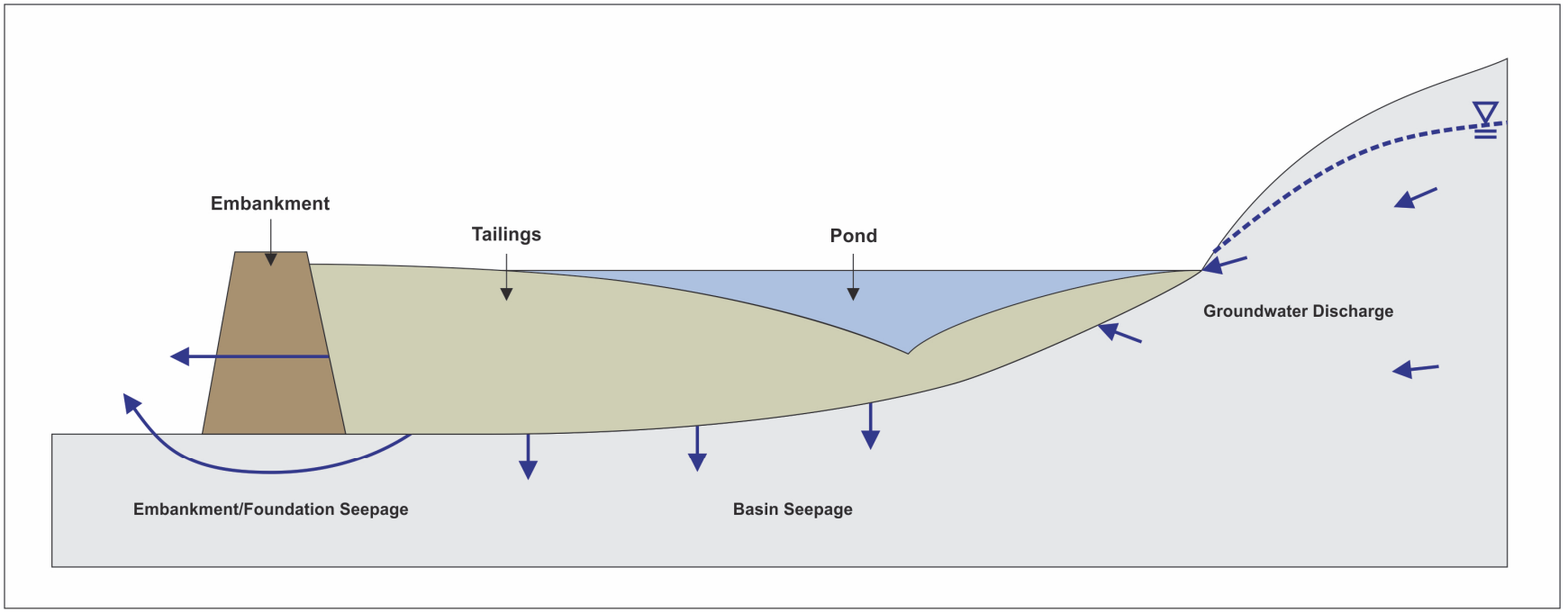

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: BULK TSF CONCEPTUAL SEEPAGE DIAGRAM
APPROVED BY: RT		BGC	PROJECT NO: 1872-002 / FIGURE NO: 7-1

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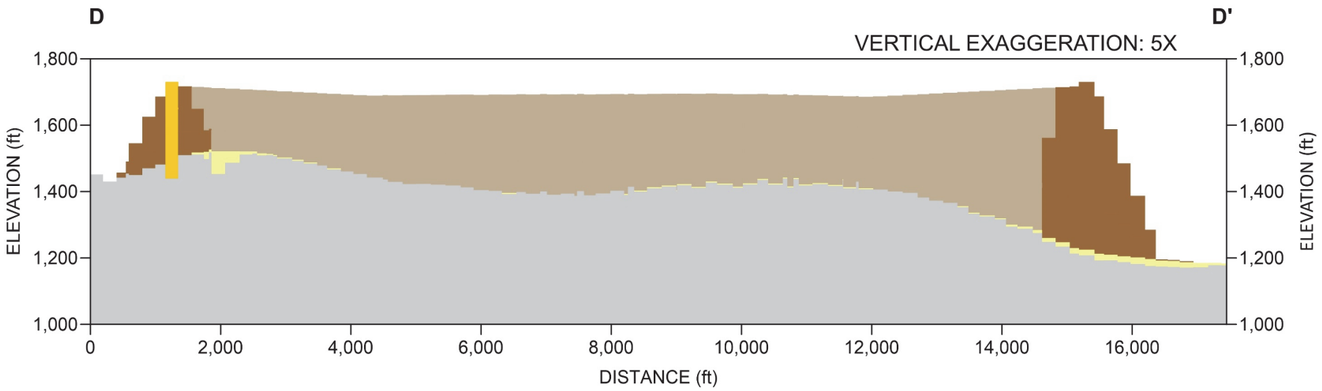

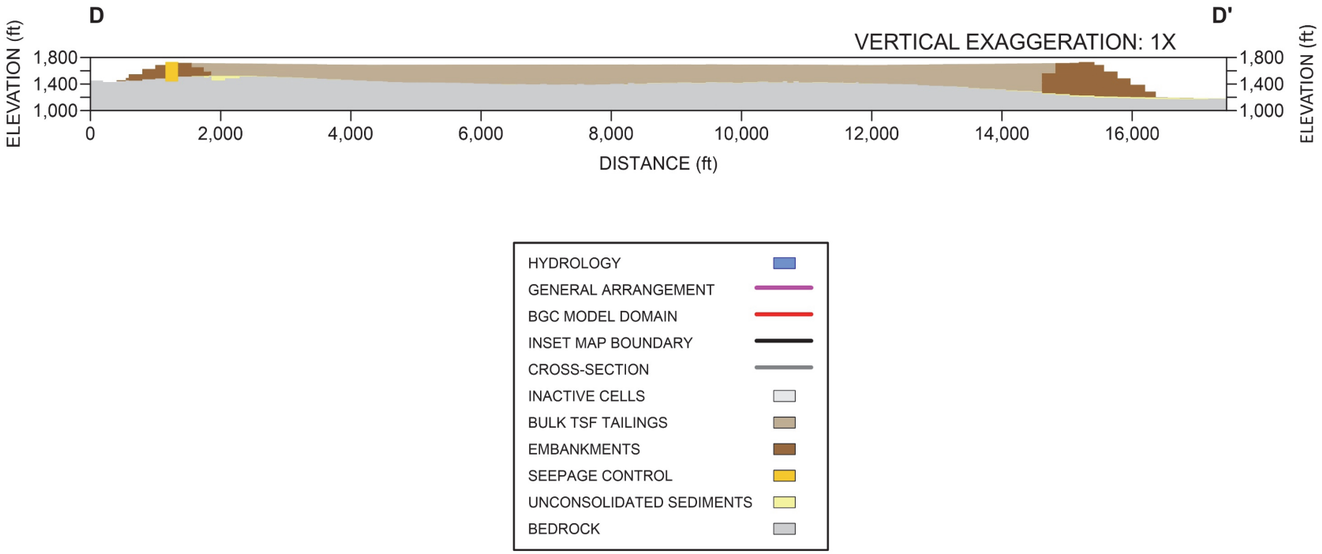

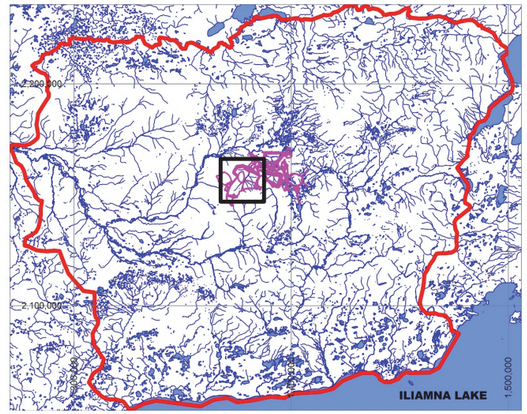

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. SEEPAGE CONTROL SIMULATED AS VERTICAL LOW HYDRAULIC CONDUCTIVITY MODEL CELLS FROM TOP OF ACTIVE MODEL TO BASE OF WEATHERED BEDROCK IN MODEL LAYER 4.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: ASSIGNED HYDROGEOLOGIC UNITS ALONG BULK TSF CROSS-SECTION D
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 7-2

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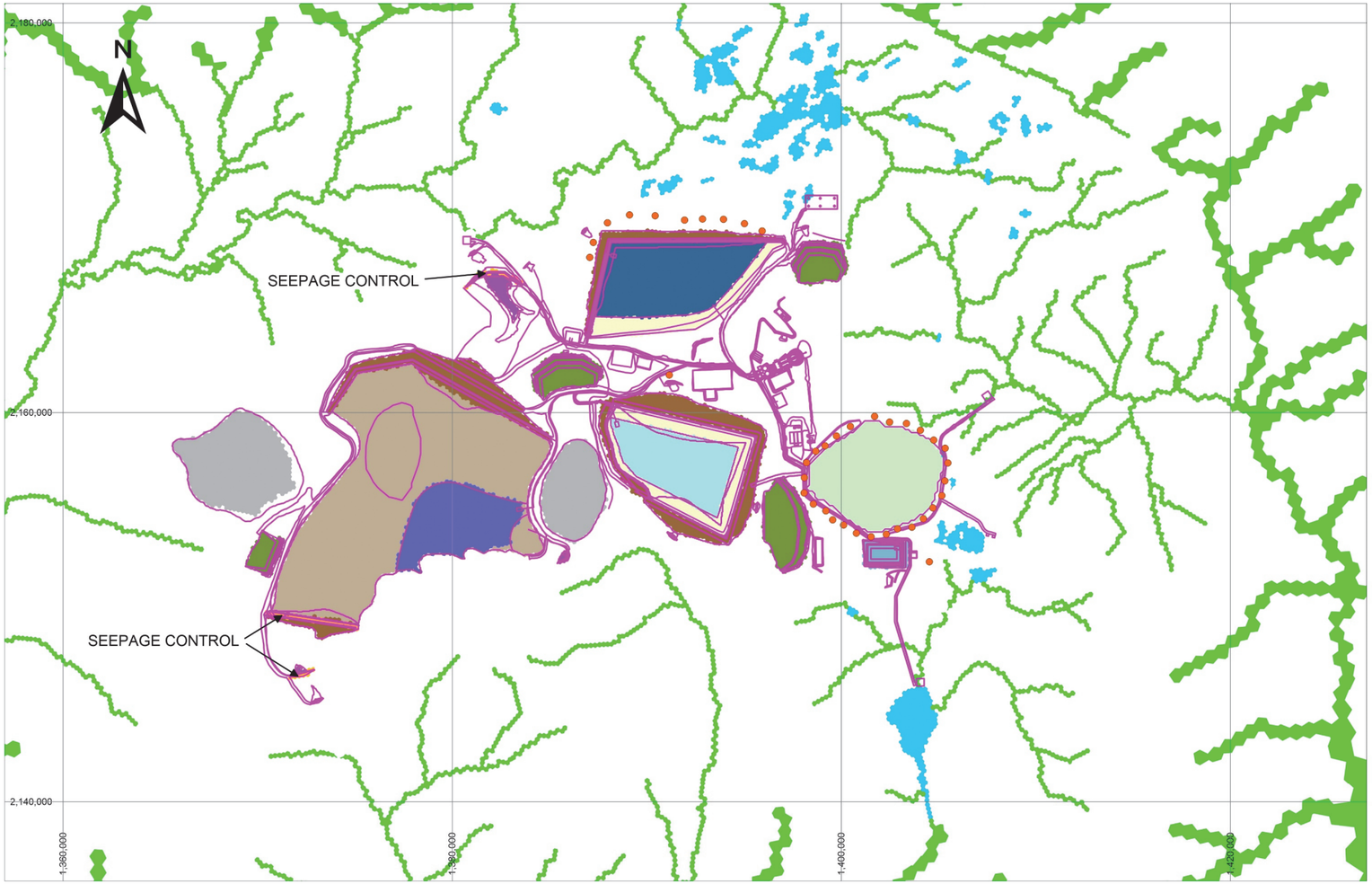

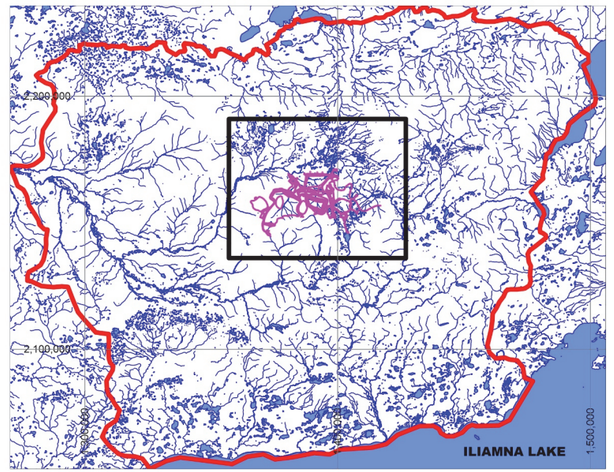

HYDROLOGY		PYRITIC TSF	
GENERAL ARRANGEMENT		BULK TSF POND	
BGC MODEL DOMAIN		BULK TSF TAILINGS	
INSET MAP BOUNDARY		LINER	
BOUNDARY CONDITIONS		EMBANKMENTS	
LAKES		SEEPAGE CONTROL	
STREAMS		SEEPAGE RECOVERY PONDS	
OPEN PIT		QUARRIES	
OPEN PIT WMP		STOCKPILES	
MAIN WMP		PUMPING WELLS	

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. OPEN PIT SIMULATED USING YEAR 20 WHITTLE PIT PROVIDED BY PLP IN EMAIL DATED FEBRUARY 19, 2019 (FILE: FINAL_PIT_APRIL_11_2017.DXF).
4. SEEPAGE CONTROL SIMULATED AS VERTICAL LOW HYDRAULIC CONDUCTIVITY MODEL CELLS FROM TOP OF ACTIVE MODEL TO BASE OF WEATHERED BEDROCK IN MODEL LAYER 4.
5. PIT DEWATERING WELLS AND SEEPAGE COLLECTION WELLS WERE NOT SIMULATED IN THE SCENARIO WITHOUT PUMPING WELLS.
6. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
7. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: BOUNDARY CONDITIONS: END-OF-MINING
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: 7-3

THE pebble PARTNERSHIP

BGC

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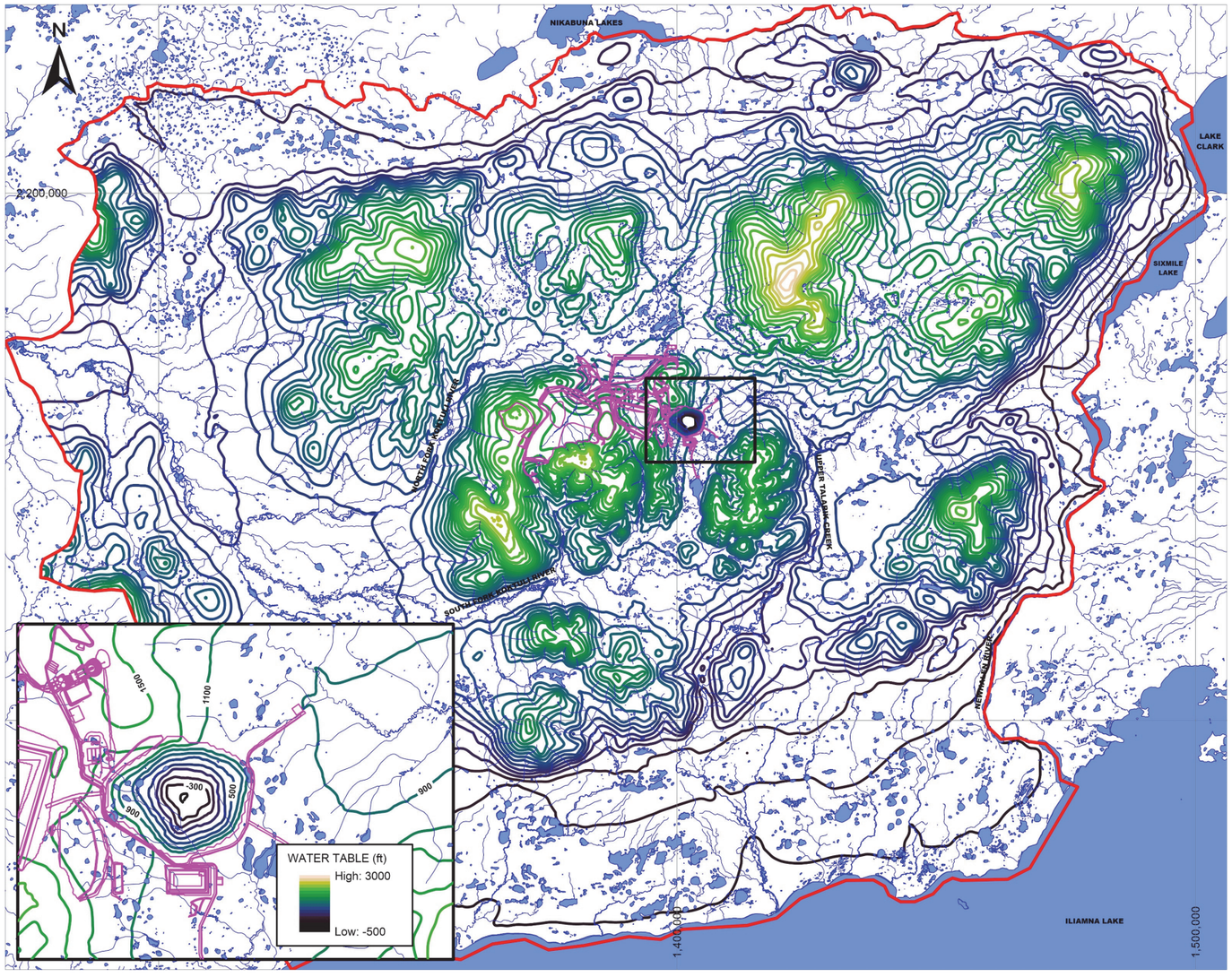

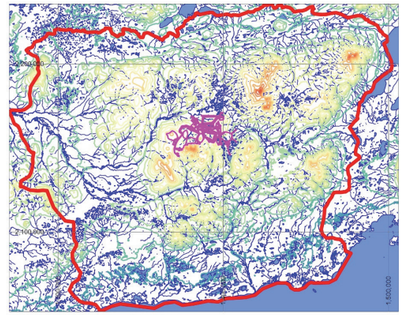

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
WATER TABLE (ft)
High: 3000
Low: 0
TOPOGRAPHY (ft)
High: 3200
Low: 0

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. CONTOUR INTERVAL 100 ft. INSET MAP CONTOUR INTERVAL 200 ft.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED END-OF-MINING WATER TABLE FOR THE SCENARIO WITHOUT PUMPING WELLS
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 7-4

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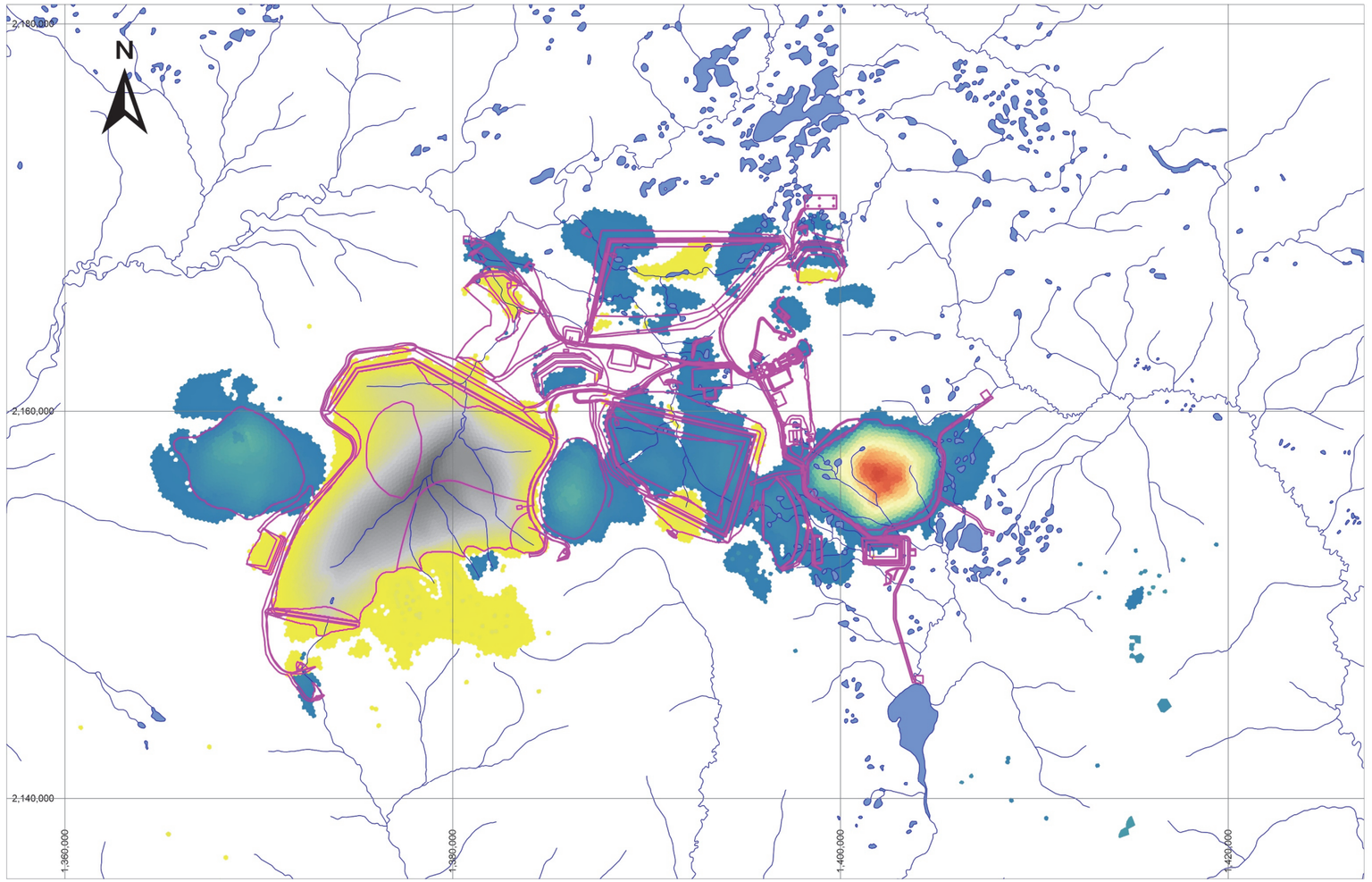

