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Memo

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Date: March 27, 2014
To: John Holt, Lamoine Planning Board Chair
From: Robert Gerber, C.G.
Subject: Review of Summit Report on additional exploration at MacQuinn Pit and additional follow-up materials

I reviewed the report entitled "Supplemental Hydrogeologic Assessment" prepared by Michael Deyling of Summit Environmental Consultants in December 2013. This report was prepared in response to a Planning Board request that the applicant, Harold MacQuinn, Inc., provide additional geologic information for a gravel pit expansion of the Kittridge Pit into Lot 31. The specifications for the acquisition of additional geologic data originally came from a report I wrote to the Planning Board on April 16, 2013, which was a peer review of the original Summit report on the geology of the site.

Status of Additional Information Requests

I made an initial review of the December 2013 report and requested additional information in a memo I wrote to you on March 15, 2014. The applicant gathered information and submitted this and their supplemental analyses and opinions through a series of emails to me through their agent, Stephen Salsbury. Some, but not all of these emails were copied to you. Apparently he was concerned about your internet bandwidth not being able to handle the size of some of the documents. The following describes what was submitted in response to my requests.

1) *Another complete synoptic (acquired at the same time) round of water level readings in the new monitoring wells and four older monitoring wells*. All water levels were lower than the November 2013 readings.
2) *A discussion of how the timing of the stream flow measurements used in the water balance computations related to whether they are baseflows only and whether these flows represent "average annual" base flows, fall high baseflows, etc.* A discussion was provided comparing antecedent precipitation readings to the time of the stream flow measurements. The measurements were taken August 26, 2013, when flow in a small watershed in sand and gravel in Washington County was 6.3 cfs (see **Attachment 1**), which was about the lowest flow of the summer

in that watershed. Over the 13 years of stream gaging in Libby Brook, the lowest flows have typically been in August and September. So I think we can conclude that the measurements at the time of flow were less than the average baseflow for the year.

3) *Divide the recharge area into units of similar recharge capability and multiplying these sub-units by a representative recharge rate for the respective units and summing those to make the comparison*. Summit did a more elaborate and complete estimate of the recharge rate to the Cold Spring aquifer system. It appears to be a reasonable evaluation of the type I have done many times.
4) *Supply page 7 of the PB-4 boring log*. It turns out there there were only 6 pages to that particular boring log and the indication that there were 7 pages was an error in the report.
5) *Provide a table of elevations and locations of geologic data points with survey-grade GPS equipment*. Salsbury provided a table of the xyz values for the geologic data points and also provided a CAD drawing that was georeferenced that I was able to pull into ArcGIS.
6) *Provide data on the string of six "CSW" wells*. I received an email from you saying you would put data on the wells into the record and that you had sent the data previously to Summit. I have not been able to find the data on the town website record of this proceeding, but I did get a list of water level readings taken in the wells from Salsbury and a plan of the locations and the x-y-z table of the well locations and elevations. I did not receive any boring logs for these wells.
7) *Michael Deyling should put his CG stamp on the report and sign it*. I was told by Salsbury that a hardcopy page with Mr. Deyling's stamp and signature was submitted directly to the Board.

In my opinion, the additional data requested has been provided and are sufficient to allow my review.

Review of New Information Provided Since My March 15, 2013, Report

There were several major issues outstanding when I wrote my March 15, 2013, review:

A) The westward extent of the clay layer that held up a perched water table that supplied Cold Spring was uncertain and therefore the proposed plan to excavate the pit in that area could have a deleterious effect on the Cold Spring yield and quality
B) The position of the deep water table in the sand and gravel within which the pit would be excavated was largely unknown and the proposed excavation plan might therefore turn out to be too ambitious.

The additional information I requested was designed to fill in the information gaps and permit the Planning Board to make an informed decision as to whether the Application met the Board requirements.

In my opinion the Applicant has fairly complied with my information requests and supplied sufficient data for the Board to be able to review and decide whether the groundwater impact part of the application meets their requirements. The new deep monitoring wells in and near the proposed pit expansion area define the approximate position of the water table under the pit. The Applicant has provided a modified pit development plan that shows in cross section the depths and extent of the proposed gravel mining. Given the great depth to the deep water table and the long time it will take to excavate gravel out to get close to that water table, *a reasonable condition of the permit would be to require that when the pit bottom is excavated to within 15 feet of the currently-estimated groundwater table position that new monitoring wells be installed over a wider area and that one year of monthly water levels be taken in those new wells (except biweekly during March, April, and May) to determine the final position for purposes of determining the final allowable bottom elevation of the pit*.

