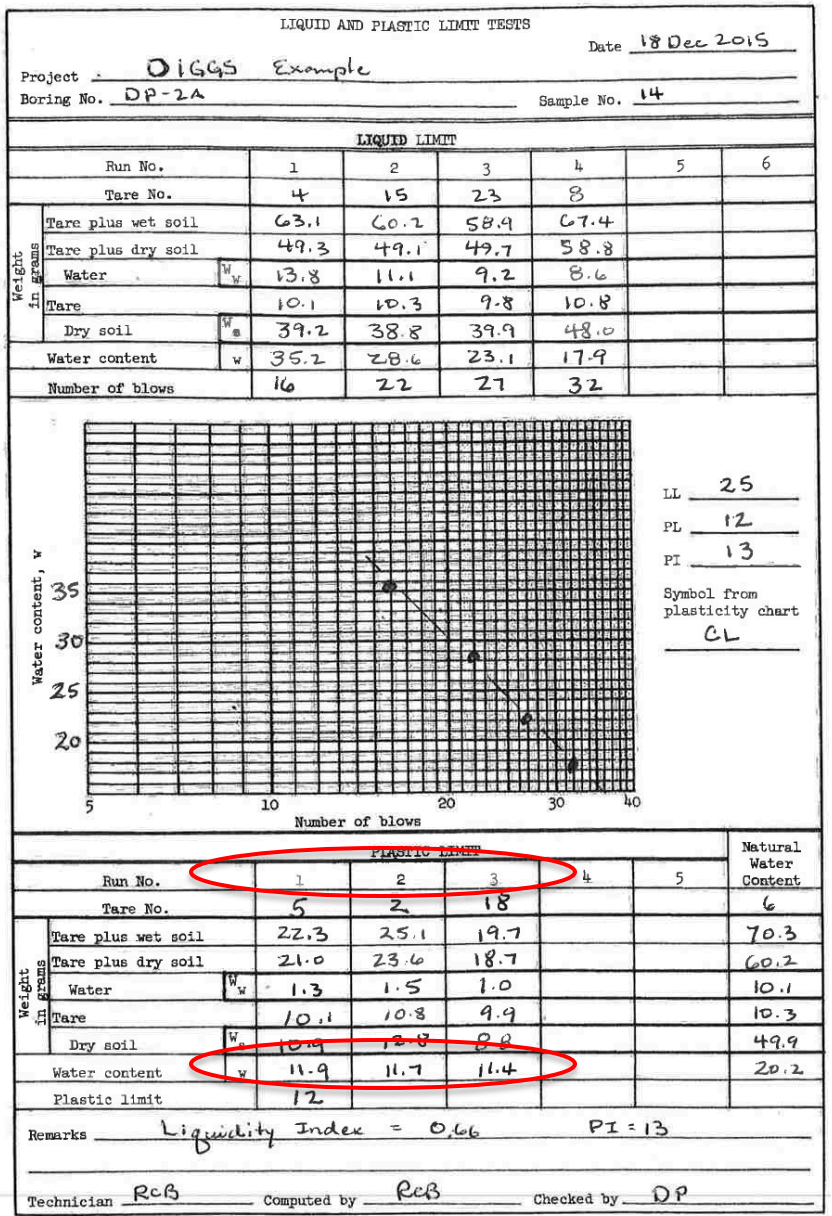

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Water content, w (35, 30, 25, 20)

Number of blows (5, 10, 20, 30, 40)

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	Plastic limit	12					

Remarks Liquidity Index = 0.66 PI = 13

Technician RCB Computed by RCB Checked by DP

```
<procedure>
  <diggs_geo:AtterbergLimitsTest gml:id="atterberg-procedure">
      ....
    <diggs_geo:plasticLimitTrial>
      <diggs_geo:PlasticLimitTrial gml:id="pl1">
        <diggs_geo:trialNo>1</diggs_geo:trialNo>
        <diggs_geo:isManual>true</diggs_geo:isManual>
        <diggs_geo:waterContent uom="%">11.9</diggs_geo:waterContent>
      </diggs_geo:PlasticLimitTrial>
    </diggs_geo:plasticLimitTrial>
    <diggs_geo:plasticLimitTrial>
      <diggs_geo:PlasticLimitTrial gml:id="pl2">
        <diggs_geo:trialNo>2</diggs_geo:trialNo>
        <diggs_geo:isManual>true</diggs_geo:isManual>
        <diggs_geo:waterContent uom="%">11.7</diggs_geo:waterContent>
      </diggs_geo:PlasticLimitTrial>
    </diggs_geo:plasticLimitTrial>
    <diggs_geo:plasticLimitTrial>
      <diggs_geo:PlasticLimitTrial gml:id="pl3">
        <diggs_geo:trialNo>3</diggs_geo:trialNo>
        <diggs_geo:isManual>true</diggs_geo:isManual>
        <diggs_geo:waterContent uom="%">11.4</diggs_geo:waterContent>
      </diggs_geo:PlasticLimitTrial>
    </diggs_geo:plasticLimitTrial>
  </diggs_geo:AtterbergLimitsTest>
</procedure>
<procedure>
  <diggs_geo:WaterContentTest gml:id="wc1">
    <testProcedureMethod>
      <Specification gml:id="wc2">
        <gml:name>ASTM-D2216</gml:name>
      </Specification>
    </testProcedureMethod>
  </diggs_geo:WaterContentTest>
</procedure>
</Test>
</measurements>
```

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