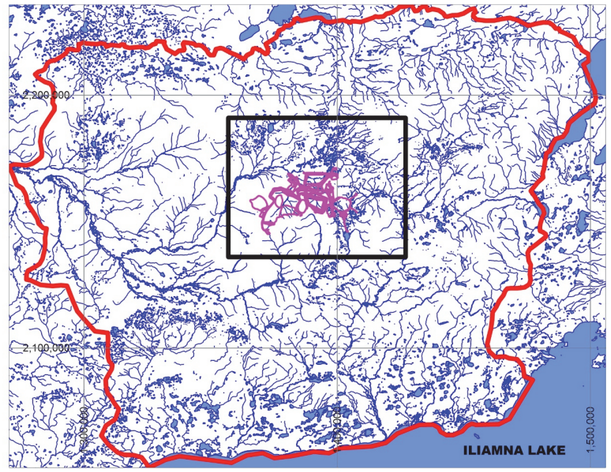

HYDROLOGY

GENERAL ARRANGEMENT

BGC MODEL DOMAIN

INSET MAP BOUNDARY

DRAWDOWN

High: 1,650 ft

Low: 3 ft

MOUNDING

High: 400 ft

Low: 3 ft

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED END-OF-MINING DRAWDOWN AND MOUNDING FOR THE SCENARIO WITHOUT PUMPING WELLS: WATER TABLE
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 7-5

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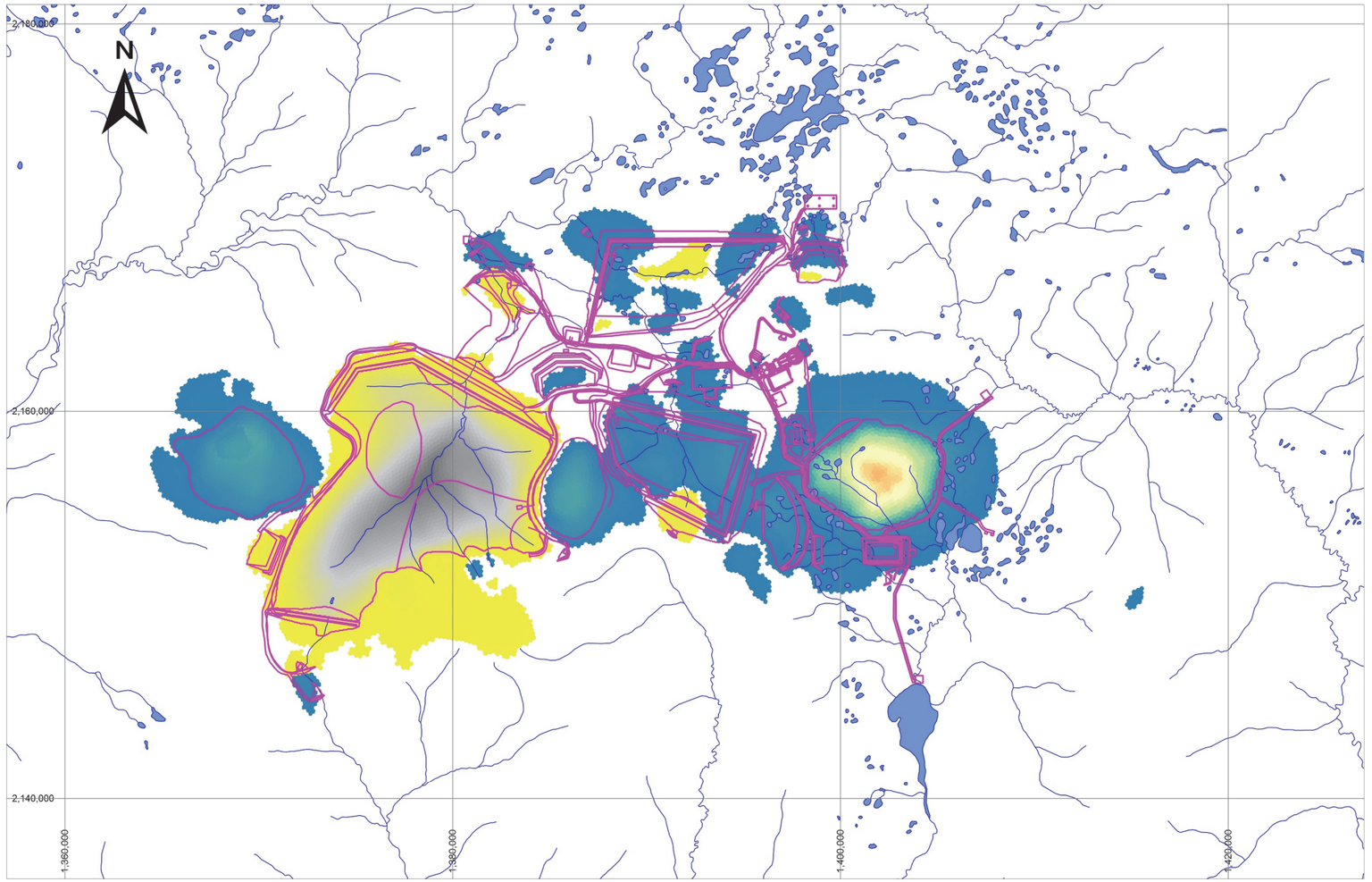

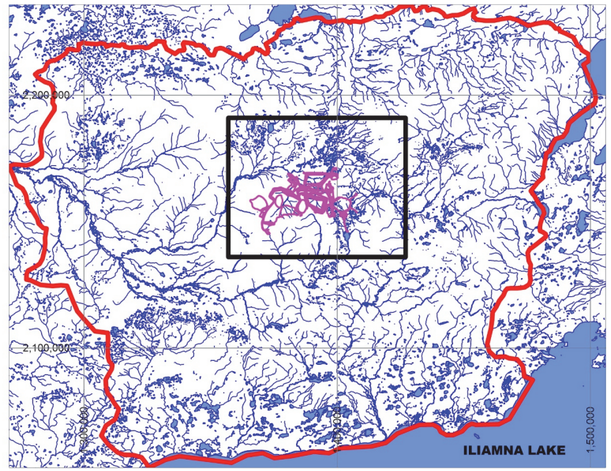

HYDROLOGY
GENERAL ARRANGEMENT
BGC MODEL DOMAIN
INSET MAP BOUNDARY

DRAWDOWN
High: 1,650 ft
Low: 3 ft

MOUNDING
High: 400 ft
Low: 3 ft

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: SIMULATED END OF MINING DRAWDOWN AND MOUNDING FOR THE SCENARIO WITHOUT PUMPING WELLS: TOP COMPETENT BEDROCK	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: 7-6

THE pebble PARTNERSHIP

BGC

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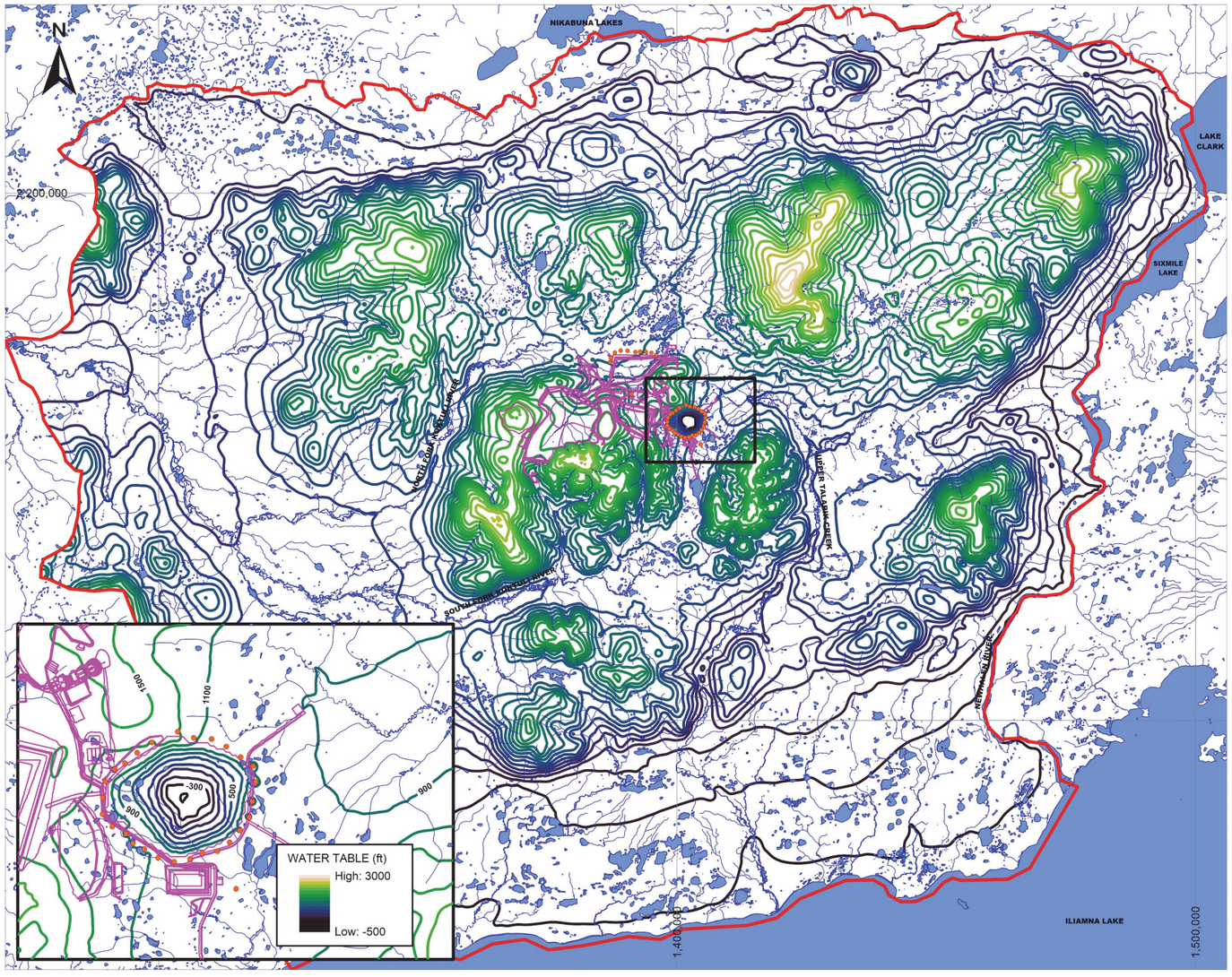

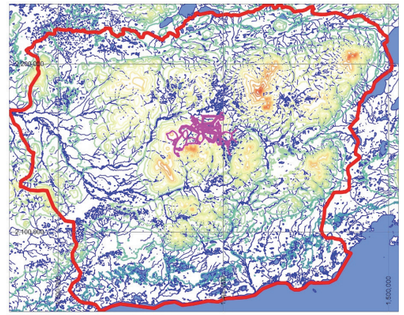

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
PUMPING WELLS
WATER TABLE (ft)
High: 3000
Low: 0
TOPOGRAPHY (ft)
High: 3200
Low: 0

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. CONTOUR INTERVAL 100 ft. INSET MAP CONTOUR INTERVAL 200 ft.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED END-OF-MINING WATER TABLE FOR THE PUMPING WELL SCENARIO
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 7-7

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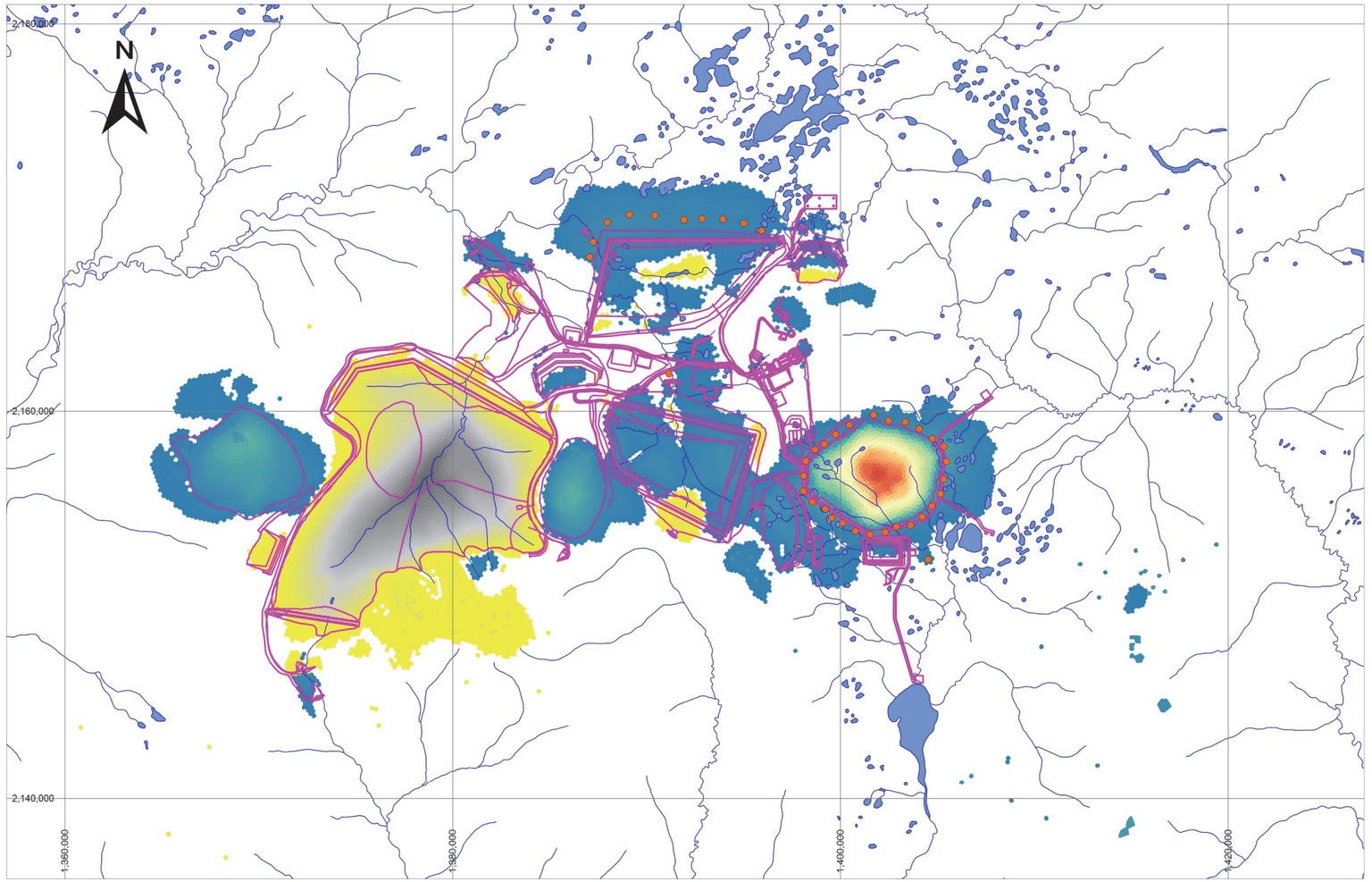

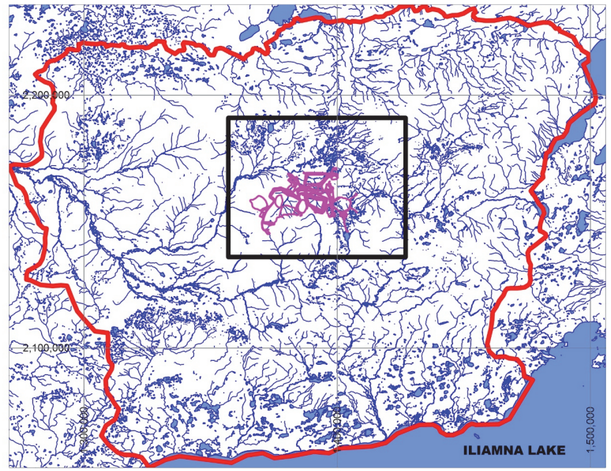

HYDROLOGY

GENERAL ARRANGEMENT

BGC MODEL DOMAIN

INSET MAP BOUNDARY

PUMPING WELLS

DRAWDOWN

High: 1,650 ft

Low: 3 ft

MOUNDING

High: 400 ft

Low: 3 ft

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED END-OF-MINING DRAWDOWN AND MOUNDING FOR THE PUMPING WELL SCENARIO: WATER TABLE
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 7-8

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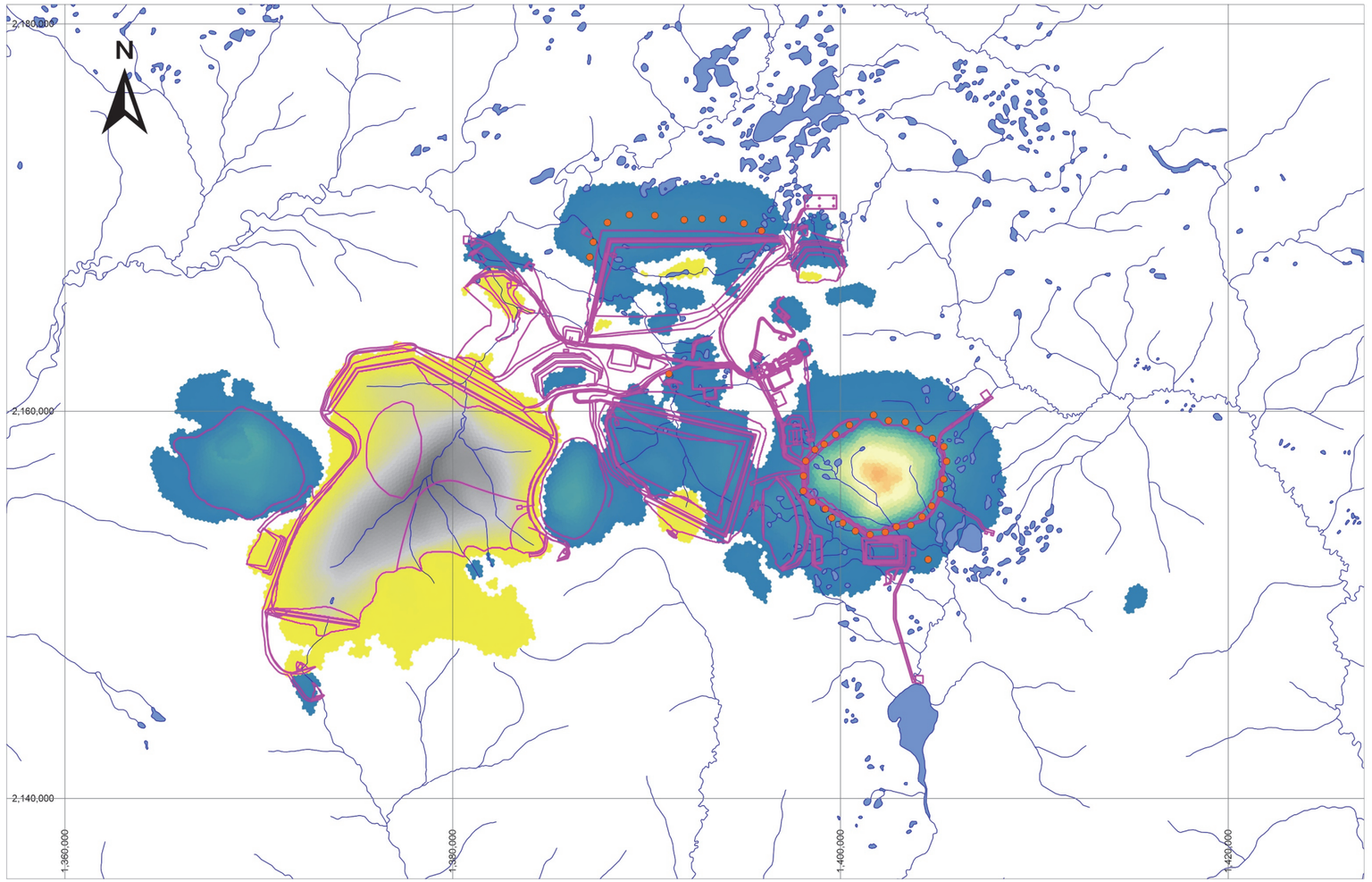

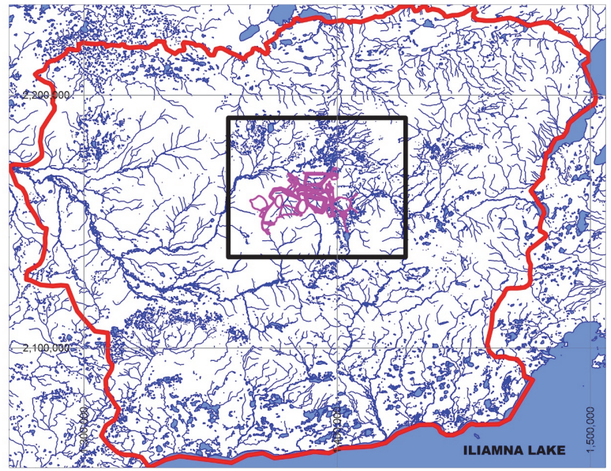

HYDROLOGY
GENERAL ARRANGEMENT
BGC MODEL DOMAIN
INSET MAP BOUNDARY
PUMPING WELLS
DRAWDOWN
High: 1,650 ft
Low: 3 ft
MOUNDING
High: 400 ft
Low: 3 ft

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED END OF MINING DRAWDOWN AND MOUNDING FOR THE PUMPING WELL SCENARIO: TOP COMPETENT BEDROCK
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 7-9