The new borings along the eastern side of the proposed pit expansion found that the westward extent of the clay layer that supports the perched water table feeding Cold Springs does not extend as far as I speculated originally that it might extend. I think we have a reasonable understanding of the extent and depth of that clay layer now. The Applicant has modified the mining plan to show protection of this clay layer and has offset the proposed mining area to the west to accommodate it. Again, *a reasonable condition of the permit would be to require that in the event the clay layer of interest (the one that forms the perched water table flowing toward Cold Spring) is intercepted farther west than currently known, then the mining plan shall be altered to stop any further mining in this area to depth and the edge of any deeper excavations be shifted westward to beyond the edge of the clay layer*.

Although we do not know everything there is to know about the recharge area of Cold Spring, we now know a lot more than previously known. I am convinced that there are indeed two separate water tables in this area: a perched water table supported by a clay layer that is embedded in the eastern flank of the esker and dips to the east; and a deep water table in sand and gravel in the core of the esker. These water tables are separated—at least along the eastern edge of the proposed pit expansion—by an unsaturated zone between the bottom of the clay and where the deeper water table is intercepted by MW-2 and PB-4D. These water tables likely merge about a quarter mile north-northeast of Cold Spring.

As to the contributing recharge area to Cold Spring, we have the revised Summit recharge area delineation from Summit's revised water balance analysis of March 20, 2014 (**Attachment 2**) which gives us a general interpretation of the recharge area and surficial geology of different portions of the recharge area. In addition, I have prepared a contour map of the shallow water (perched) table that seems to be related to Cold Spring as **Attachment 3**. **Attachment 3** was prepared by entering the x and y coordinates of all of the points of known (measured) and inferred (streams with approximate LiDAR elevations) water table, converted elevations to NAVD88 datum and contoured the data using a simple linear interpolation procedure. There are two groundwater "highs" that

seem to feed the Cold Spring, assuming groundwater flowlines are more or less perpendicular to the groundwater contours on **Attachment 3**. The smaller of the two watersheds seems to extend northwest from Cold Spring and extend along the northern side of the string of CSW monitoring wells, terminating near a small high in the water table identified as elevation 136' on the figure. One anomaly along this area is the significantly lower groundwater elevation at CSW-05. The other portion of the recharge area and the portion that is probably more likely to keep the relatively constant level in the spring is the large recharge area suggested by the closed contour of elevation 136 to the south of Cold Spring, which includes a bog area. There is a suggestion that along the western edge of this closed contour there is a connection and shallow groundwater flow to the north that passes through the area of CSW-02 and CSW-03, entering gravel where the ground surface is almost 30 feet higher than the water table elevation, and passing through the Cold Spring area. There is sufficient watershed area to supply the 12 gpm withdrawal rate from Cold Spring.

Response to Dr. Brutsaert Concerns

Dr. Willem Brutsaert filed a memo dated January 2014 with the Planning Board called "Impressions of Summit's Supplemental Hydrogeologic Study, DEC 2013." Because Dr. Brutsaert is a credible professional in the matters that the Board has requested my assistance, I will attempt to address his concerns based on what I know and deduce from the information I have seen, but the Board may want to consider his comments further and request additional data from the Applicant if they feel that information is needed to assist in the decision-making process.

Bullet 1—*The supplemental data raises more questions than it answers on the distribution of the clay/silt layer*. I do not agree with this. I think we know more now, particularly within the proposed gravel expansion area. There are other questions remaining about the exact nature and distribution of the clay-silt layer beyond the Applicant's site, but those questions do not need to be answered to determine whether the mining plan is appropriate.

Bullet 2—*The topography of the land near Cold Spring suggests that the surficial soil is fine-grained and not sand and gravel*. I disagree. The stream pattern development as displayed on **Attachment 3** is suggestive of groundwater sapping within a material like sand, possibly underlain by clay-silt. A similar pattern can be observed, for example, in the upper reaches of Branch Brook in Kennebunk (**Attachment 4**) where a thick sand overlies clay and groundwater seeps out of the sand over the top of the clay.

Bullet 3—*The geochemistry of the Cold Spring water has not been examined*. I agree. There is none in the record that I could find and it would be helpful, for example, to determine whether my hypothesis that some of the water from the spring recharges from a bog to the south is valid. Again, although this would be helpful to a better understanding of the origin of the Cold Spring Water I do not think it is critical to a determination of the groundwater regime on the proposed expansion site.

Bullet 4—*Concerned why there is no water in MW3 and PB4*. My particular interpretation of PB-4S is that it is on top of the western edge of the clay-silt deposit and at this position, the well would only have water during a period following a major snowmelt or rainfall event when the downward rate of infiltration within the clay layer is less than the mass rate of the wetting front coming down from the ground surface as it reaches the clay layer. I think that a well placed at the top of the clay layer at MW3 would be likely to have water, at least much of the year, but the well was constructed in such a way that is screened largely below the clay layer, thus permitting any water flowing through the clay-silt to go down the well and dissipate as unsaturated flow into the sand and gravel beneath the clay layer. The bottom of the MW3 well should be no deeper than the approximate top of the clay layer in order to measure the state of a perched water table on top of the clay there.

Bullet 5—*The water balance study (December 2013) does not appear to include all parts of the watershed nor account for ET losses*. I agree that the first water balance study was not a good evaluation of the problem, which is why I suggested an approach used in the peer-reviewed paper that Dr. Hebson and I wrote. The revised Summit water balance study is a more comprehensive and better approach to the problem and I think that based on the available data it is a reasonable interpretation of what is currently known.

Bullet 6—*The recharge area of Cold Spring does not make sense based on Summit's December 2013 map*. This is a lengthy bullet that covers a lot of ground and offers opinion. Even the more recent March 2014 revised recharge area map that was submitted by Summit with their March 20, 2014, memo does look strange to the south of Cold Spring. But if you look at my **Attachment 3**, which is a contour map based on linear interpolation of the available shallow groundwater elevations, there does appear to be an avenue of groundwater flow from the south toward Cold Spring that makes sense hydraulically as I discuss on the bottom of page 3 and top of page 4 of this memo. Again, although it would nice to unravel all the secrets of Cold Spring, I do not think that the Applicant should be required to do that as we already know what we need to know to evaluate the proposed gravel pit expansion area.

Bullet 7—*The water table supplying Cold Spring is connected to the deeper water table to the west-northwest and excavating material from this area will cause Cold Spring to dry up*. I do not agree with this statement. Along the eastern edge of the MacQuinn property and east of the proposed expansion the data clearly support two distinct water tables, separated by many tens of feet. I think the two water tables converge about a quarter mile to the north about elevation 80' to 90' where the brook emanating from the Cold Spring area flows into the eastern panhandle of the MacQuinn property. The water tables would also converge east of this brook where the gravel thins and pinches out. We do not have enough information to know what happens with the deep water table south of Cold Spring. But as long as the applicant does not excavate into and drain the deep water table, regardless of how that interacts in detail with the perched water table there should not be an effect on Cold Spring.

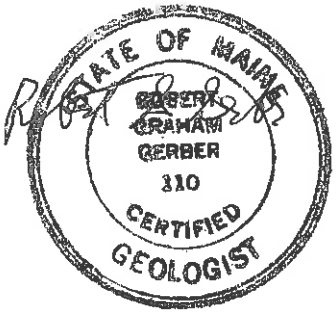
Bullet 8—*A synoptic round of groundwater level measurements is needed and the data needs to be independently peer-reviewed.* This is an independent review of the data. A synoptic round of monitoring well measurements was taken on March 21, 2014. It was probably not equivalent to seasonal high in either the perched water table or deep water table. For the perched water table, the long string of water level measurements in the CSW monitoring wells since 2009 show the March 17, 2014, measurements were below the spring high water elevations measured in past years. This is undoubtedly due to the long cold snowy winter and the fact that the spring thaw had not really set in yet at the time of the measurements. For the deep water table, as I pointed out in my memo of March 15, 2014, the very large unsaturated zone from the gravel pit ground surface to the deep unsaturated zone will mean that large recharge events at the surface will take months to be expressed in the deep wells. In fact the Nov. 12, 2014, groundwater elevation in PB1-2013 was 33.31' on 3/21/14 versus 37.18' NGVD88 on 11/12/13, or almost 4 feet lower. Since both the perched and deep water tables would not be expected to vary by more than a few feet in this area, if the Board adopts my proposed permit condition relating to measuring water tables, there should be better data later to make final determinations on how deep the pit can be excavated.