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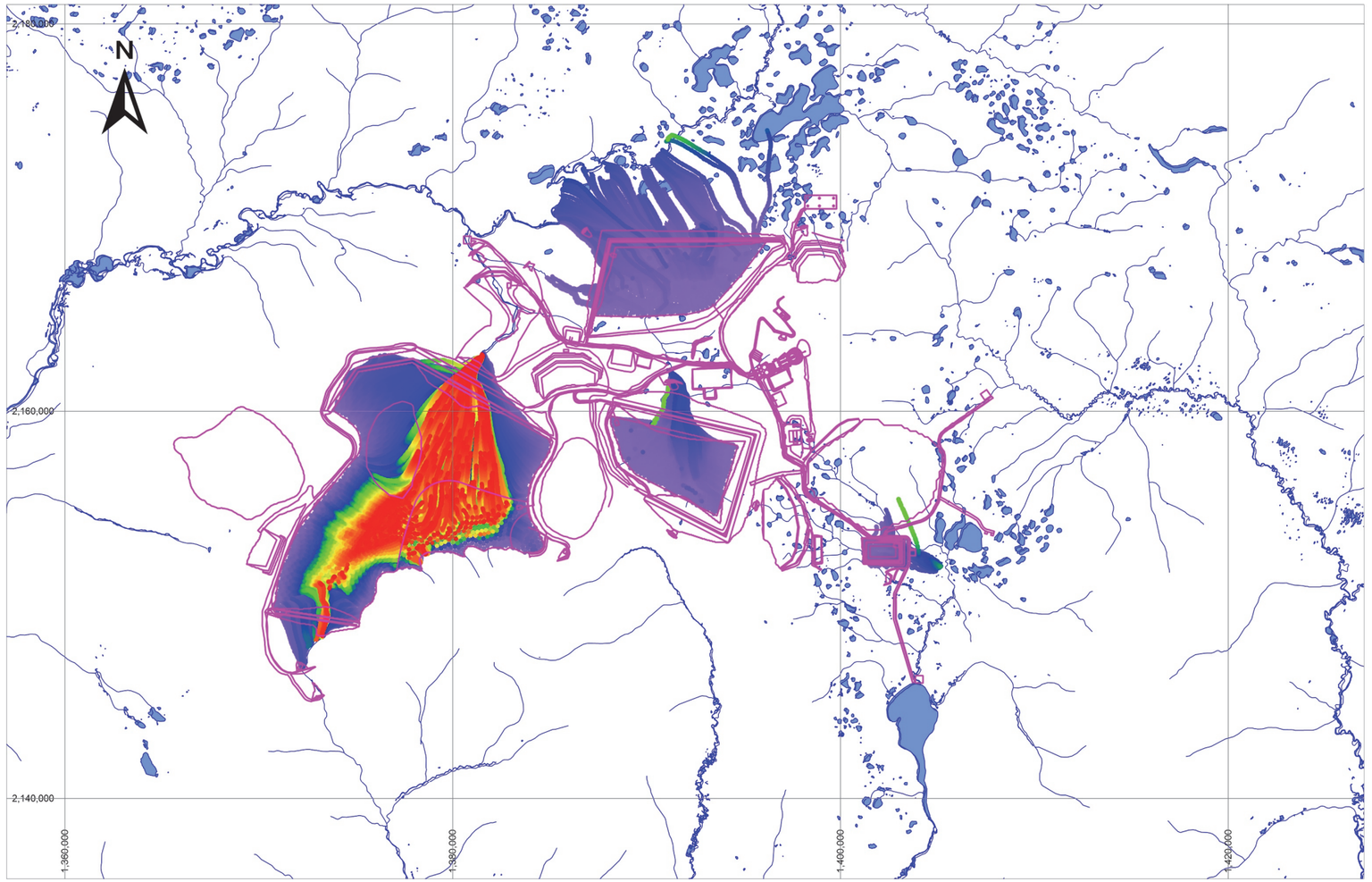

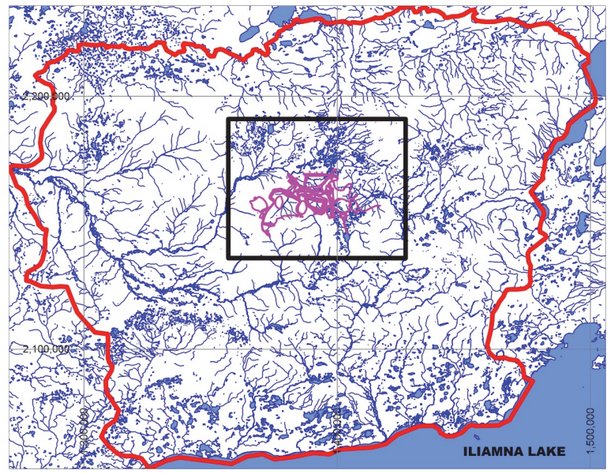

HYDROLOGY
GENERAL ARRANGEMENT
BGC MODEL DOMAIN
INSET MAP BOUNDARY
PARTICLE TRAVEL TIME (yr)
High: 100
Low: 0

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: PARTICLE TRACKING RESULTS: SCENARIO WITHOUT PUMPING WELLS END-OF-MINING	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: 7-10

THE pebble PARTNERSHIP

BGC

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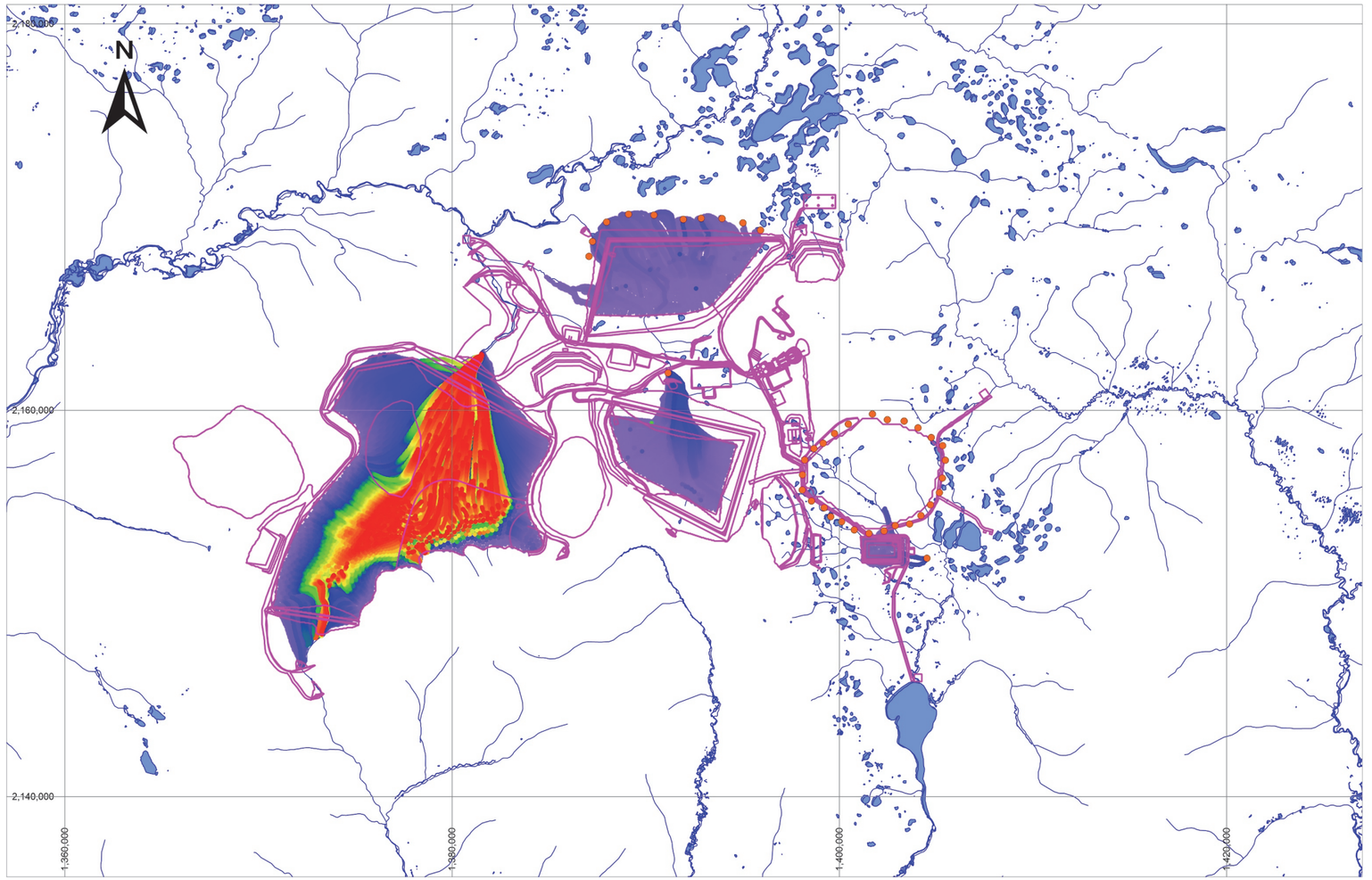

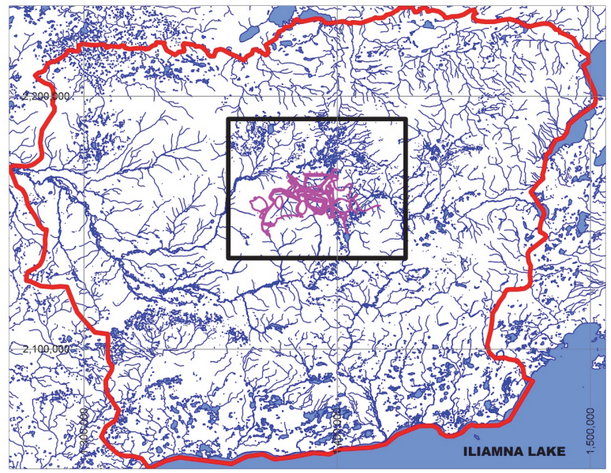

HYDROLOGY
GENERAL ARRANGEMENT
BGC MODEL DOMAIN
INSET MAP BOUNDARY
PUMPING WELLS
PARTICLE TRAVEL TIME (yr)
High: 100
Low: 0

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: PARTICLE TRACKING RESULTS: SCENARIO WITH PUMPING WELLS END-OF-MINING	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: 7-11

THE pebble PARTNERSHIP

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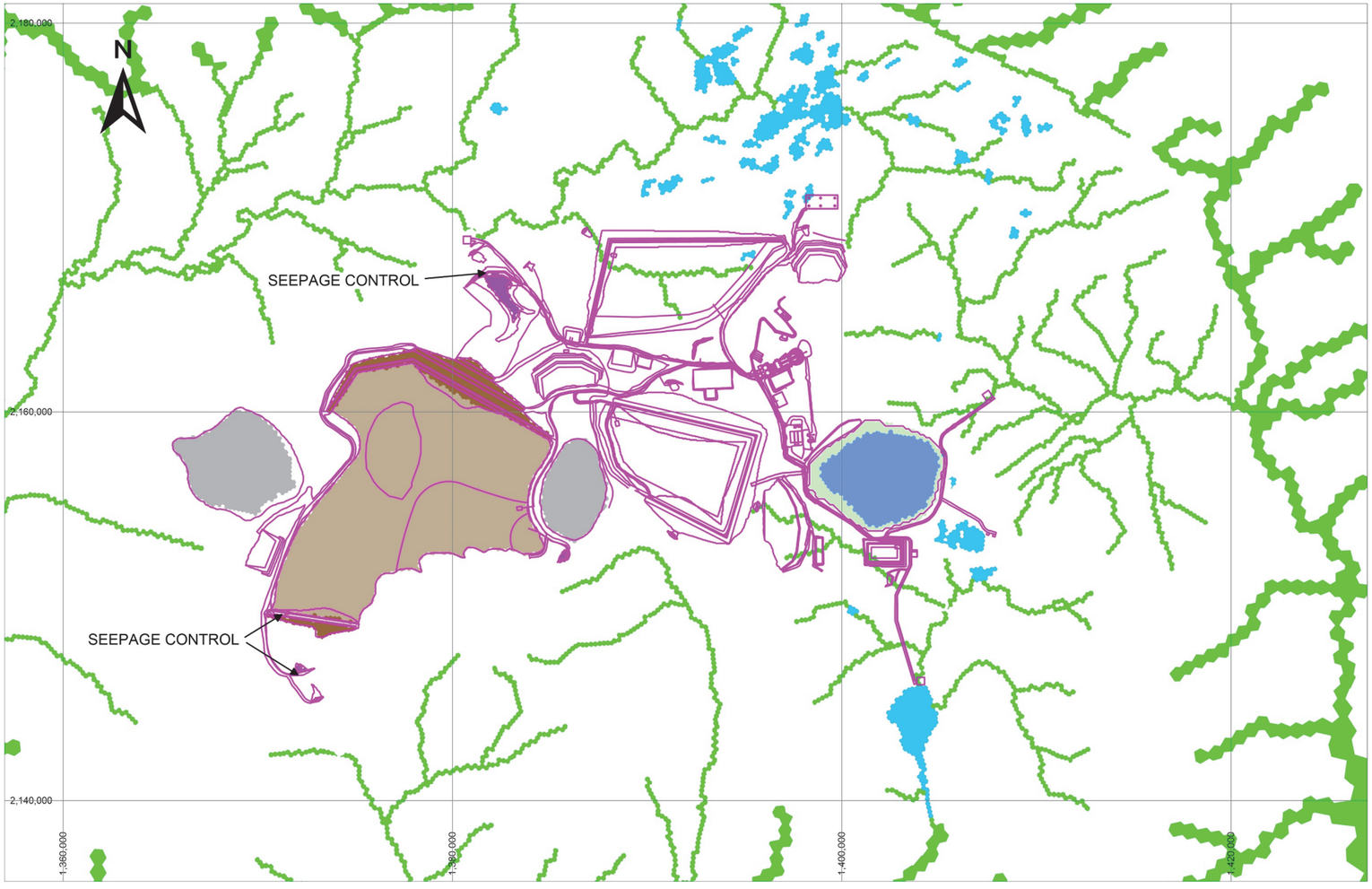

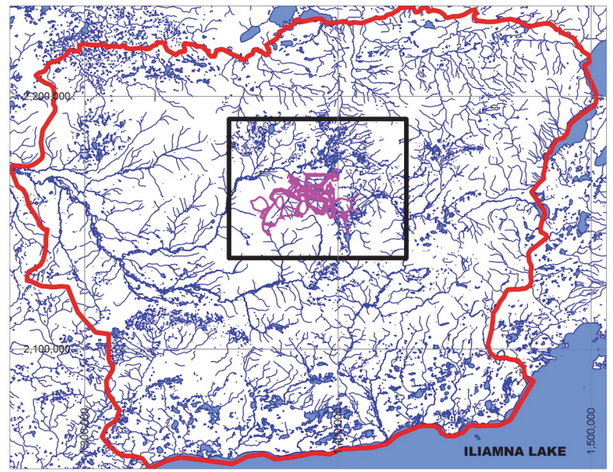

HYDROLOGY
GENERAL ARRANGEMENT
BGC MODEL DOMAIN
INSET MAP BOUNDARY
BOUNDARY CONDITIONS
LAKES
STREAMS
OPEN PIT WALLS
PIT LAKE
RECLAIMED BULK TSF TAILINGS
RECLAIMED EMBANKMENTS
SEEPAGE RECOVERY PONDS
RECLAIMED QUARRIES
SEEPAGE CONTROL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. OPEN PIT SIMULATED USING YEAR 20 WHITTLE PIT PROVIDED BY PLP IN EMAIL DATED FEBRUARY 19, 2019 (FILE: FINAL_PIT_APRIL_11_2017.DXF).
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: BOUNDARY CONDITIONS: POST-CLOSURE	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: 8-1

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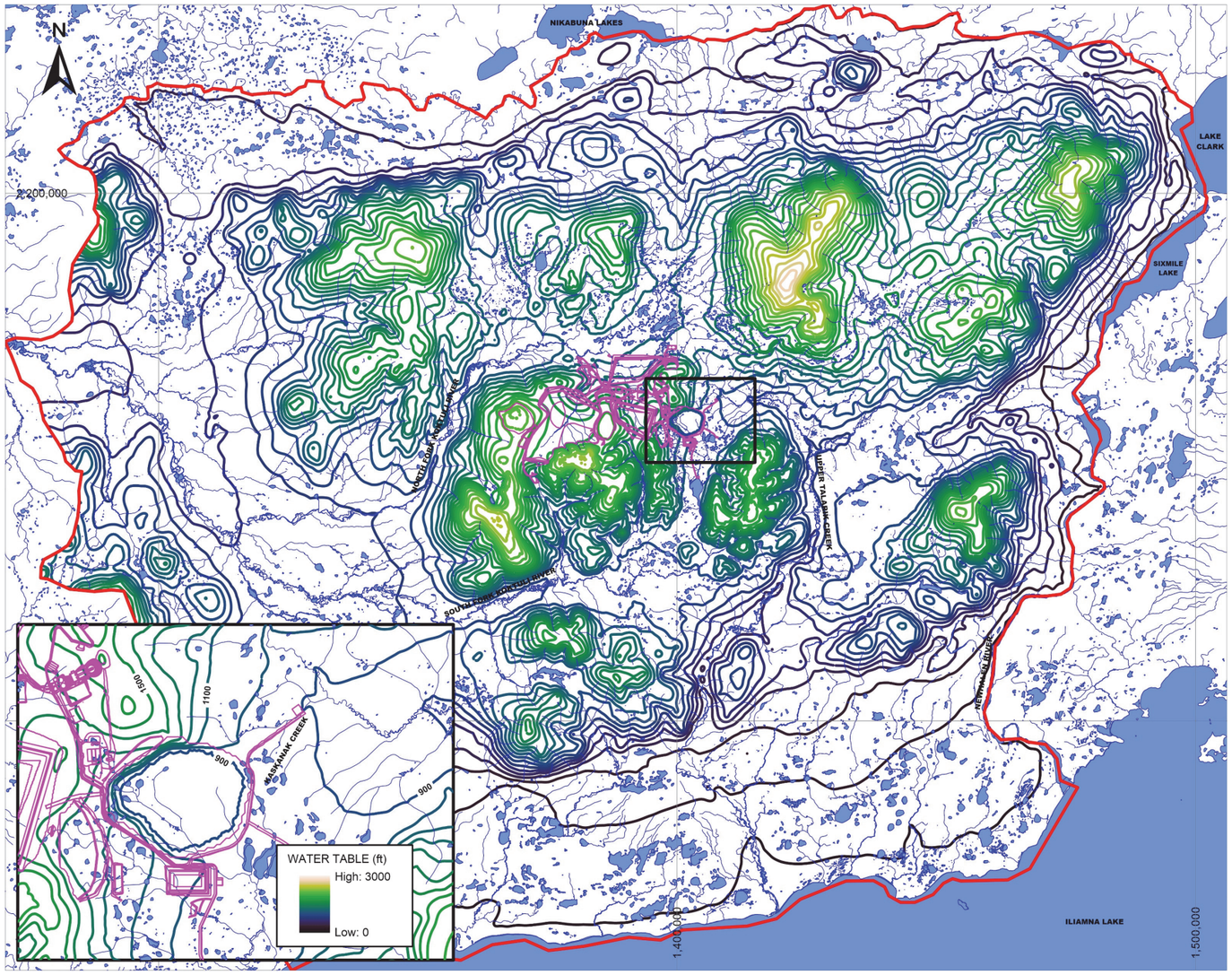

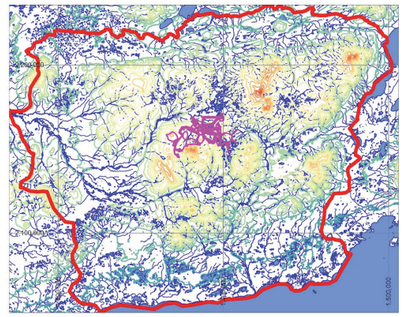

HYDROLOGY
MODEL DOMAIN
MINE FOOTPRINT
WATER TABLE (ft)
High: 3000
Low: 0
TOPOGRAPHY (ft)
High: 3200
Low: 0

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. CONTOUR INTERVAL 100 ft.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: SIMULATED WATER TABLE: POST-CLOSURE
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: 8-2

THE pebble PARTNERSHIP

BGC

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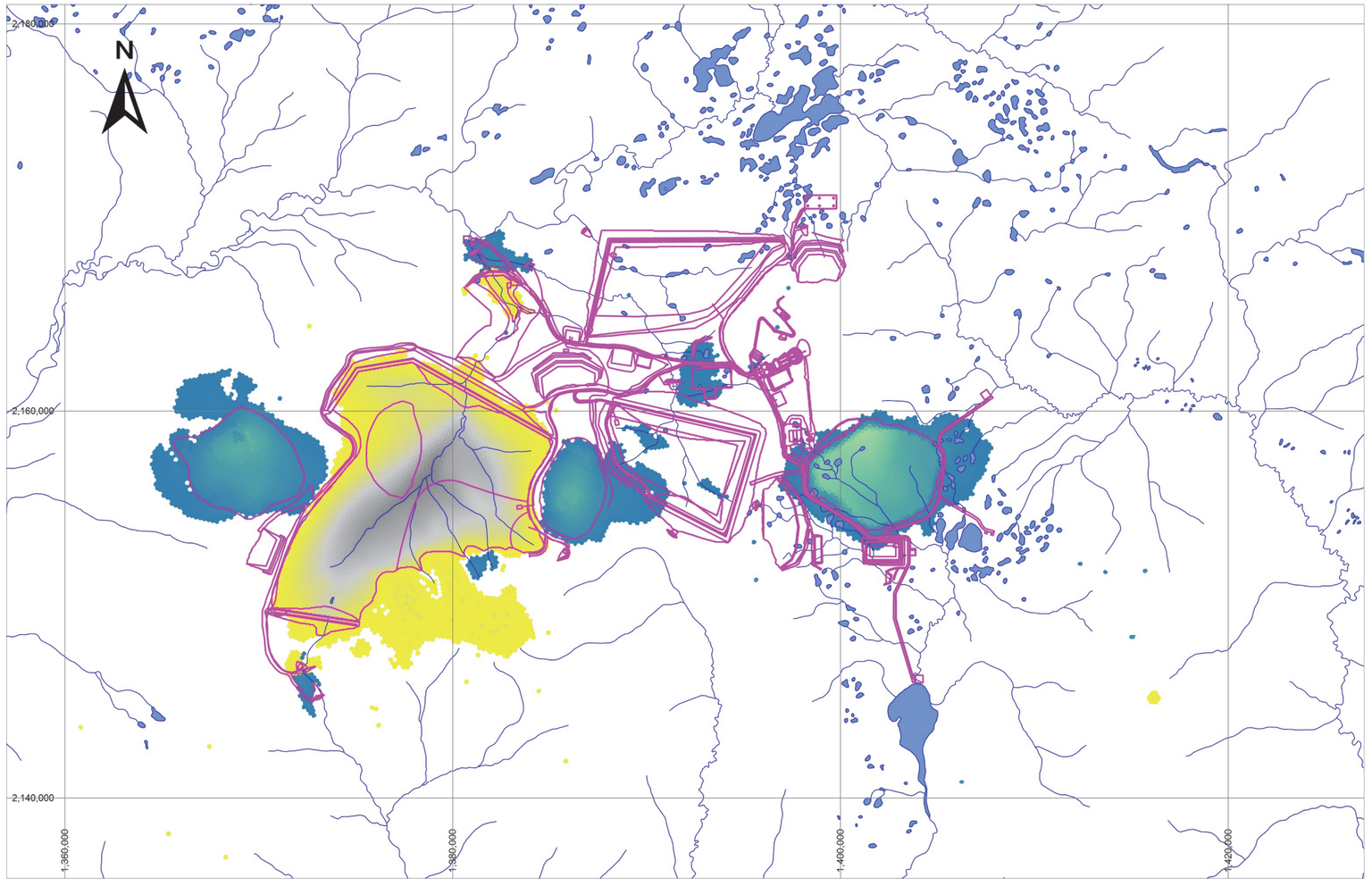