Summary

As with anything dealing with the underground, we do not know everything possible to know. But I do believe that we do know enough now to understand reasonably well the extent of the clay that slopes up under the sand from Cold Spring into the proposed pit expansion area. The Applicant has defined that approximate limit and if the Board adopts the proposed permit condition I have suggested in moving the pit limits if the clay is found to extend farther west, then the spring should be protected.

There are two separate water tables and we have a better idea where the deep water table lies. The exact distribution of the seasonally high water table in the bottom of the proposed exploration will be better determined once a large amount of material is removed from the pit and the water table begins to respond more directly to precipitation and snowmelt events. I have suggested a permit condition to apply that will assist in this matter.

The Applicant has modified the expansion plan to move the eastern edge of the pit west to accommodate the clay layer and to adjust the bottom of the pit elevation to what we now know about the deep water table. From this point forward the Board needs to evaluate all the new information provided by the Applicant and by me and determine if the plan as revised meets they Planning Board criteria.



Robert G. Gerber, Certified Geologist #110
4 Attachments

Attachment 1

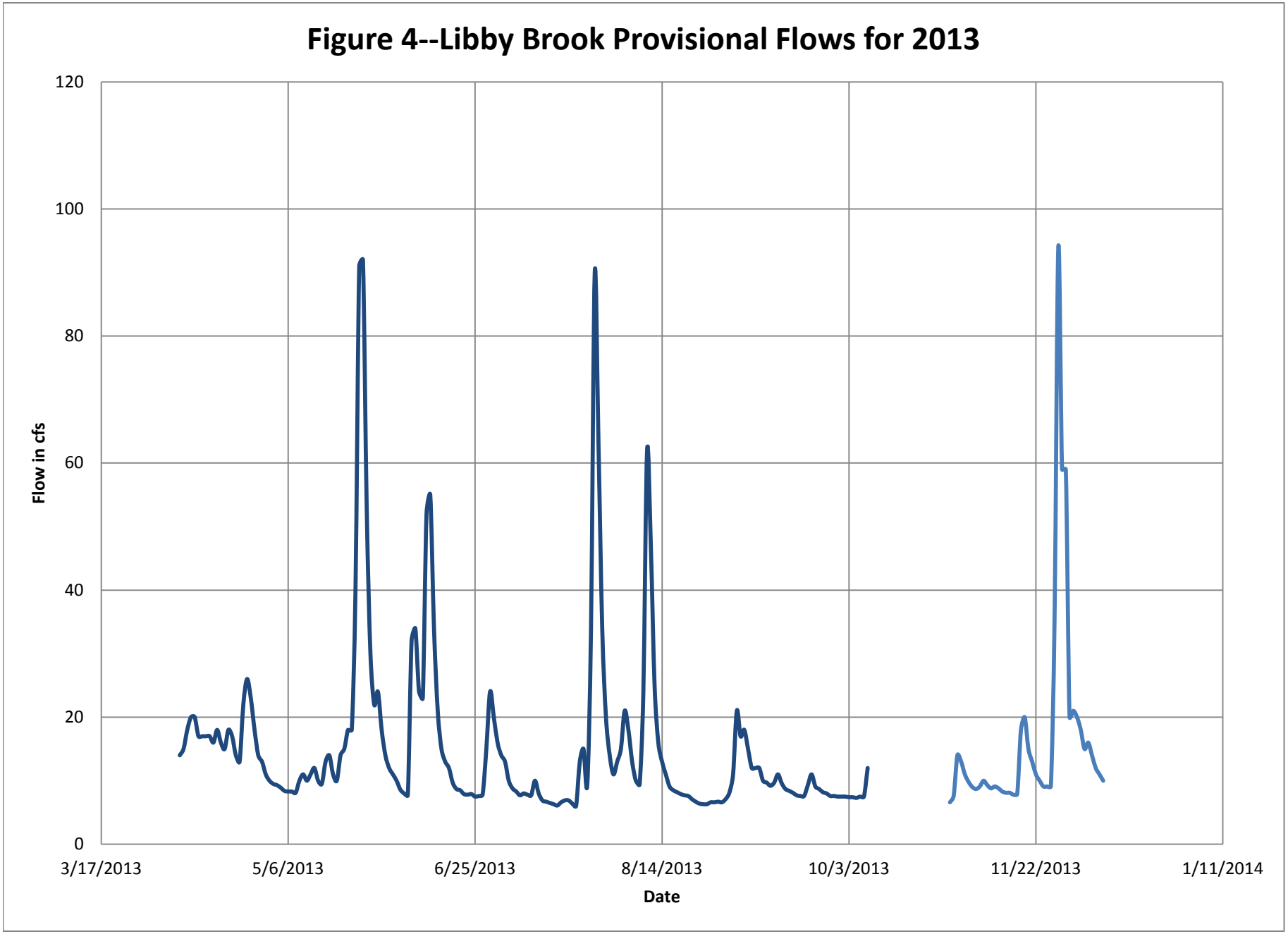


Figure 4--Libby Brook Provisional Flows for 2013
120
100
80
60
40
20
0
Flow in cfs
3/17/2013
5/6/2013
6/25/2013
8/14/2013
10/3/2013
11/22/2013
1/11/2014
Date

Attachment 2

SCALE: 1" = 600'

0 300 600 1200

NORTH

B [52 GPM]

C [30 GPM]

D [28 GPM]

A [1.5 GPM]

B SAND & GRAVEL (±54 ACRES)

C CLAY & SILT (±73 ACRES)

D CLAY & SILT (±46 ACRES)

E SILTY TILL (±123 ACRES)

A SAND & GRAVEL (±38 ACRES)

EXISTING KITTRIDGE PIT

PROPOSED EXPANSION AREA

UNNAMED BROOK

ARCHERS BROOK

MILL ROAD

BOG [138.8]

TEST BORING BLUEBERRY FIELD "ROAD"

SPRING STATIC WATER LEVEL [137.8]

COLD SPRING HOUSE STATIC WATER LEVEL [133 ±]

TEST BORING MILL ROAD

MW-2-2010 [86.1]

MW-4-2013 [87.6]

MW-3-2012 [<109.9 - DRY]

PB-1-2013 [87.2]

PB-2-2013 [79.6]

PB-3-2013 [80.2]

PB-4S-2013 [DRY]

PB-4D-2013 [86.2]

CSW-05 [122.94]

CSW-04 [134.54]

CSW-03 [133.09]

CSW-02 [133.28]

CSW-01 [133.34]