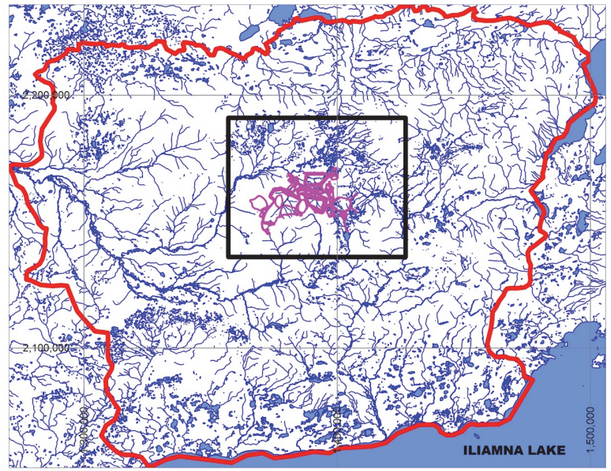

HYDROLOGY

GENERAL ARRANGEMENT

BGC MODEL DOMAIN

INSET MAP BOUNDARY

DRAWDOWN

High: 1,650 ft

Low: 3 ft

MOUNDING

High: 400 ft

Low: 3 ft

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED DRAWDOWN AND MOUNDING POST-CLOSURE: WATER TABLE
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: 8-3

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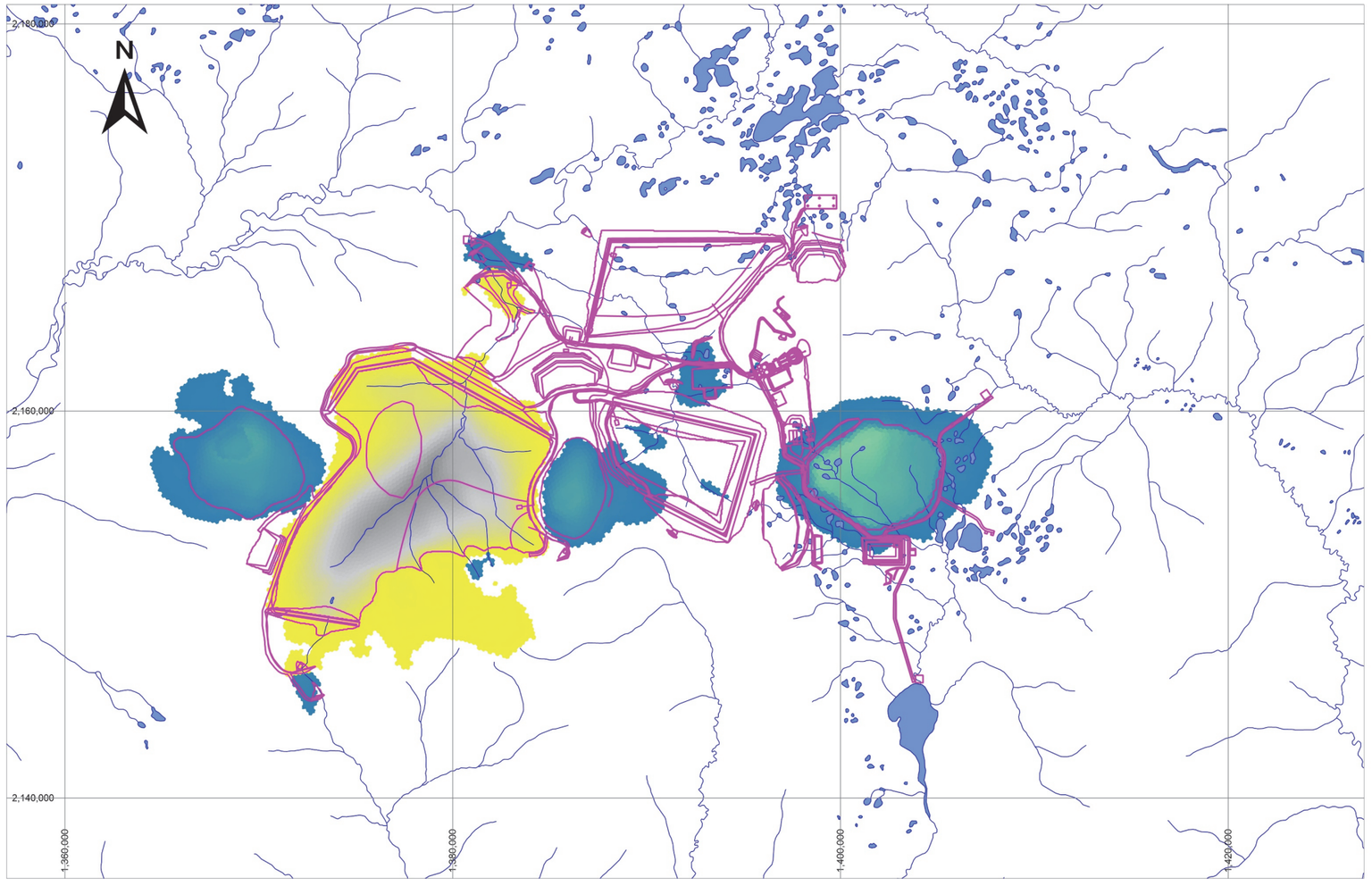

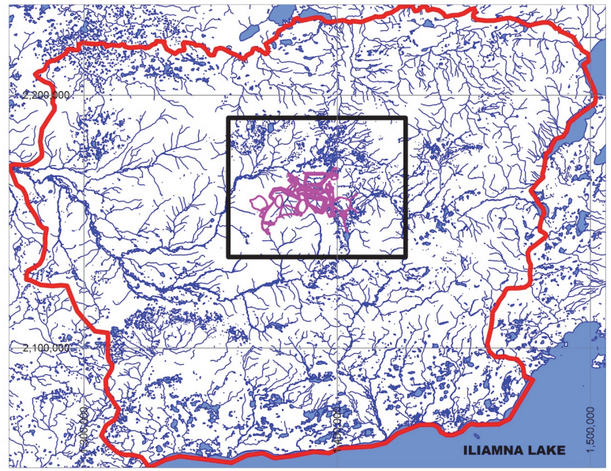

HYDROLOGY

GENERAL ARRANGEMENT

BGC MODEL DOMAIN

INSET MAP BOUNDARY

DRAWDOWN

High: 1,650 ft

Low: 3 ft

MOUNDING

High: 400 ft

Low: 3 ft

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: SIMULATED DRAWDOWN AND MOUNDING POST-CLOSURE: TOP COMPETENT BEDROCK
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: 8-4

THE pebble PARTNERSHIP

BGC

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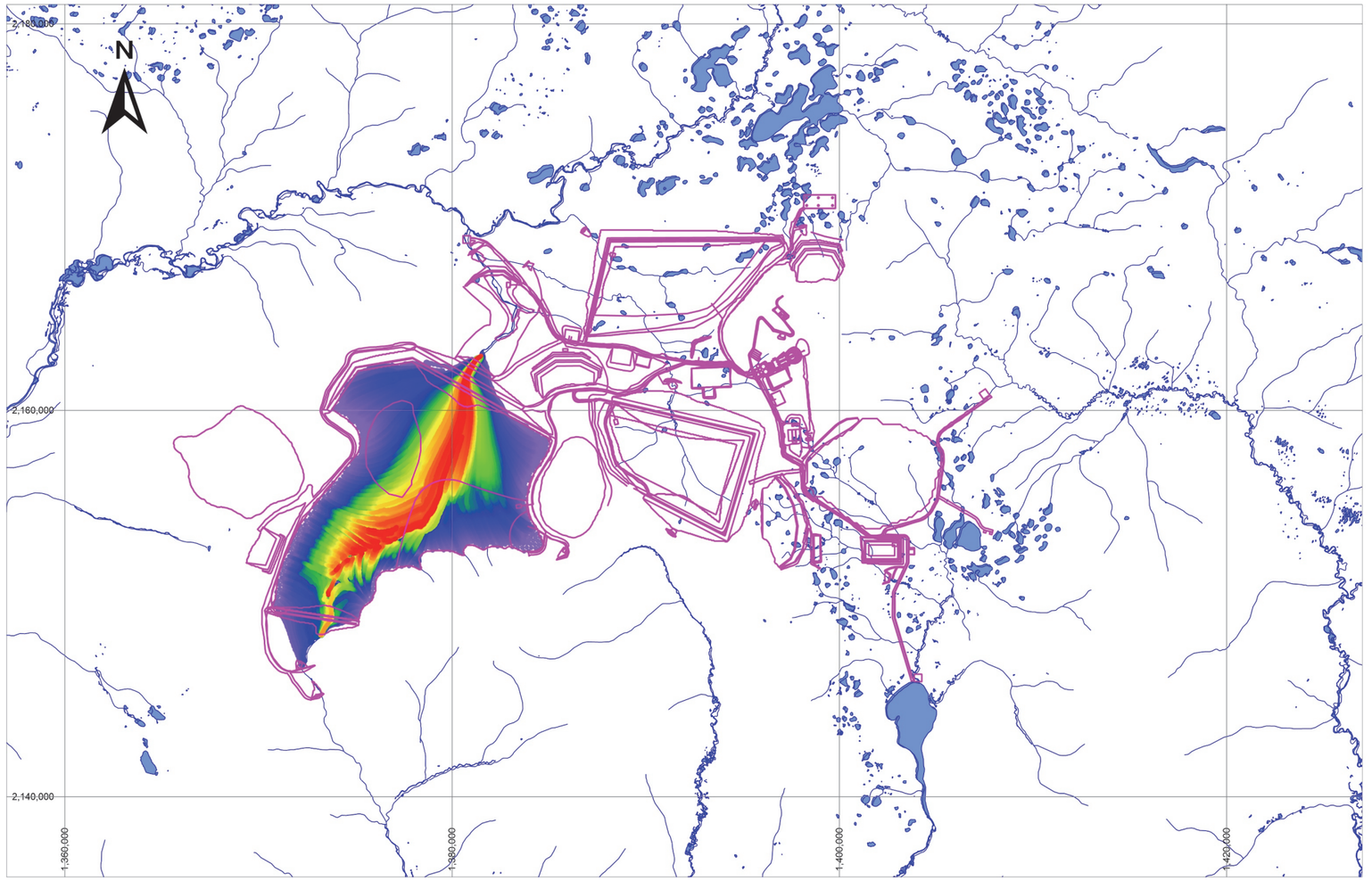

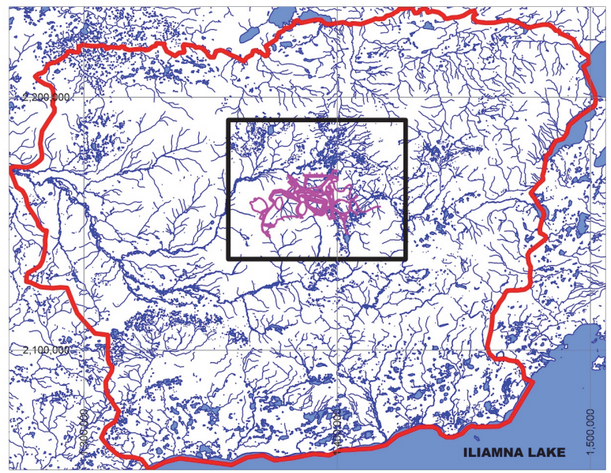

HYDROLOGY
GENERAL ARRANGEMENT
BGC MODEL DOMAIN
INSET MAP BOUNDARY
PARTICLE TRAVEL TIME (yr)
High: 100
Low: 0

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: PARTICLE TRACKING RESULTS: POST-CLOSURE	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: 8-5

THE pebble PARTNERSHIP

BGC

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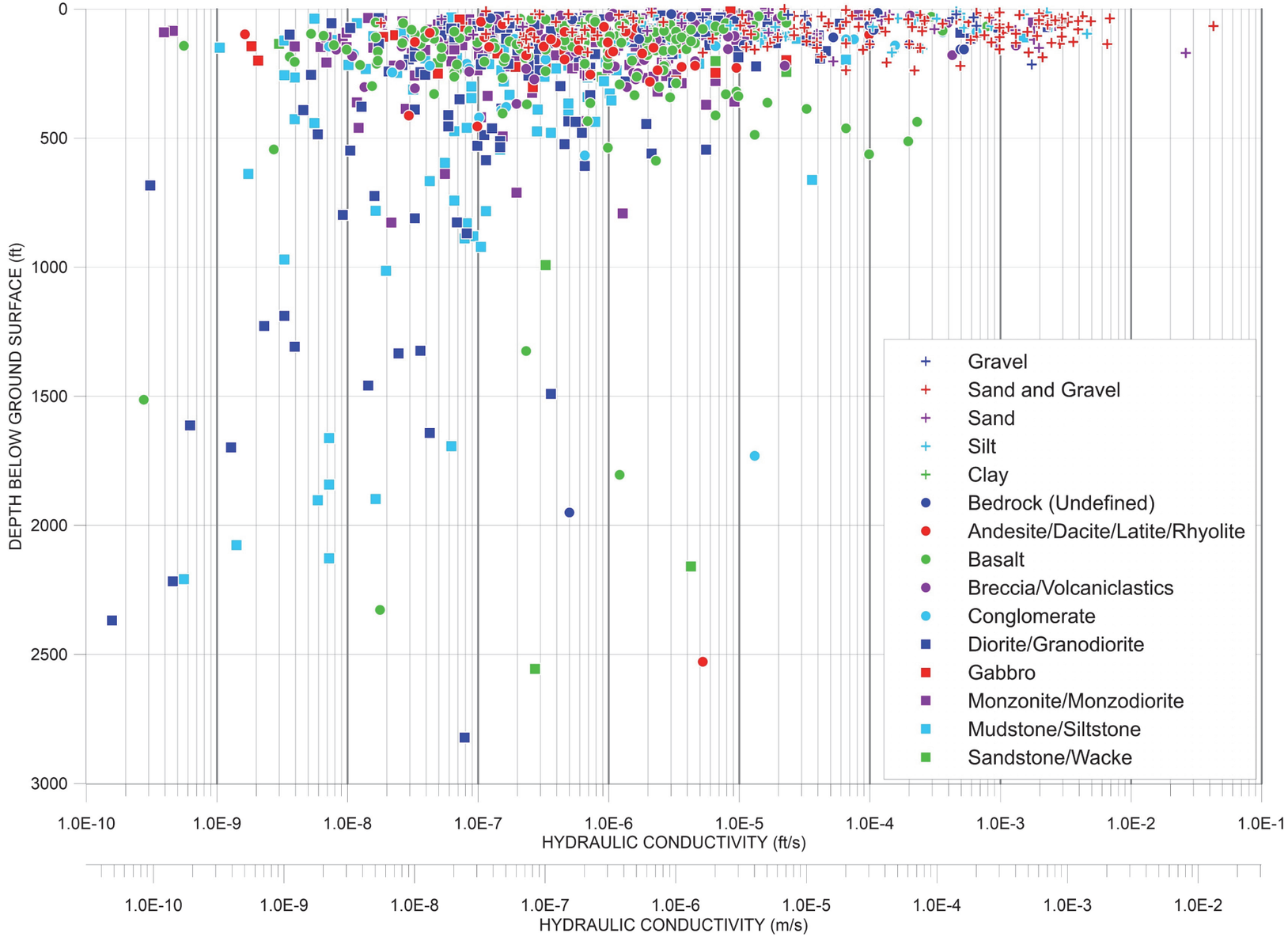
APPENDIX A
HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH



NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: ALL GEOLOGY COMBINED
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-1

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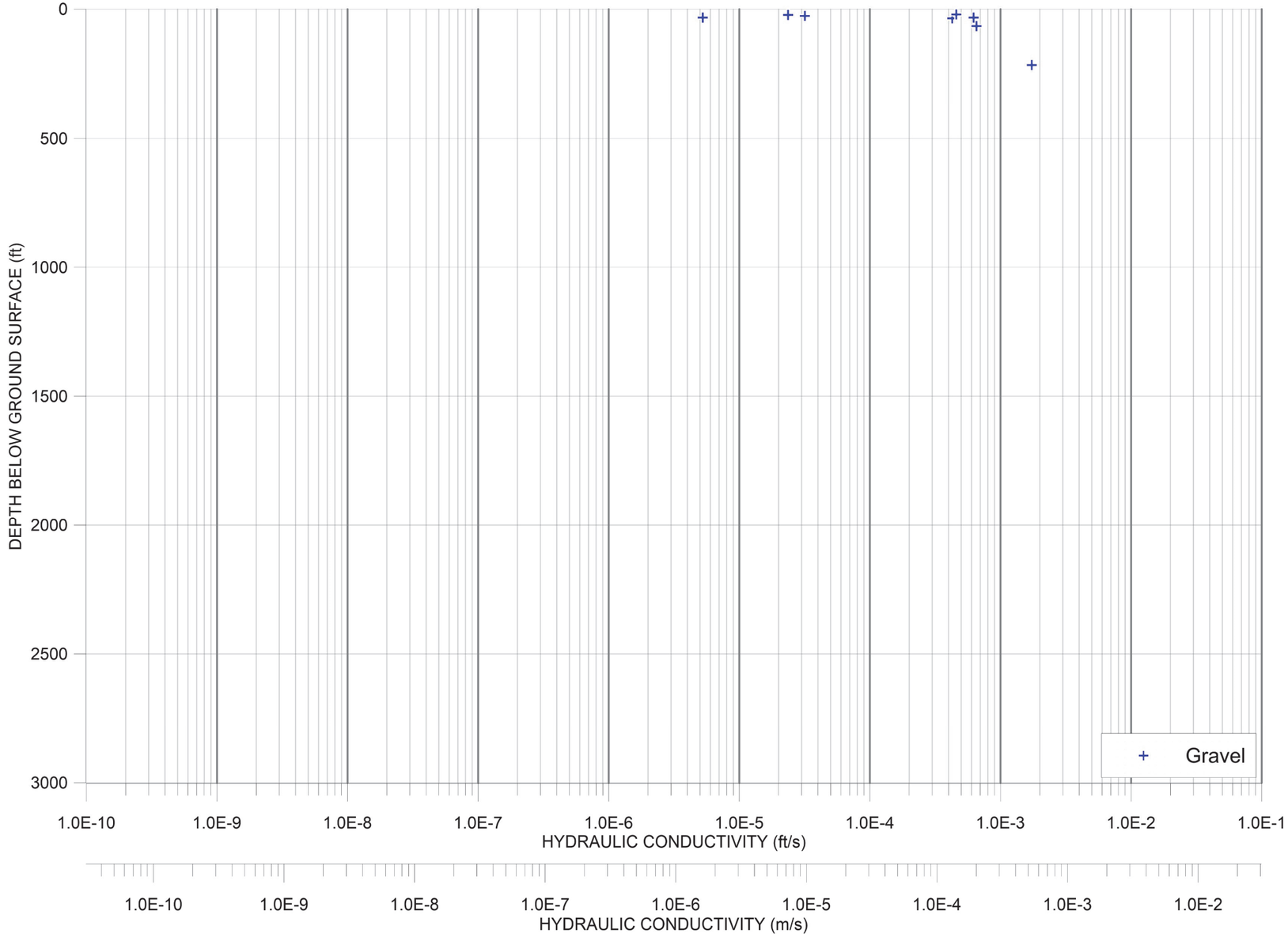

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: GRAVEL
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-2

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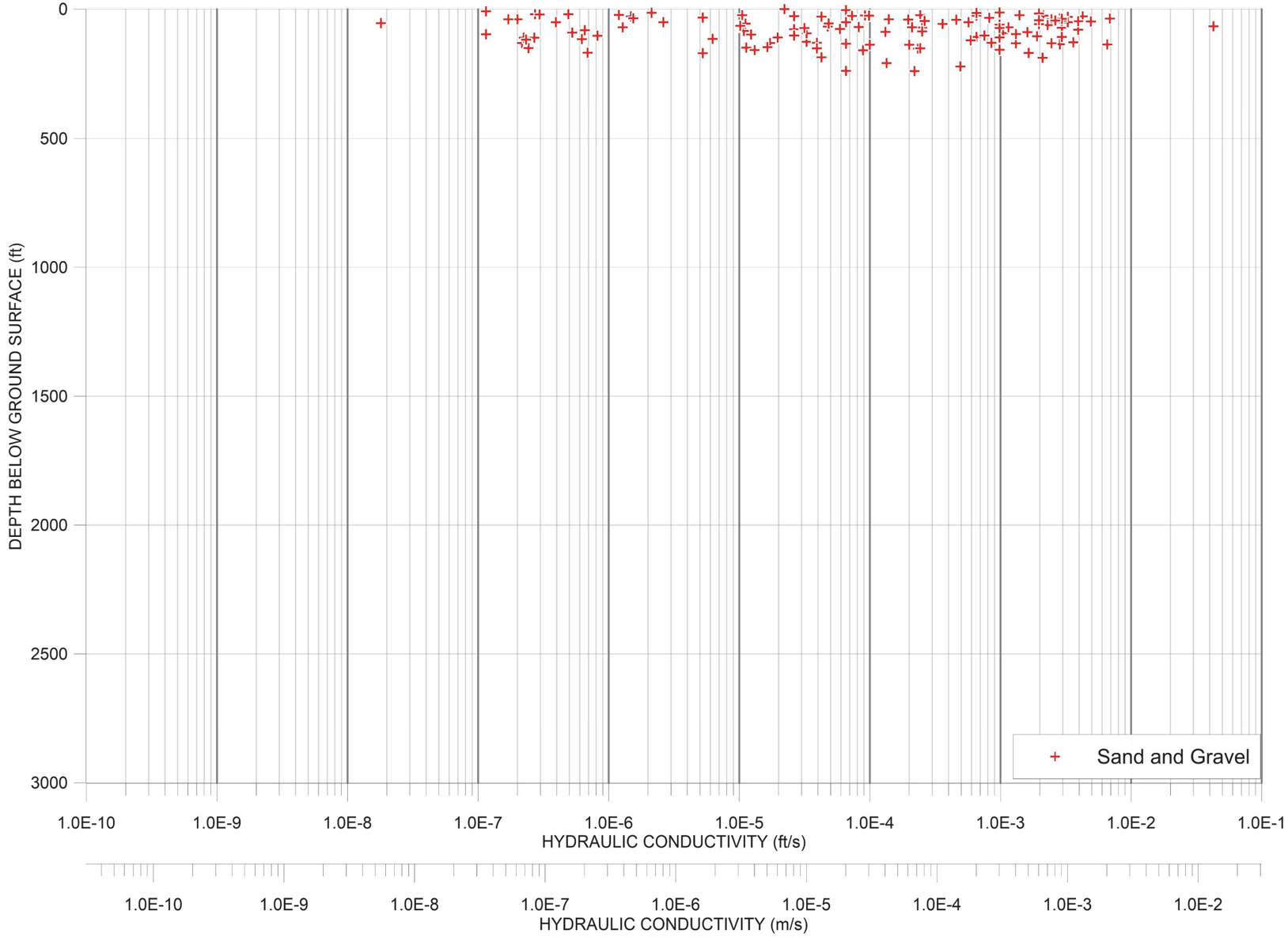

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: SAND AND GRAVEL
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-3

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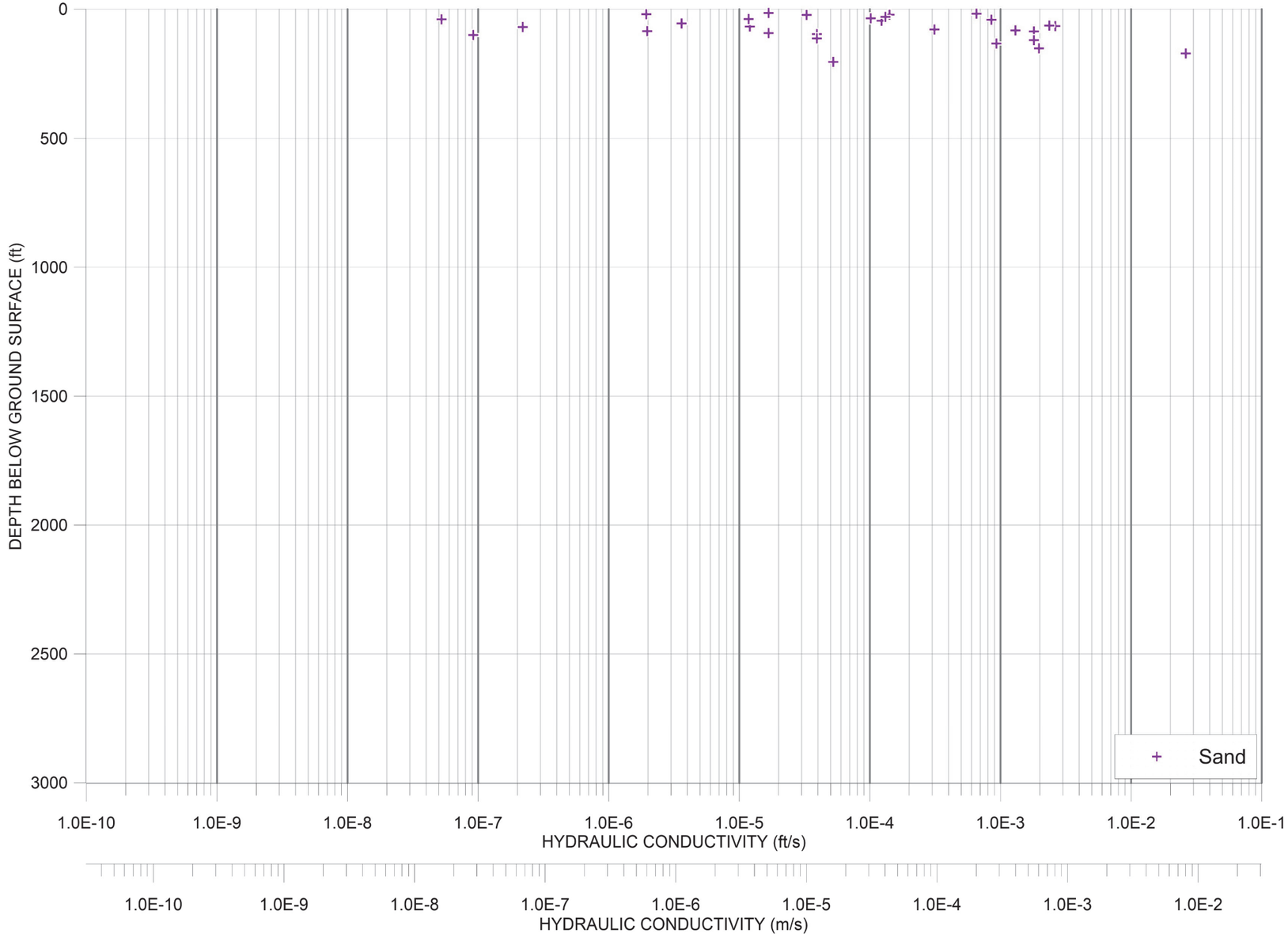

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: SAND
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-4

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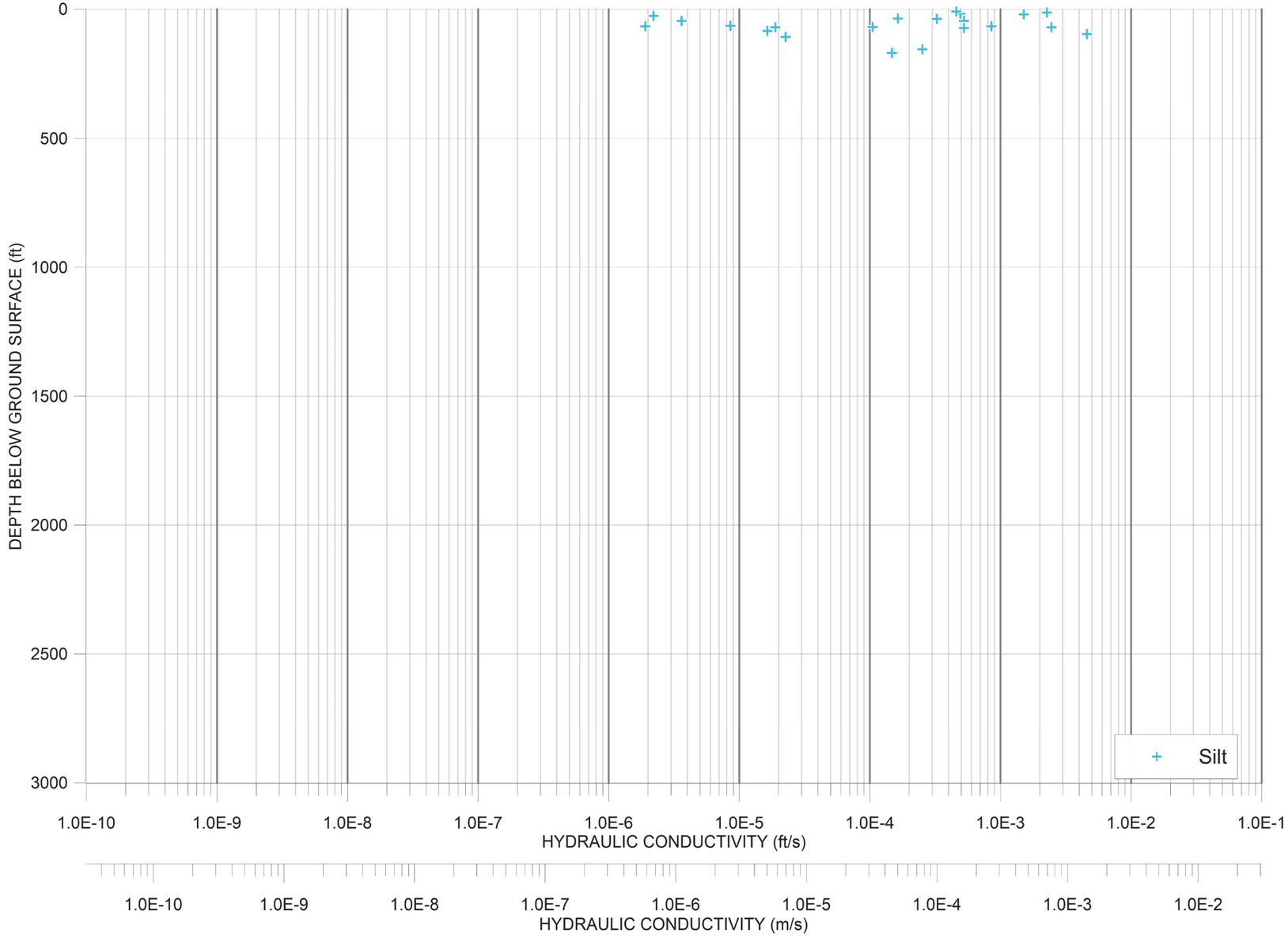

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: SILT
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-5

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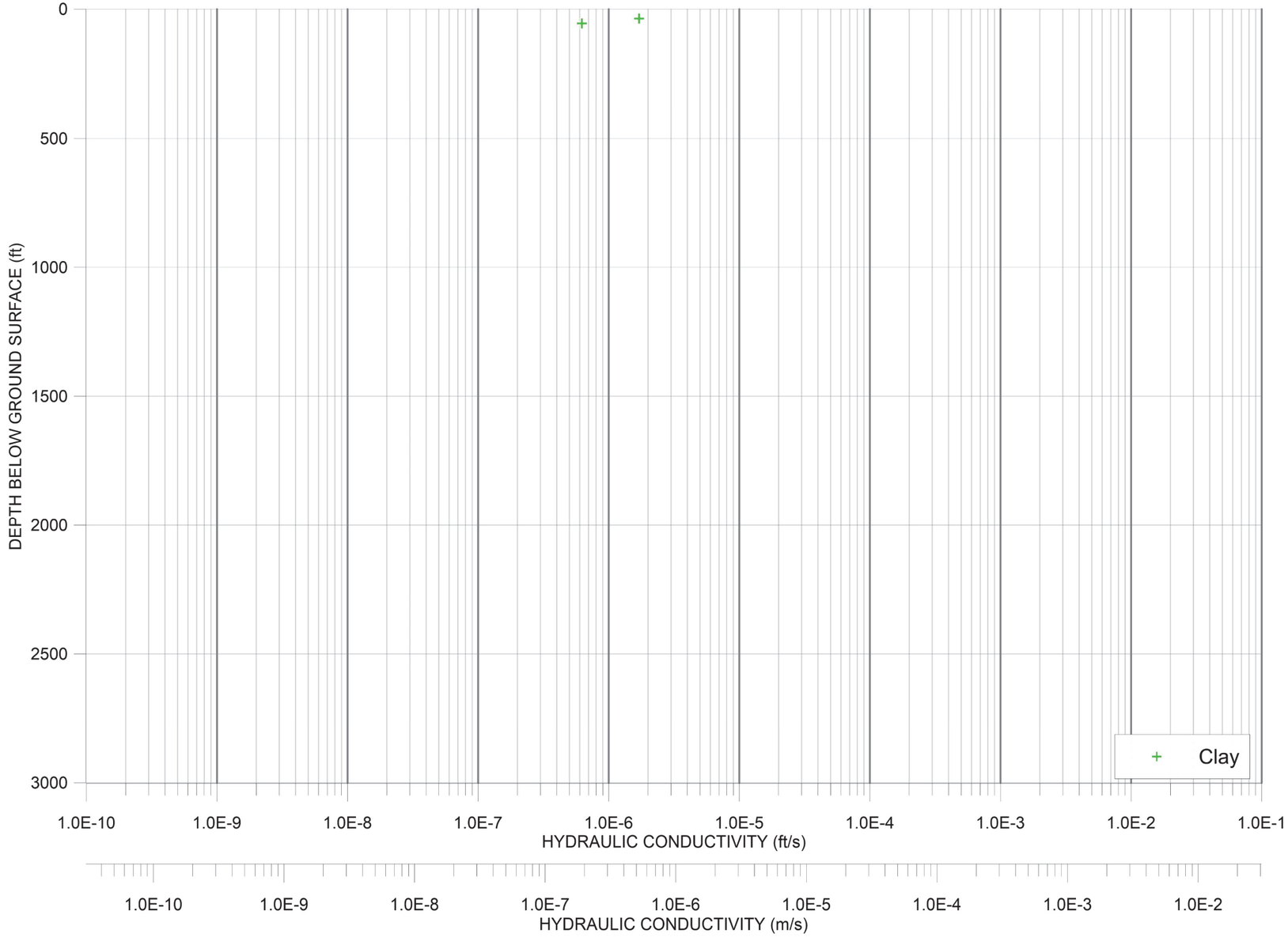

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: CLAY	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: A-6

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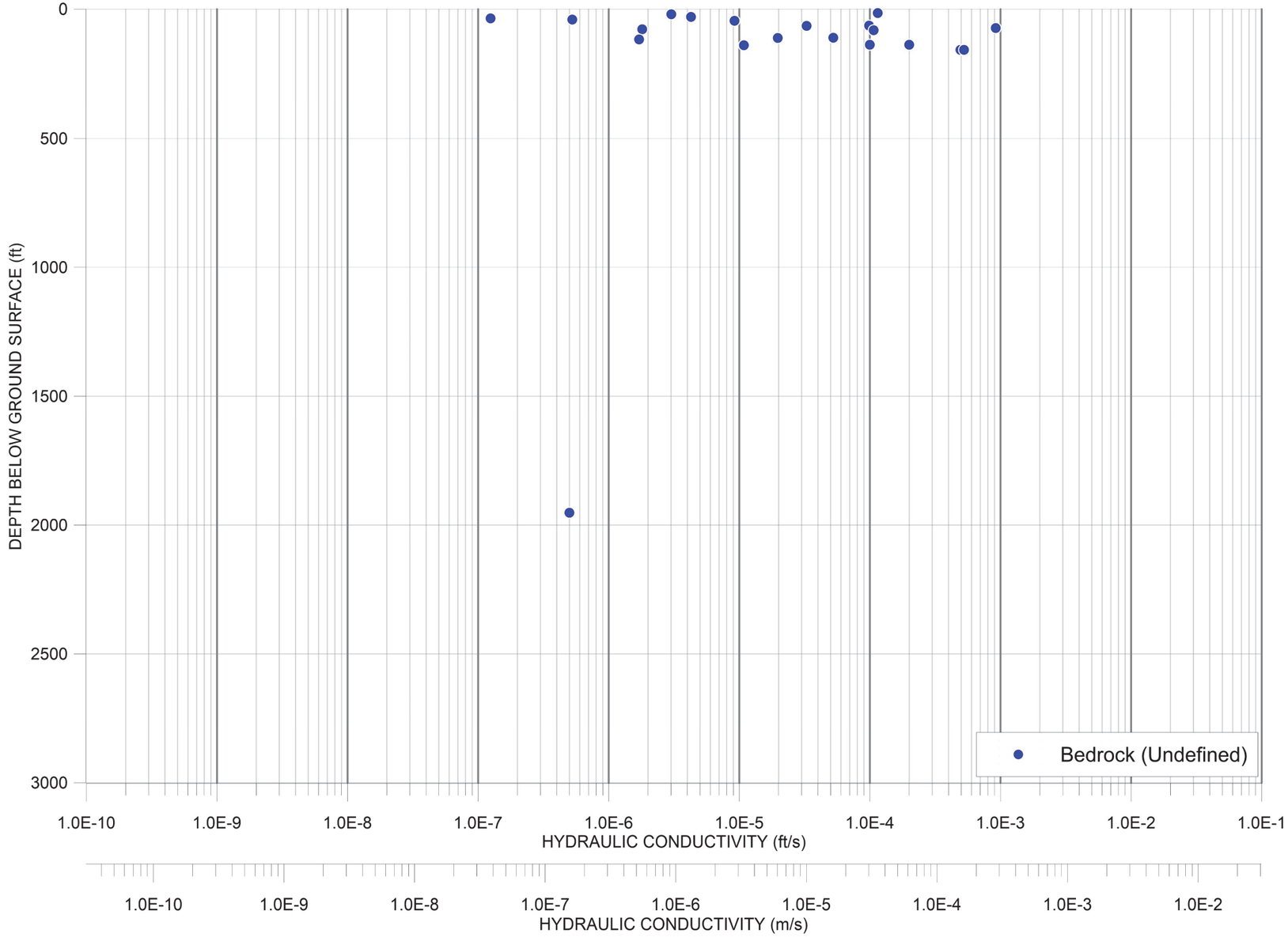

NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: BEDROCK (UNDEFINED)
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-7

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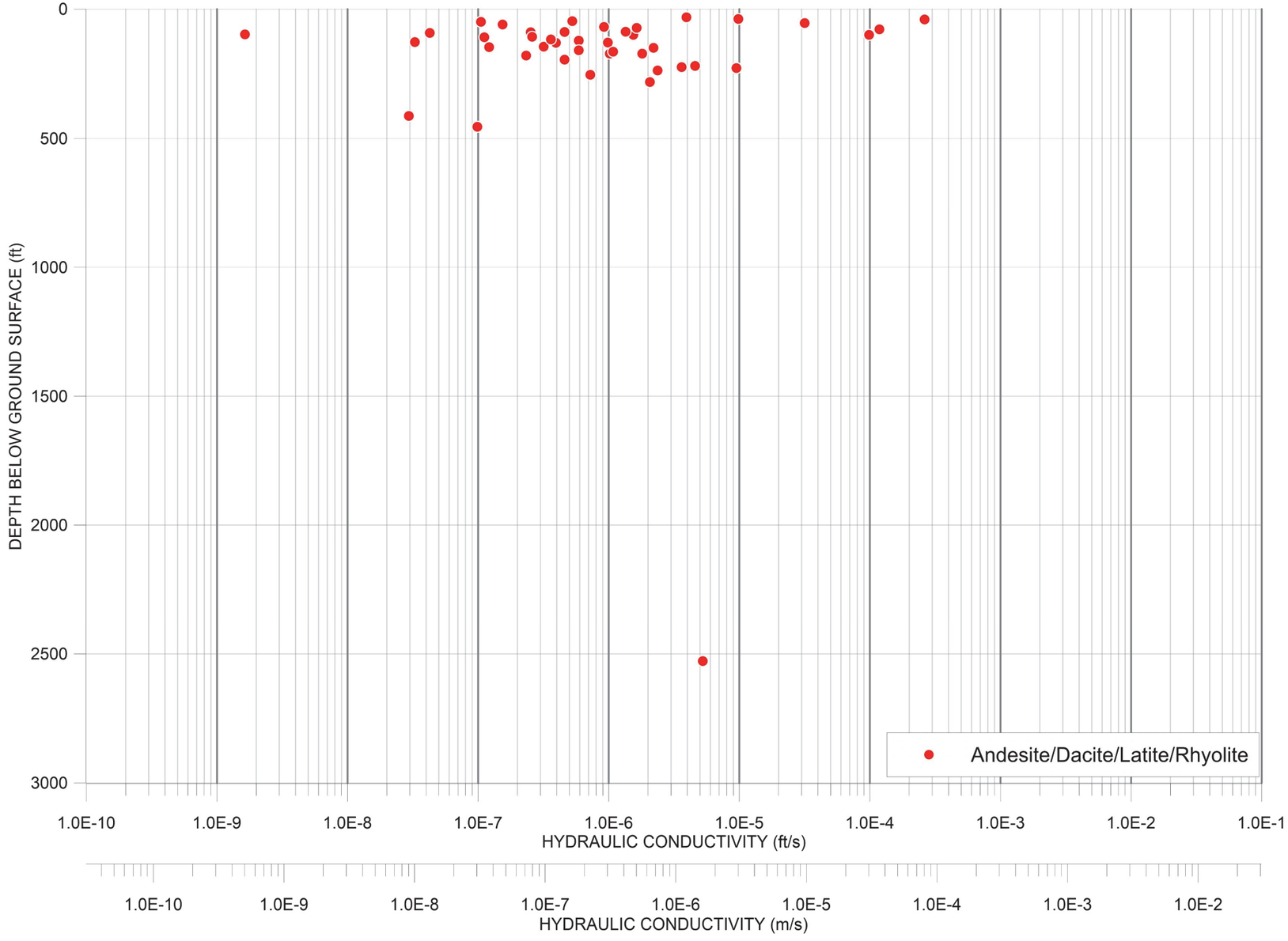

NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: ANDESITE/DACITE/LATITE/RHYOLITE
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-8