PZ-2003-3

PZ-2003-2

75 100 125 150 175

SUPPLEMENTAL WATER BALANCE CONTRIBUTION AREAS

KITTRIDGE PIT – ROUTE 184 – LAMOINE, MAINE

640 MAIN ST.
LEWISTON, ME 04240

Tel.: (207) 795-6009
Fax: (207) 795-6128
www.summitenv.com

Summit Environmental Consultants
A CES, Inc. Company

DATE: MAR. 2014	DRAWN BY: SBM	SCALE: AS NOTED
JOB NO.: 11-3240.5	CHECKED BY: MAD	CADD: N/A

NOTES

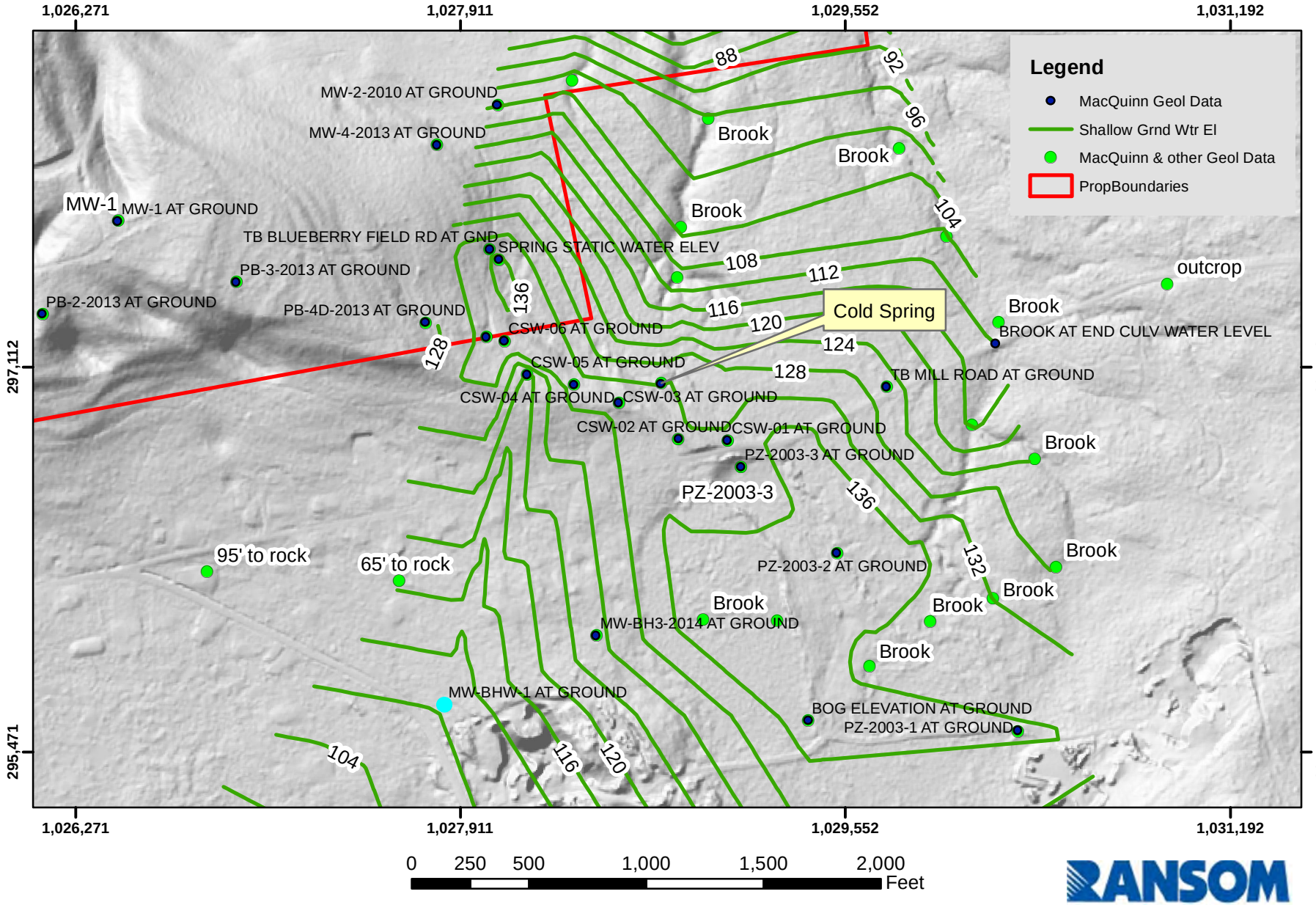
1) BASE PLAN AND TOPOGRAPHIC COUTOURS IN NGVD29 DATUM PROVIDE BY HERRICK & SALBURY, INC. ELEVATIONS BASED ON UNITED STATED GEOLOGICAL SURVEY (USGS) DATABASE. GENERAL STREAM LOCATIONS APPROXIMATED BASED ON USGS TOPOGRAPHIC MAP AND SURVEYED STREAM LOCATIONS NEAR STREAM FLOW MEASURING POINTS A, B, C & D.
2) CONTRIBUTION AREAS BASED ON SURFICIAL MATERIALS INFORMATION FROM ON-SITE BORINGS AND MAINE GEOLOGICAL SURVEY SURFICIAL GEOLOGY MAP.

A — GROUNDWATER CONTRIBUTION AREAS WITH AREA AND SURFICIAL MATERIAL INDICATED

O A [1.5 GPM] — BROOK FLOW MEASURING POINT & FLOW MEASURED ON AUGUST 26, 2013

—125— TOPOGRAPHIC COUNTOUR (FEET)