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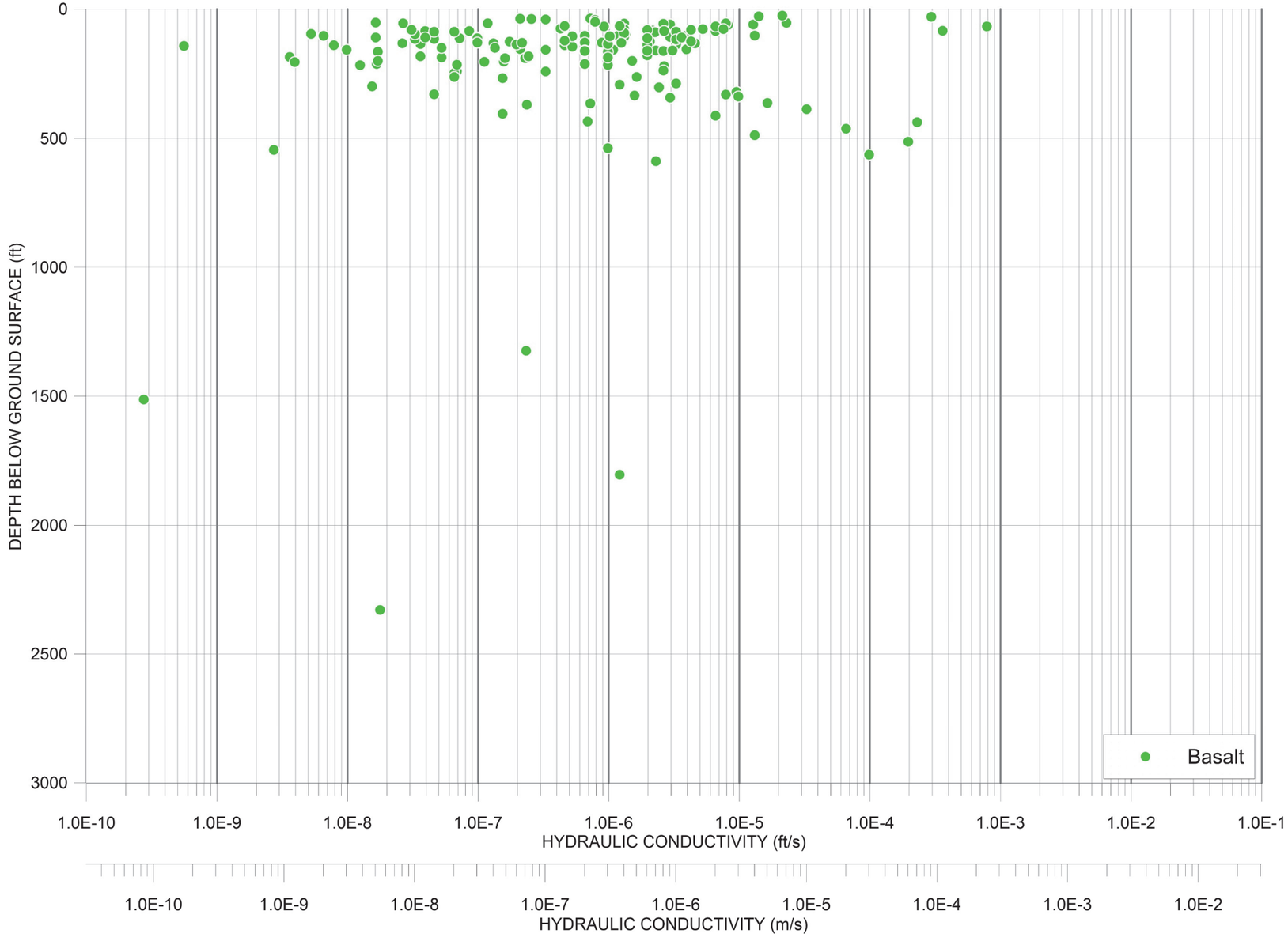

NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: BASALT
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-9

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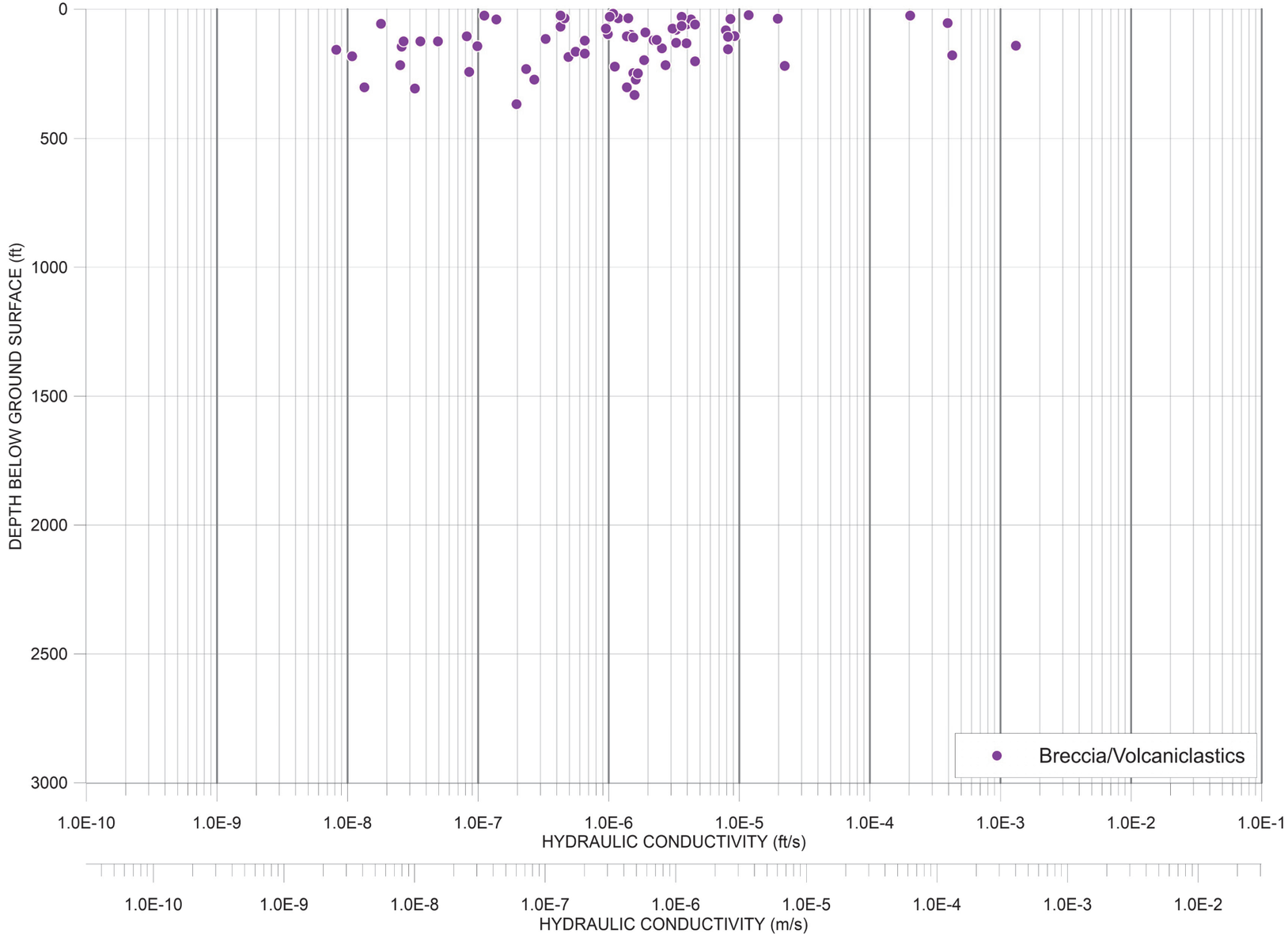

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PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: BRECCIA /VOLCANICLASTICS
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-10

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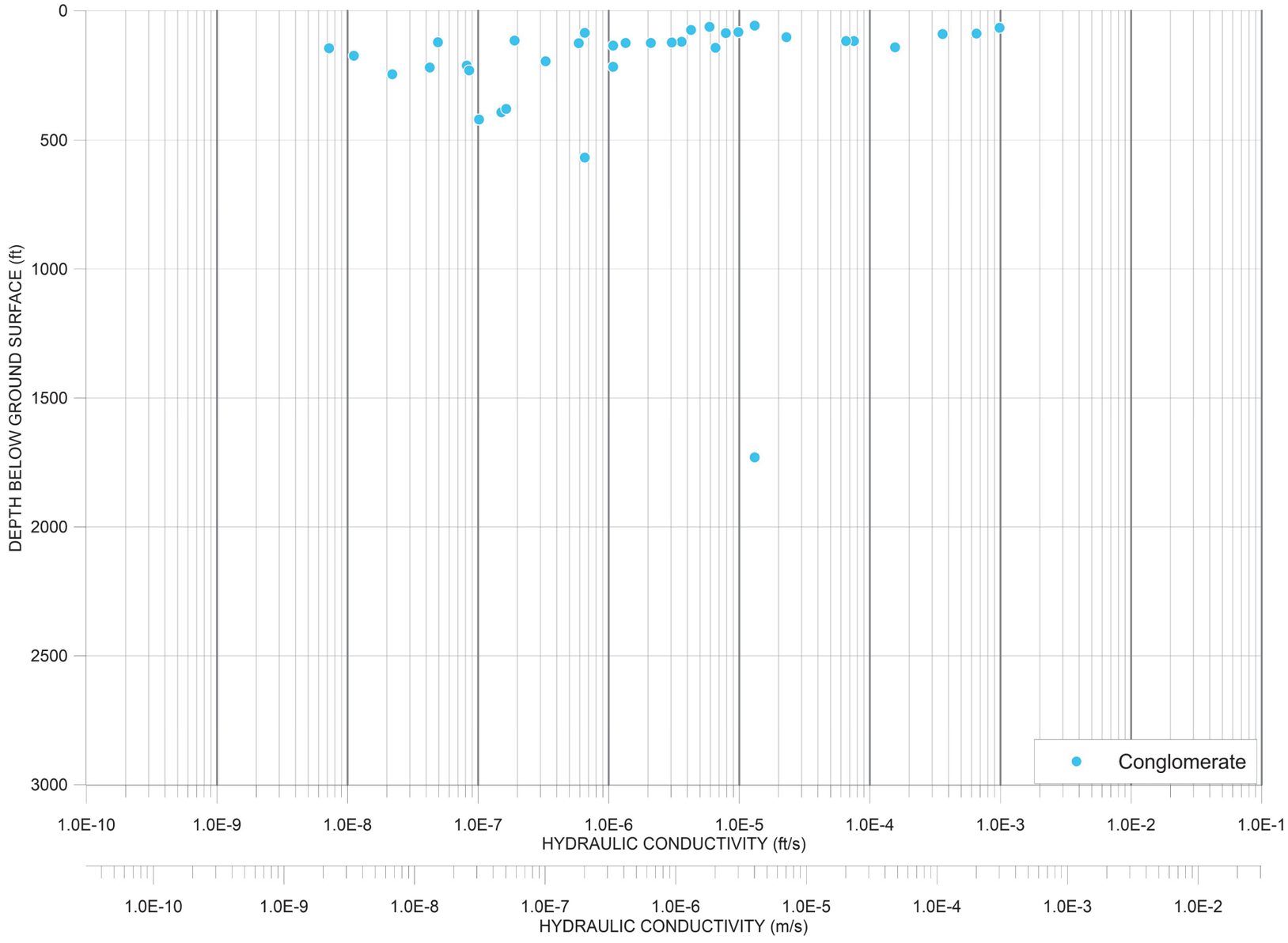

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APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-11

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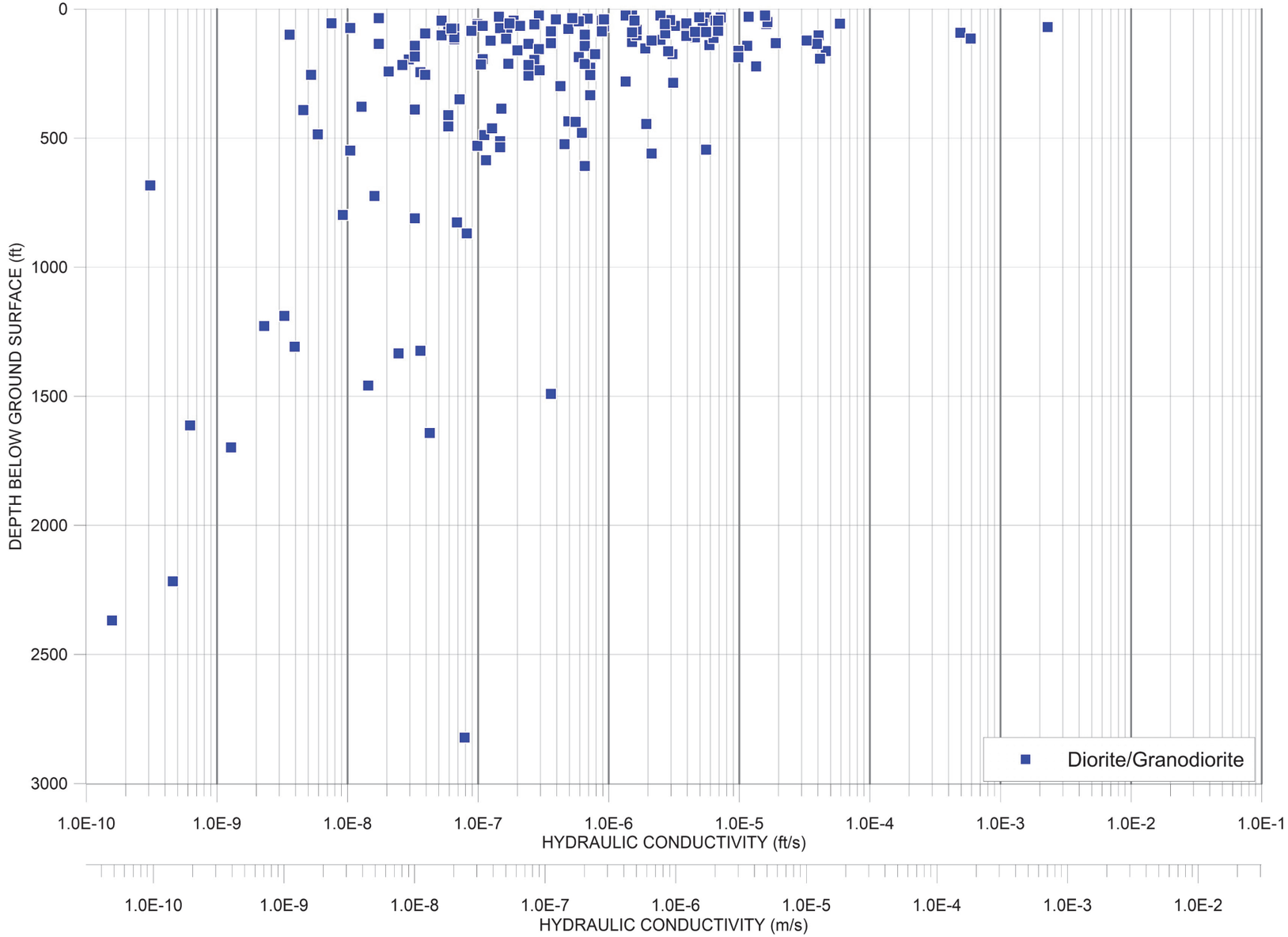

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APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-12

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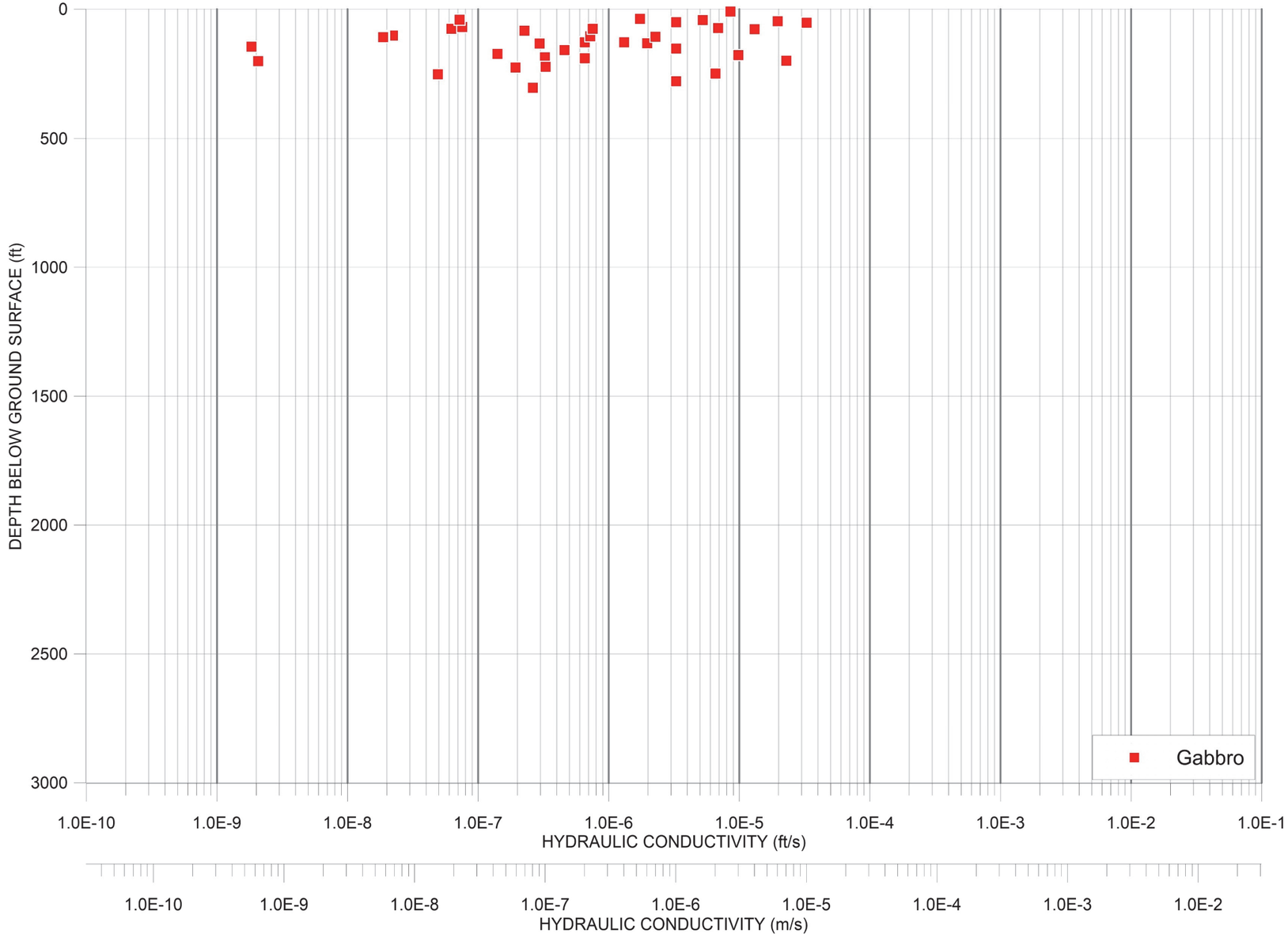

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APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: A-13

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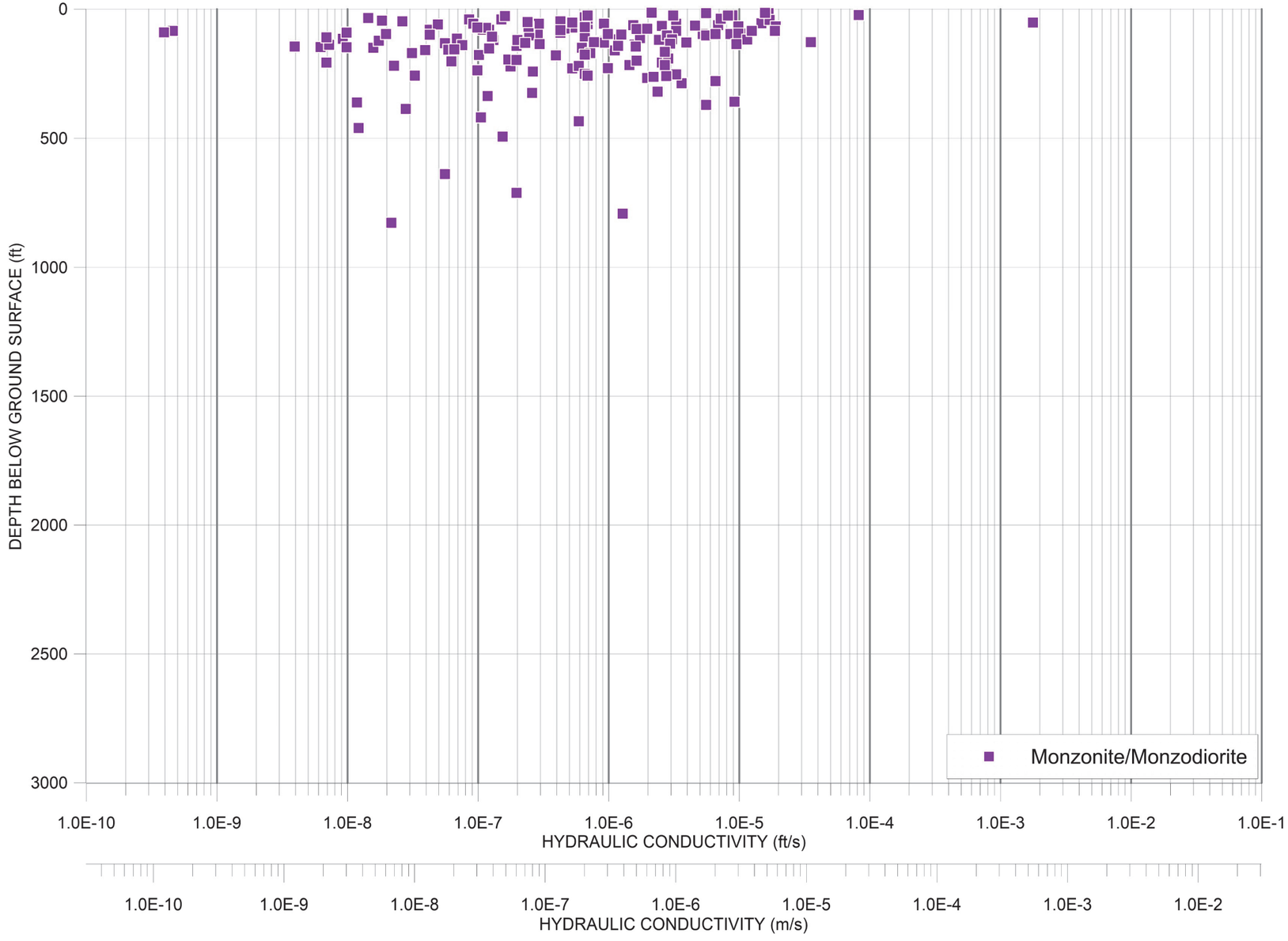

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PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: MONZONITE/MONZODIORITE	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: A-14

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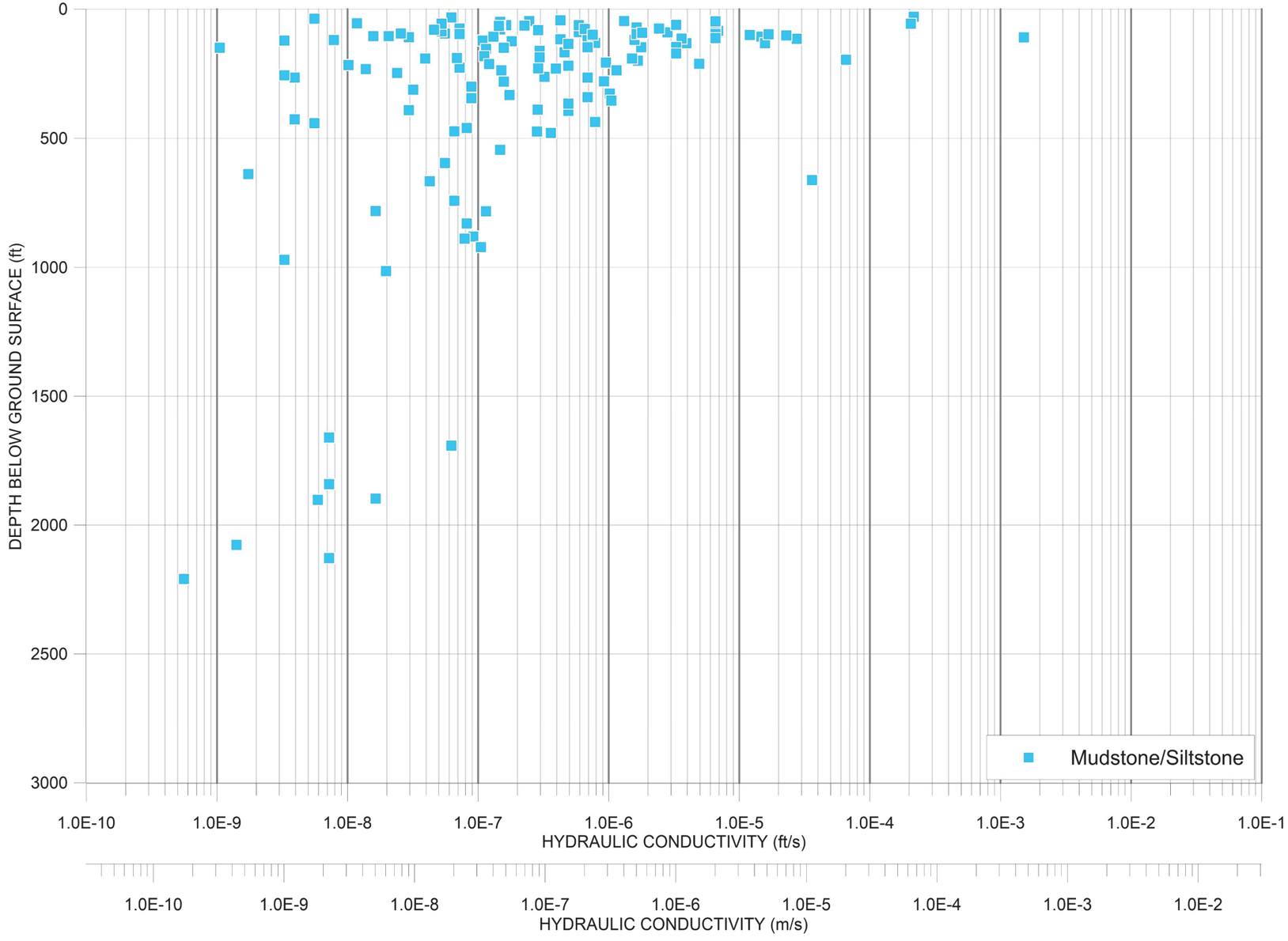

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PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: MUDSTONE/SILTSTONE
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-15

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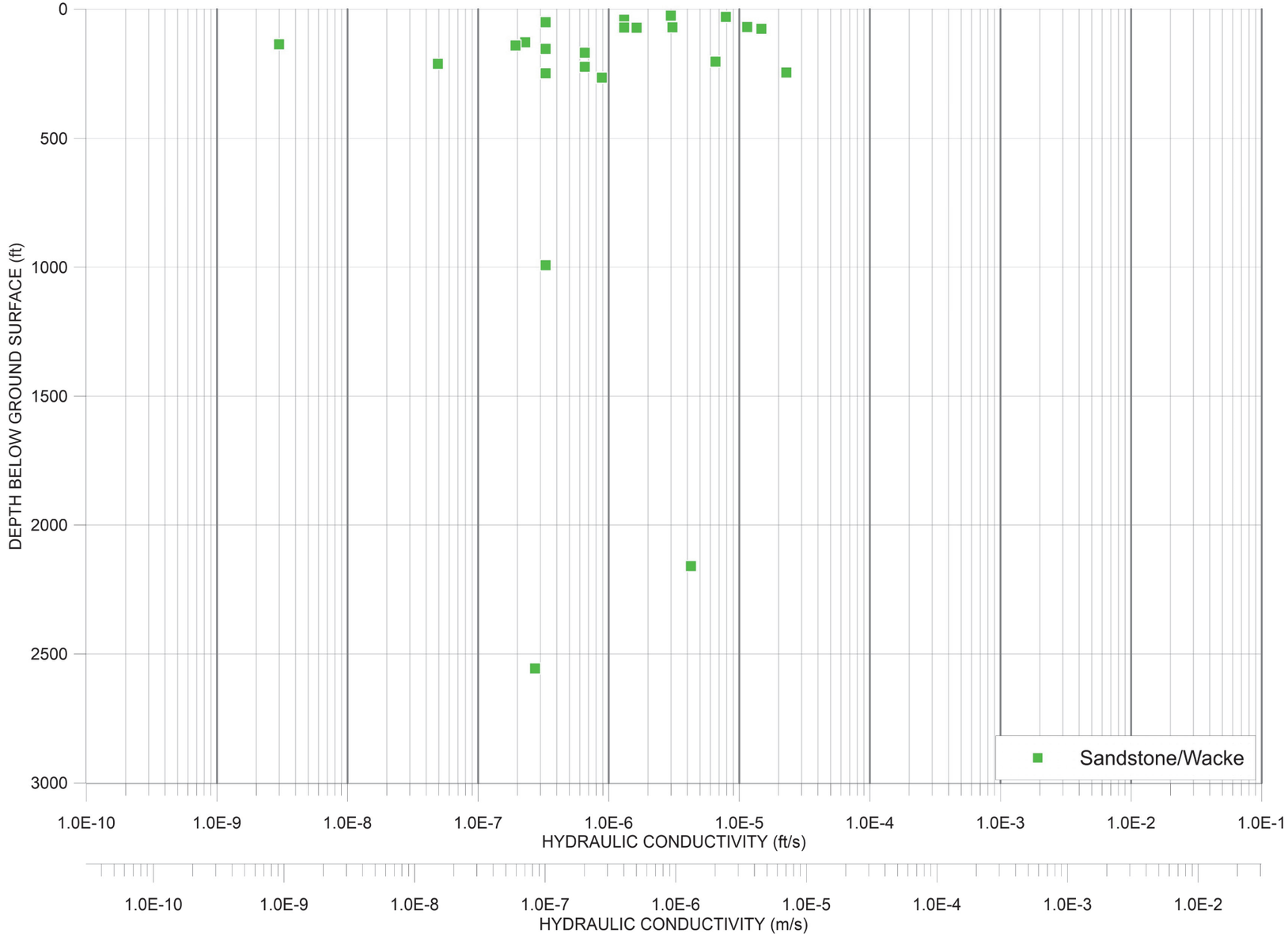

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PREPARED BY: JDM	CHECKED BY: TWC			FIGURE TITLE: HYDRAULIC CONDUCTIVITY ESTIMATES WITH DEPTH: SANDSTONE/WACKE
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: A-16

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APPENDIX B
GH12-334S PUMPING TEST ANALYSIS

BGC ENGINEERING USA INC.
AN APPLIED EARTH SCIENCES COMPANY
701 12th Street – Suite 211, Golden, CO USA 80401
Telephone (720) 598-5982

Project Memorandum

To:	**Pebble Limited Partnership**	**Doc. No.:**	**1872002.0235**
Attention:	**James Fueg, Stephen Hodgson**	**cc:**	**Loretta Ford**
From:	**Dawn Paszkowski, Randi Thompson**	**Date:**	**April 19, 2019**
Subject:	**Analysis of 2013 Pumping Test at GH12-334S**		
Project No.:	**1872-002**		

1.0 INTRODUCTION

On January 9, 2019, Pebble Limited Partnership (PLP) requested that BGC Engineering Inc. (BGC) analyze the pumping test completed at GH12-334S in 2013, and prepare a brief technical memorandum documenting the pumping test analysis and results. BGC understands that the pumping test analysis will be used to 1) supplement the existing site database of hydrogeologic parameters from hydraulic response testing, 2) inform calibration of the numerical hydrogeologic model, and 3) support responses to Environmental Impact Statement (EIS) requests for information (RFIs).

1.1. Background

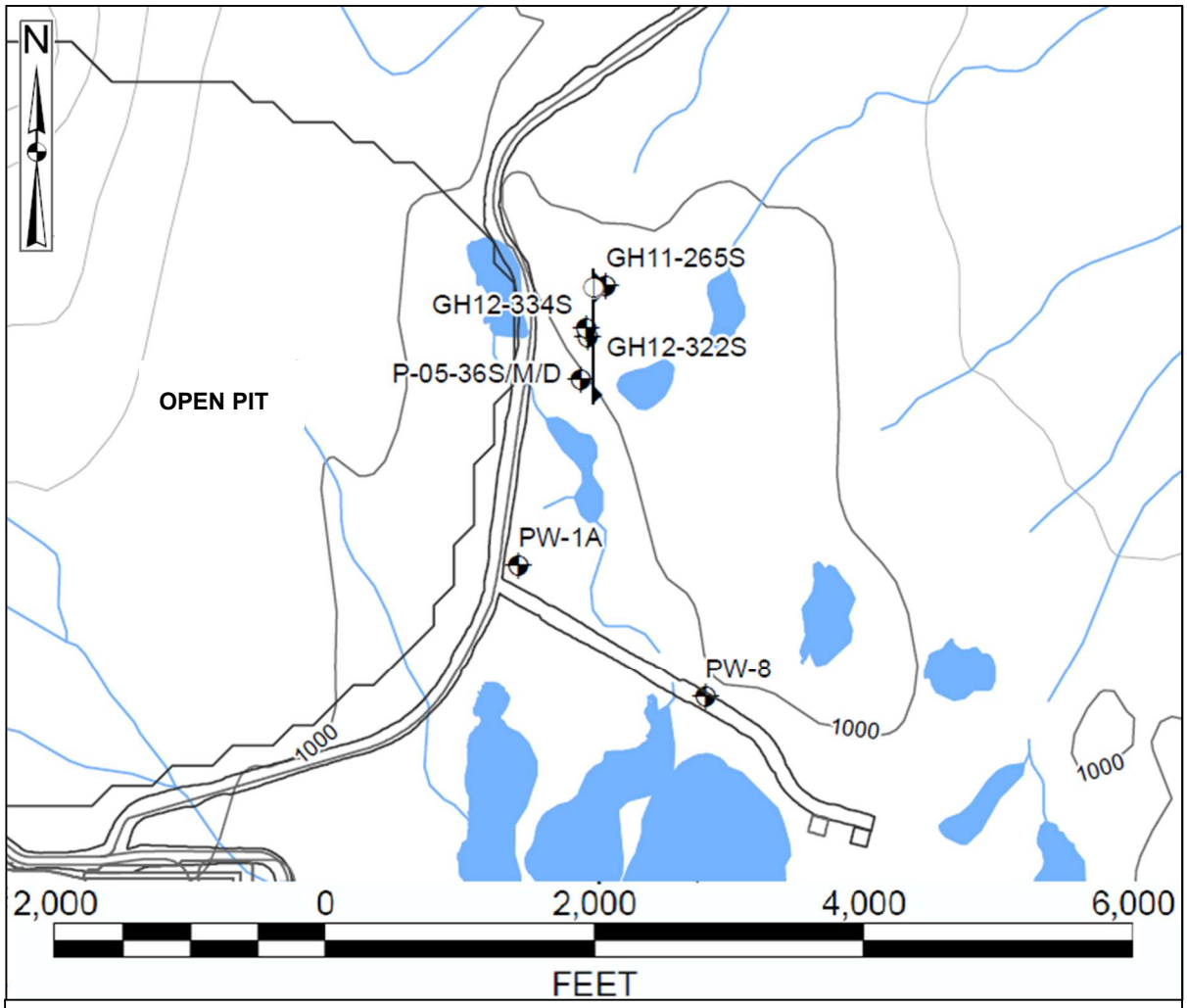
The pumping test at well GH12-334S was completed by SLR International Corporation (SLR) in July 2013. SLR (2013) documents the timeline of pumping test activities, baseline test (i.e., static water level monitoring), step-drawdown test, pumping test, and recovery monitoring period. The SLR report includes data tables and plots, raw data from transducers, scanned field forms, and instrument calibration certificates. No analysis or interpretation of pumping test results is presented.

The locations of pumping well GH12-334S and monitoring wells GH11-265S, GH12-322S, and P-05-36S, -36M, and -36D, which were used to monitor pumping test response, are shown in Figure 1-1. Wells GH12-334S and GH12-322S were drilled in 2012 by Foundex using a Sonic RRD-100 drill rig; the drilling field program was overseen by SLR (PLP, May 30, 2013). Monitoring well GH11-265S was installed during a 2011 Foundex Sonic heli-rig drilling program overseen by SRK Consulting (SRK, October 2012). Nested monitoring wells P-05-36S, -36M, and -36D were drilled in 2005 by Foundex using an ODEX HT700 drill rig. Installation of these wells was overseen by SLR, as reported in Knight Piesold Ltd. (KP, March 12, 2007).

1.2. Scope of Work

This memorandum documents the analysis of the 48-hr pumping test completed at GH12-334S between July 23 and 25, 2013, and the subsequent recovery monitoring period ending July 29, 2013. BGC has analyzed the pumping test and recovery data only; the step test completed in advance of the pumping test was not reviewed as part of this analysis. BGC has relied on the

groundwater elevation data collected by SLR, including manual measurements and data collected using pressure transducers with data loggers.



Notes:
1. Pebble Project general arrangement (GA) was provided by PLP on December 19, 2018.

Figure 1-1. Location of pumping well and monitoring network for 2013 pumping test completed at GH12-334S.

2.0 AQUIFER TESTING ANALYSIS

As documented in SLR (2013), the pumping test at GH12-334S consisted of approximately 48 hours of pumping and discharge. Water level data were collected using pressure transducers and dataloggers, a vibrating wire piezometer, and a handheld water level meter. The initial pumping rate of 16.0 US gpm (87 m^3/d) was decreased incrementally over the course of the test to 14.5 US gpm (79 m^3/d), to prevent drawdown in the pumping well from reaching the pump intake depth; the variable pumping rate was considered in the analysis. Water was discharged to

a non-wetland area approximately 1,800 ft (550 m) east of the pumping well (SLR, 2013). For the purpose of the pumping test analysis, it is assumed that this discharge occurred sufficiently far from the test area to not impact observed pumping test responses.

2.1. Monitoring Network and Observed Drawdown

The monitoring network for the 2013 pumping test consisted of five observation wells within an approximately 500 ft (150 m) radius of the pumping well (SLR, 2013). The pumping well and monitoring well network are shown on Figure 1-1, with well completion details summarized in Table 2-1. Borehole logs for both the pumping and monitoring wells are provided in Appendix A.

Table 2-1. Pumping well and monitoring well completion details.

Well ID	Pumping Well / Monitoring Well	Collar Coordinates[1]		TOC[2] Elevation	Ground Elevation	Well Diameter	Screened Interval		Screened Unit
		Easting	Northing				From	To	
		(ft)	(ft)	(ft)	(ft)	(in)	(ft)	(ft)	
GH12-334S	Pumping Well	1405787.89	2157448.91	1046.38	1043.18	4	926.68	886.68	sand, clay, gravel, bedrock
GH12-322S	Monitoring Well	1405795.65	2157380.12	1045.00	1041.20	2	891.60	882.30	clay, gravelly silt, bedrock
GH11-265S	Monitoring Well	1405929.25	2157754.28	1035.80	1032.80	2	869.30	859.30	bedrock
P-05-36D	Monitoring Well	1405755.41	2157046.46	1014.43	1012.13	2	874.23	864.23	bedrock
P-05-36M	Monitoring Well	1405763.54	2157031.92	1015.27	1012.17	2	931.94	921.94	sand and gravel
P-05-36S	Monitoring Well	1405746.05	2157061.15	1014.38	1011.81	2	988.36	978.36	sand and gravel

Notes:
1. Projection is NAD 1983 StatePlane Alaska 5 FIPS 5005 (Feet).
2. TOC indicates "top of casing"; both TOC and ground surface elevations obtained from borehole logs (Appendix A).
3. Screened interval calculated using ground surface elevation and screened unit based on information presented in borehole logs.

The observed end-of-test drawdown values for the pumping well and monitoring wells are presented in Table 2-2. A clear drawdown response is evident in all of the deeper monitoring locations (i.e., GH11-265S, GH12-322S, and P-05-36D), while the response at shallow monitoring locations P-05-36S and -36M is less pronounced.

Table 2-2. Groundwater elevation and pumping test maximum drawdown summary.

Well ID	Distance from GH12-334S[1,2]	Groundwater Elevation		Maximum Drawdown
		Pre-Test[3]	Post-Test[4]	
	(ft)	(ft asl)	(ft asl)	(ft)
GH12-334S	0.17	990.10	945.12	44.98
GH12-322S	70	991.26	983.92	7.34
GH11-265S	335	979.36	975.71	3.65
P-05-36D	410	992.81	990.64	2.17
P-05-36M	420	992.49	991.85	0.64
P-05-36S	395	991.89	991.62	0.27

Notes:
1. Approximate distance from GH12-334S as reported in SLR (2013), with the exception of GH11-265S which was corrected to 335 ft.
2. Approximate distance from pumping well GH12-334S reported as the radius of the pumping well (i.e., 2").
3. Pre-test groundwater elevations measured on July 23, 2013 using pressure transducers, with the exception of P-05-36M which was measured manually.
4. Post-test groundwater elevations collected at the end of the pumping test (i.e., when pumping ceased) on July 25, 2013, and reported in SLR (2013).

2.2. Conceptual Model and Analysis Method

The pumping well and monitoring well completions, which are summarized in Table 2-1, are shown in cross-section on Figure 2-1. In general, the deep monitoring intervals (i.e., GH11-265S, GH12-322S, and P-05-36D) are completed in shallow bedrock, and the shallower monitoring intervals (i.e., P-05-36S and -36M) are completed in “sand with gravel” (Appendix A). The

stratigraphic profile at P-05-36 indicates that there are layers of silt and/or clay between the -36S, -36M, and -36D monitoring intervals. The pumping well, GH12-334S, is screened across approximately 2 ft (0.6 m) of sand, 28 ft (8.5 m) of clay, and approximately 10 ft (3 m) of gravel with silt and sand and bedrock at the bottom of the well screen.

The thick package of clay that comprises much of the screened interval likely has limited hydraulic conductivity (Freeze & Cherry, 1979); consequently, pumping test responses would be expected in either the sand unit above the clay or the gravel and bedrock unit below the clay. The observed drawdown responses in monitoring wells screened in the lower overburden and/or upper bedrock (i.e., GH11-265S, GH12-322S, and P-05-36D) suggest a good hydraulic connection between and through these units. Thus, it is inferred that the pumping test at GH12-334S primarily tested this confined lower-overburden/upper-bedrock zone. Because of these observations, data from monitoring wells P-05-36S and -36M, which are screened in the upper sand and gravel deposits and exhibited small drawdowns, were excluded from the analysis.

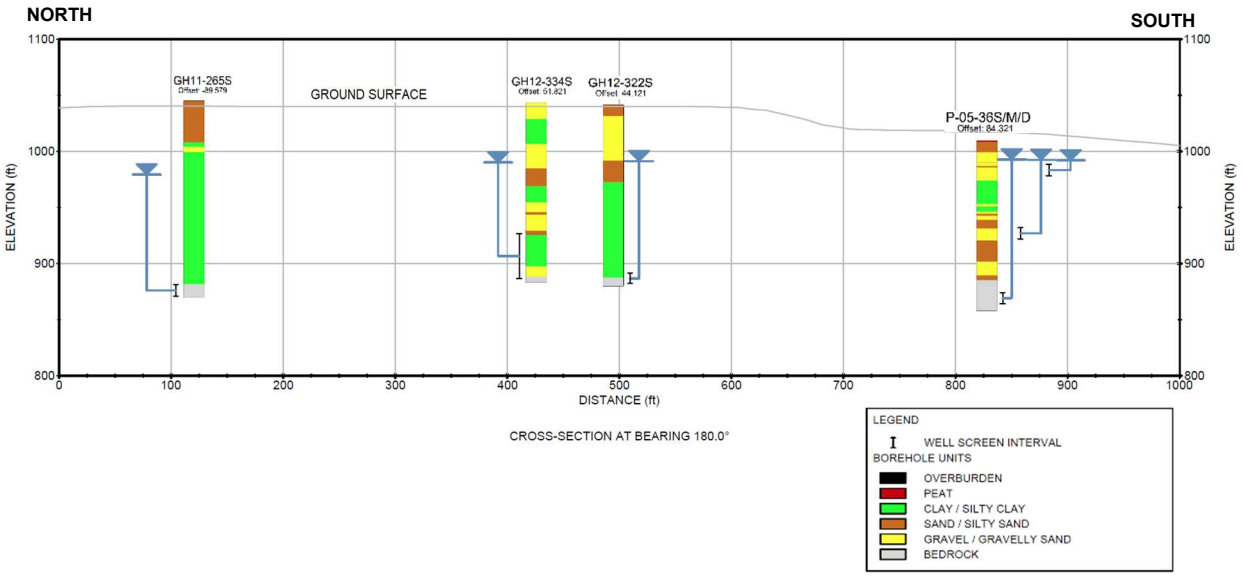


Figure 2-1. Cross-section showing pumping well and monitoring network for 2013 pumping test completed at GH12-334S.

The pumping test discharge and recovery data were analyzed using AQTESOLV version 4.50.002 (Duffield, 2007), an industry-standard software package for the design and analysis of aquifer tests. The Theis (1935) solution was used to simultaneously fit the observed drawdown and recovery data for each monitoring well. The pumping test completed at GH12-334S meets the general requirements of pumping at a quasi-constant rate from a non-leaky confined aquifer that are applicable to the Theis solution. The solution yields estimates of transmissivity and storativity of the aquifer; estimates of hydraulic conductivity were obtained using estimates for the effective thickness of the aquifer. The pumping test analyses (i.e., AQTESOLV plots) are included in Appendix B, and results are discussed in the following section.