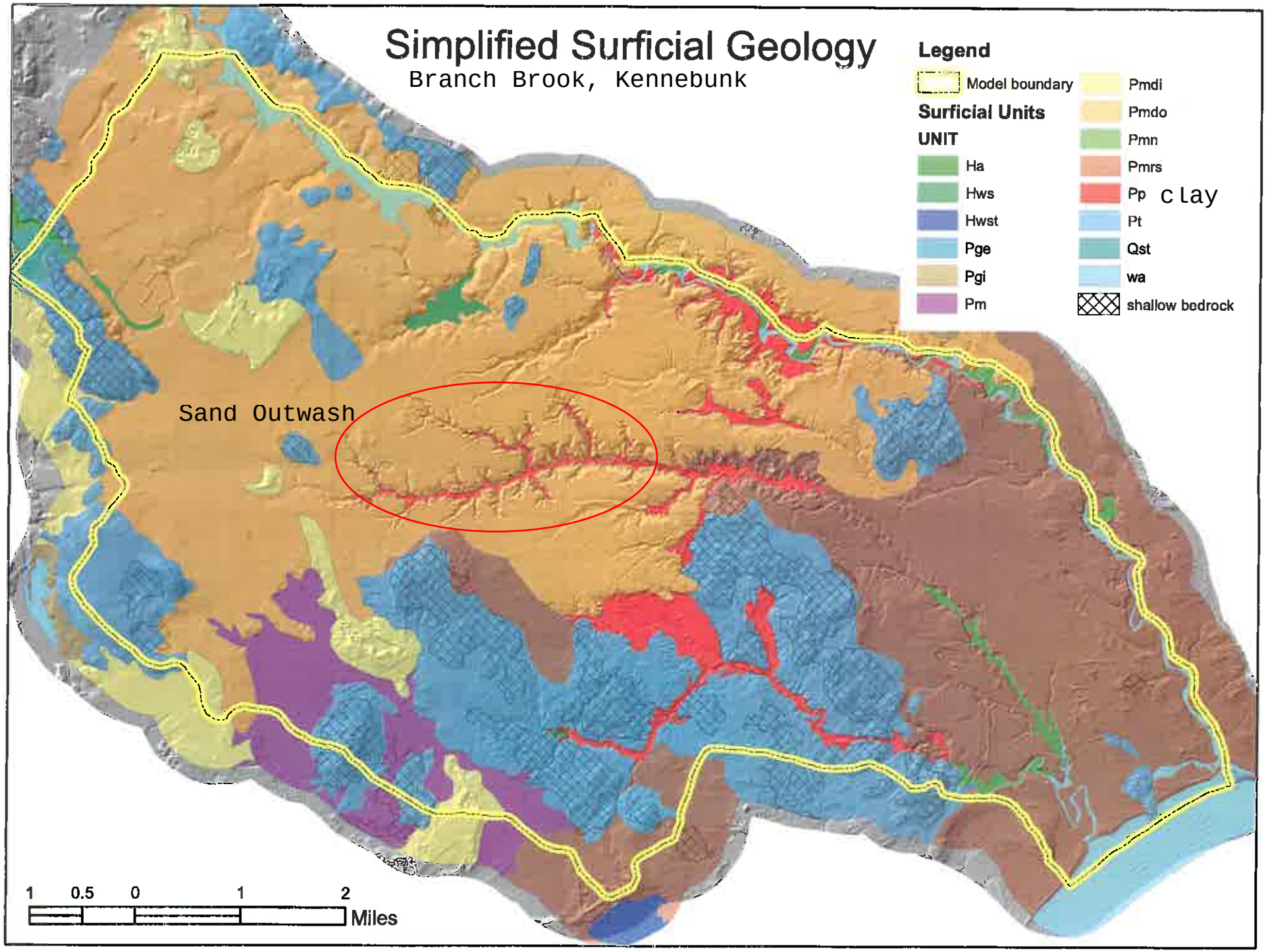
Attachment 3



Elevation Contours of Shallow Ground Water Table (NAVD88, ft.)
Town of Lamoine, MacQuinn Gravel Pit Expansion Review
Digital Elevation Model Developed from 2-m LiDAR
Grid is UTM, NAD83, 19N, meters
RGG 3-26-14 131.06066

RANSOM Consulting, Inc.

Attachment 4


Simplified Surficial Geology
Branch Brook, Kennebunk
Legend
Model boundary
Surficial Units
UNIT
Ha
Hws
Hwst
Pge
Pgi
Pm
Pmdi
Pmdo
Pmn
Pmrs
Pp
clay
Pt
Qst
wa
shallow bedrock
Sand Outwash
1 0.5 0 1 2
Miles