3.0 RESULTS & DISCUSSION

Analysis results from the pumping test completed at GH12-334S are summarized in Table 3-1. Transmissivity, T, results varied between 174.4 and 304.6 ft^2/d ($1.9x10^{-4}$ and $3.3x10^{-4}$ m^2/s), with a geometric mean of 229.6 ft^2/d ($2.5x10^{-4}$ m^2/s). Storativity, S, a unitless property, varied between $1.8x10^{-4}$ and $1.9x10^{-2}$ with a geometric mean of $7.7x10^{-4}$.

Table 3-1. Aquifer hydraulic properties from pumping test at GH12-334S.

Well ID	AQTESOLV Results[1,2]		Aquifer Thickness (b)[3]	Calculated Hydraulic Conductivity (K)[4]		Calculated Specific Storage (S_s)[5]	
	T	S					
	(ft^2/d)	(-)	(ft)	(ft/d)	(m/s)	(ft^{-1})	(m^{-1})
GH12-334S	174.4	1.9E-02	10.0	17.4	6.2E-05	1.9E-03	6.3E-03
GH12-322S	214.9	2.0E-04	10.0	21.5	7.6E-05	2.0E-05	6.6E-05
GH11-265S	243.3	1.8E-04	10.0	24.3	8.6E-05	1.8E-05	6.1E-05
P-05-36D	304.6	4.9E-04	23.0	13.2	4.7E-05	2.1E-05	7.0E-05
Minimum	174.4	1.8E-04	10.0	13.2	4.7E-05	1.8E-05	6.1E-05
Maximum	304.6	1.9E-02	23.0	24.3	8.6E-05	1.9E-03	6.3E-03
Geometric Mean	229.6	7.7E-04	12.3	18.6	6.6E-05	6.3E-05	2.1E-04

Notes:
1. AQTESOLV results represent best-fit to drawdown and recovery data for each monitoring point, calculated using Theis solution and AQTESOLV automatic matching function.
2. The Theis solution provides results in the form of transmissivity, T, and storativity, S.
3. Aquifer thickness minimum based on saturated thickness of aquifer from bottom of well screen to bottom of clay or silt confining layer.
4. Calculated hydraulic conductivity (K) based on the relationship T = K b, where b is saturated aquifer thickness
5. Calculated specific storage (S_s) based on the relationship S = S_s b.

Specific storage, S_s, was calculated from the definition S = S_s b, where b is the saturated thickness of the aquifer. At each monitoring location, the saturated aquifer thickness was considered to be the length of aquifer material from bottom of well screen to bottom of silt or clay confining layer. The estimates of S_s varied between $1.8x10^{-5}$ and $1.9x10^{-3}$ ft^{-1} ($6.1x10^{-5}$ and $6.3x10^{-3}$ m^{-1}), with a geometric mean of $6.3x10^{-5}$ ft^{-1} ($2.1x10^{-4}$ m^{-1}).

Estimated hydraulic conductivity, K, was calculated from the definition T = K b. The estimated K results, calculated from individual well responses, varied between 13.2 and 24.3 ft/d ($4.7x10^{-5}$ and $8.6x10^{-5}$ m/s), with a geometric mean of 18.6 ft/d ($6.6x10^{-5}$ m/s). These estimates of K agree well with results from single-well response testing completed at the monitoring locations, as reported in Schlumberger Water Services (SWS, March 2015). Slug test results for wells GH11-265S and GH12-322S were 13.0 ft/d ($4.6 x10^{-5}$ m/s) and 21.8 ft/d ($7.7x10^{-5}$ m/s), respectively (SWS, March 2015)[1]. The geometric mean K for slug tests completed at P-05-36D was 0.5 ft/d ($1.9x10^{-6}$ m/s) (SWS, June 2011)[2], lower than the minimum K estimated from the pumping test at GH12-334S, and perhaps reflecting the smaller radius of influence of a slug test vs. a pumping test.

At a broader scale, the estimated K values calculated from the pumping test at GH12-334S align well with aggregated results from all hydraulic response tests completed in the Pebble deposit area (SWS, March 2015). The GH12-334S pumping test results also agree well with results from pumping tests completed in the nearby PW-1 and PW-8 (Figure 1-1), which are both completed

[1] Response test analyses and results are provided in Appendix 8.1C of SWS (March 2015).
[2] Response test analyses and results are provided in Appendix 8.1C of SWS (June 2011).

in weathered bedrock and yielded results of 4.5 ft/d ($1.6x10^{-5}$ m/s) and 5.7 to 6.5 ft/d ($2.0x10^{-5}$ to $2.3x10^{-5}$ m/s), respectively (SWS, June 2011)[3].

The radius of influence due to pumping at GH12-334S, assuming 100% efficiency of the pumping well, appears to be approximately 600 ft (180 m), as indicated by the intercept of the dashed line and zero drawdown in Figure 3-1. An alternate interpretation excluding the pumping well from the analysis suggests a radius of influence of approximately 1000 ft (305 m) and a well efficiency of approximately 50% (as indicated by the solid line in Figure 3-1).

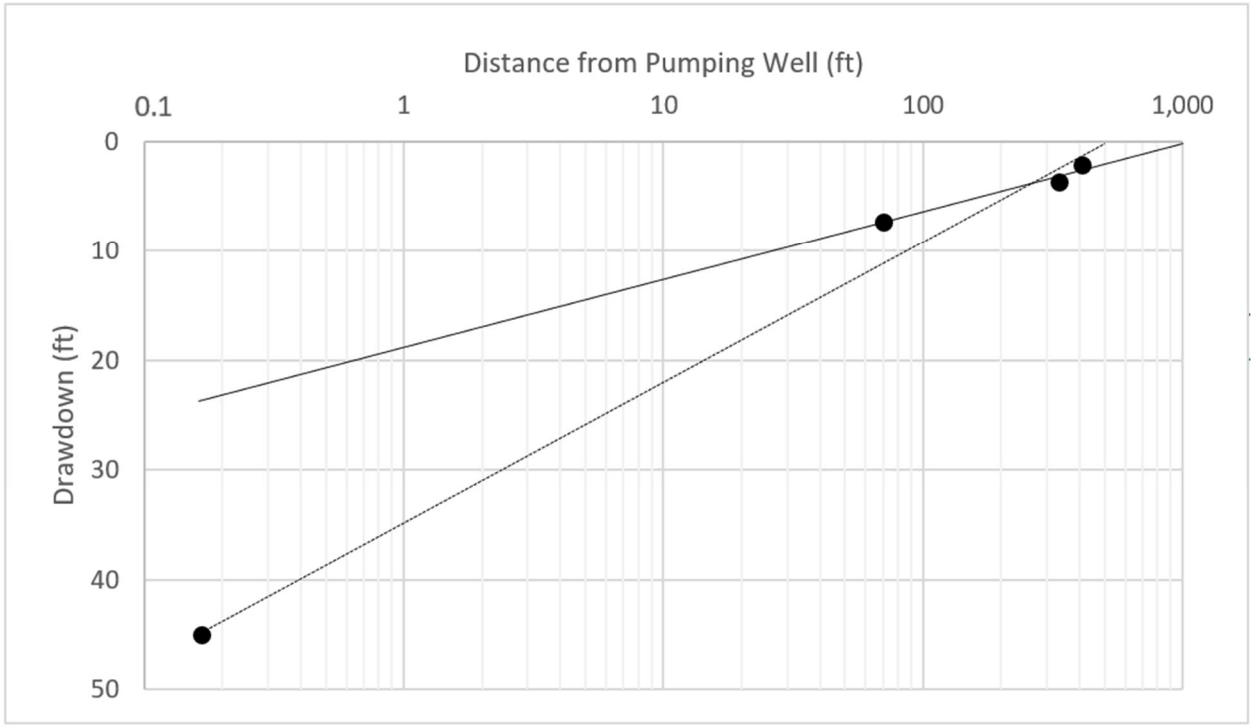


Figure 3-1. Distance-drawdown plot for constant rate discharge test at GH12-334S.

The analysis and interpretation of the pumping test conducted at GH12-334S in 2013 contributes to the overall understanding of the hydraulic properties of the deep overburden and shallow bedrock near the proposed open pit, near the South Fork Koktuli and Upper Talarik Creek watershed divide.

[3] Pumping test results are documented in Appendix 8.1D of SWS (June 2011).

4.0 CLOSURE

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Yours sincerely,

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per:

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RT/CAM/sah/mm

Attachments: Appendix A – Borehole Logs
Appendix B – Aqtesolv Plots

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APPENDIX A
BOREHOLE LOGS

srk consulting

THE pebble PARTNERSHIP

Borehole Log

PROJECT: Pebble Mine PFS
CLIENT: Pebble Limited Partnership (PLP)

PROJECT NO: 2CP018.004
DRILLING CONTRACTOR: Foundex
DRILLING NETHOD: Sonic Heli-rig
LOGGED BY: BB/MMM
DATE OF EXPLORATION: 3-Sep-11
TO: 4-Sep-11

HOLE NUMBER: **GH11-265S**
LOCATION: Southwest Alaska
COORDINATES: E 1405932 N 2157773
DATUM: NAD 83 UTM Zone 5
GROUND ELEV (ft): 1032.8
TOTAL DEPTH (ft): 174.5

Depth From Surface (ft)	Instrumentation	Lithological Symbol	USCS	LITHOLOGIC DESCRIPTION (Type: subtype, density, structure plasticity, colour, moisture)	Sample Type/No.	UCS (kPa) / Torvane Intact (kPa) Rem (kPa)	SPT Results (Blows per foot) No. of Blows	Atterberg Limits and Moisture Content PL LL MC	Gravel/Sand/Fine (%) >4.75mm/ 0.075-4.75 / <0.075	Drilling Notes and Comments
0			SM	**Sand, silty, gravelly, compact, well graded, brown, moist**			12			Slight artesian flow at 10'.
				Silt, clay, sand, gravel, cobble mixture, stiff, moist, non-plastic to medium plastic, brown, dilatency=none to low, subrounded						
10					59005		8			
					59009					
				Fissured, low plastic		195				
20			CL, ML, SM,GM		59006			18%	10/60/40	Some rust coloring; pyrite.
										Too stiff for torevane and pocketpenetrometer readings
					59011					
30				Sand layer to 35', gravelly, some cobble, dense, dry, well graded, light brown, dilatency=none	59007		32	14%		Fines washed out top of run.
				Grading to silt, and sand, gravelly, low plastic, light brown						
				Grading to clay, hard, medium plastic						
40					59008			29%	0/20/80	
				Gravel layer to 45': and sand, silty, poorly graded, light brown, damp, dilatency=none	59010					Assume that fines washed out.
							30			
				Trace sand, damp, medium plastic,	59013	319				

Well Construction

Fill, Grout, Bentonite, Sand, Slough, Cover, Casing, Screen, End Cap, Sump, Transducer, Wire

Lithological Symbol

Organics, Clay, Sand, Bedrock, Gravel, Cobble, Silt, Boulder

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THE pebble PARTNERSHIP

Borehole Log

PROJECT: Pebble Mine PFS
CLIENT: Pebble Limited Partnership (PLP)

PROJECT NO: 2CP018.004
DRILLING CONTRACTOR: Foundex
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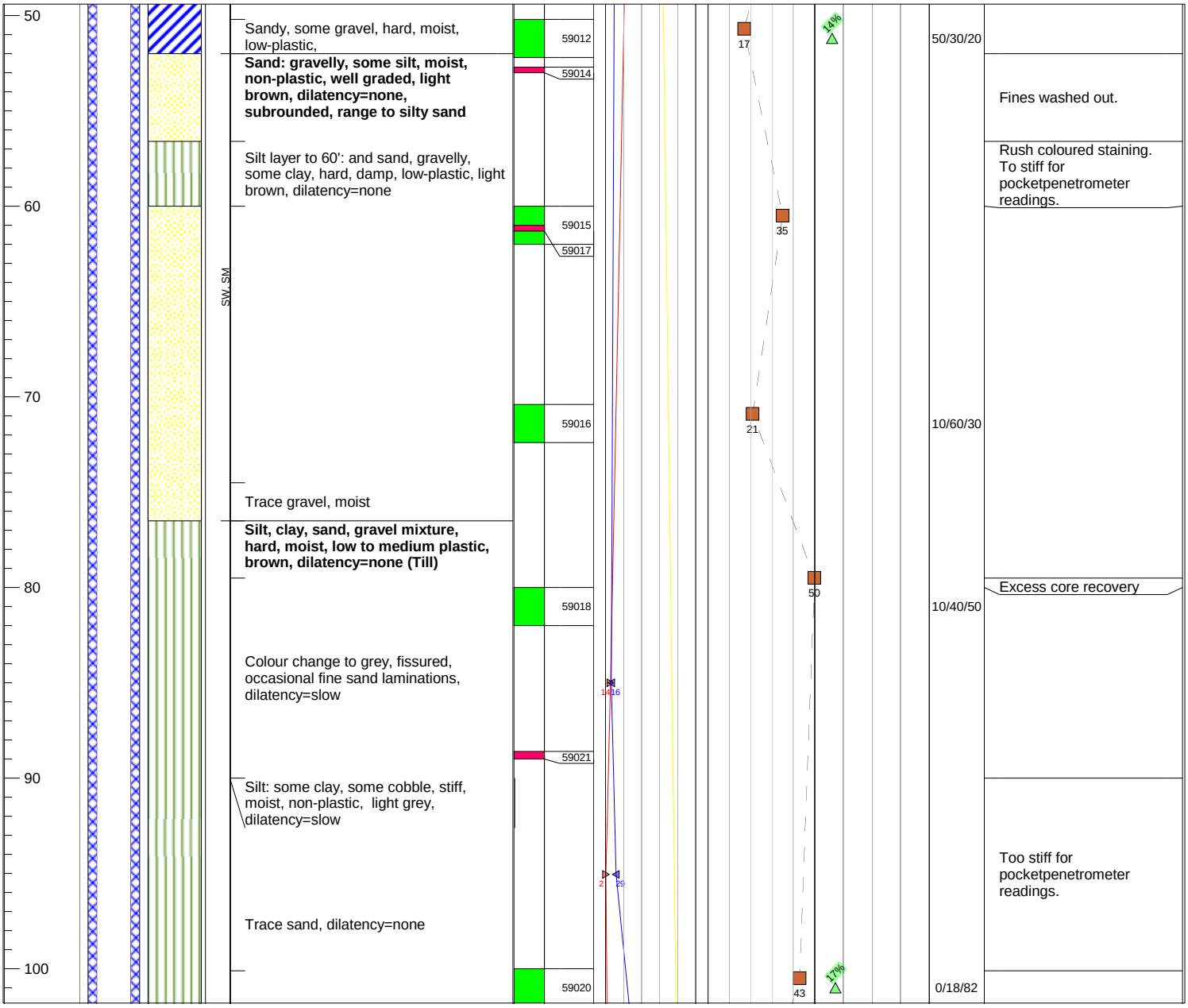

Well Construction

Fill, Grout, Bentonite, Sand, Slough, Cover, Casing, Screen, End Cap, Sump, Transducer, Wire

Lithological Symbol

Organics, Clay, Sand, Bedrock, Gravel, Cobble, Silt, Boulder

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THE pebble PARTNERSHIP

Borehole Log

PROJECT: Pebble Mine PFS
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PROJECT NO: 2CP018.004
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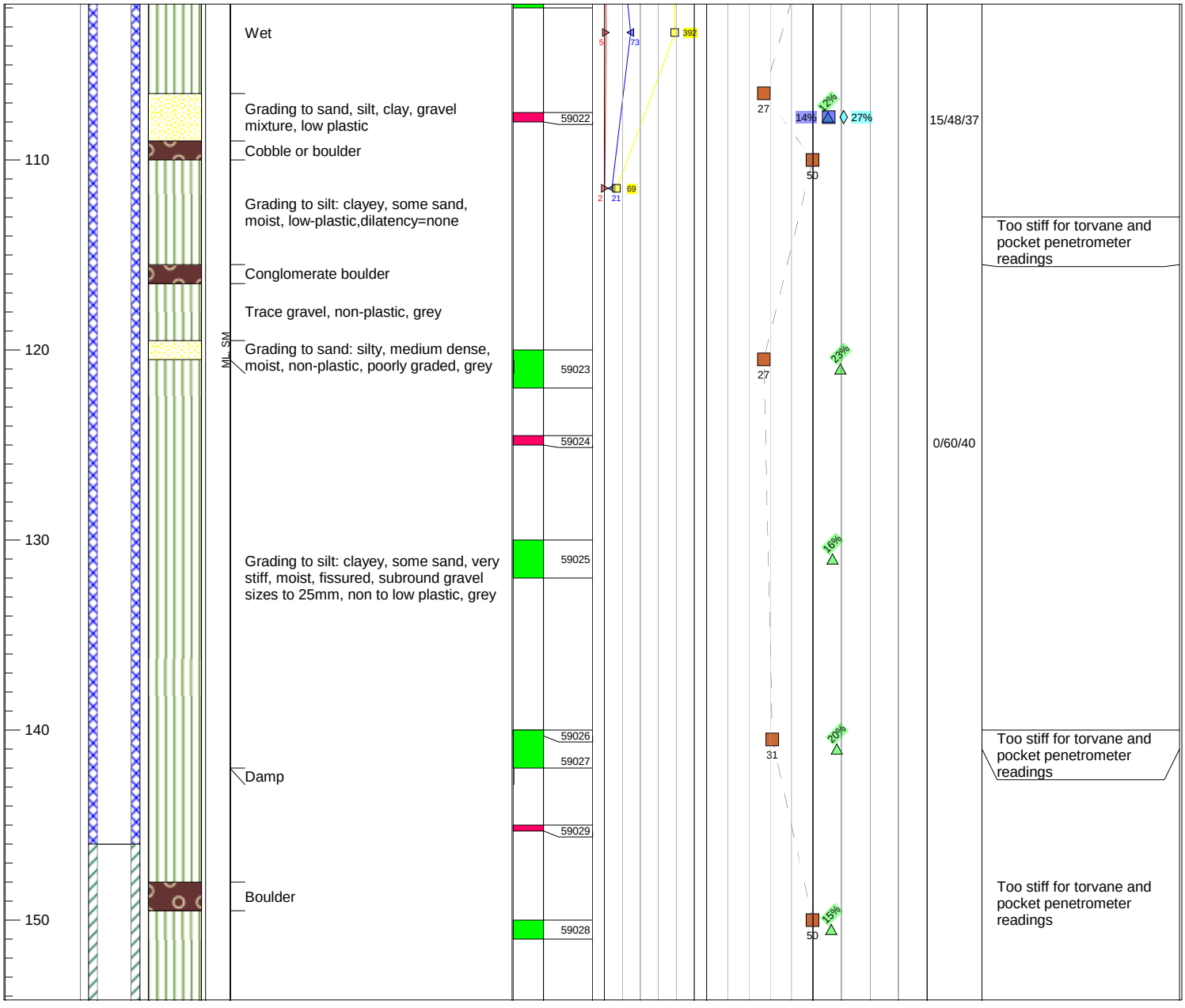

Well Construction

Fill, Grout, Bentonite, Sand, Slough, Cover, Casing, Screen, End Cap, Sump, Transducer, Wire

Lithological Symbol

Organics, Clay, Sand, Bedrock, Gravel, Cobble, Silt, Boulder

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Borehole Log

PROJECT: Pebble Mine PFS
CLIENT: Pebble Limited Partnership (PLP)

PROJECT NO: 2CP018.004
DRILLING CONTRACTOR: Foundex
DRILLING NETHOD: Sonic Heli-rig
LOGGED BY: BB/MMM
DATE OF EXPLORATION: 3-Sep-11
TO: 4-Sep-11

HOLE NUMBER: **GH11-265S**
LOCATION: Southwest Alaska
COORDINATES: E 1405932 N 2157773
DATUM: NAD 83 UTM Zone 5
GROUND ELEV (ft): 1032.8
TOTAL DEPTH (ft): 174.5

Depth From Surface (ft)	Instrumentation	Lithological Symbol	USCS	LITHOLOGIC DESCRIPTION (Type: subtype, density, structure plasticity, colour, moisture)	Sample Type/No.	UCS (kPa) / Torvane Intact (kPa) Rem (kPa)	SPT Results (Blows per foot) No. of Blows	Atterberg Limits and Moisture Content PL LL MC	Gravel/Sand/Fine (%) >4.75mm/ 0.075-4.75 / <0.075	Drilling Notes and Comments
160				Grading to sand: and silt, gravelly, medium dense, damp, non-plastic, poorly graded, grey, dilatency=none	59030					
					59031					
				Grading to silt: sandy, gravelly, very stiff, damp, non-plastic, grey						No recovery. Washout on run, assumed to be silt at top of run.
170				**Bedrock: hard, grey, laminated structure**						
				EOH						
180										

Sample Type/No.: Grab, Shelby, SPT

UCS (kPa): 0 100 200 300 400 500
Torvane Intact (kPa) Rem (kPa): 0 50 100 150 200 250

SPT Results (Blows per foot) No. of Blows: 0 10 20 30 40 50

Atterberg Limits and Moisture Content: PL 0 25 50 75 100; LL; MC

Well Construction

Fill, Grout, Bentonite, Sand, Slough, Cover, Casing, Screen, End Cap, Sump, Transducer, Wire

Lithological Symbol

Organics, Sand, Gravel, Cobble, Silt, Boulder, Clay, Bedrock

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0								
	5 / 9						ML **Sandy SILT**, fine to coarse grained sand, low plasticity, dark gray	All soils were described in accordance with ASTM Method D2488 using the Visual-Manual Method. Soil classifications and additional information obtained from laboratory testing were used to update soil descriptions, as applicable. Bedrock lithology descriptions were compiled from SLR's field descriptions and PLP Geology Logs.
5								First core advanced to 9 feet bgs Trace subangular to subrounded gravel, 5-10 feet
10		SPT	6-17-23	17 / 18			10.0 GC **Clayey GRAVEL with Sand**, fine to coarse angular to subrounded gravel, fine to coarse grained sand, no structure, very loose, dark gray to olive gray	Very fast drilling; angular to subangular gravel, 10-17 feet Occasional clasts broken by bit, 10-26 feet
	7.5 / 10							
15								

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION:
Type: Steel
Diameter: 6 inch
WELL CASING: 0 to 149.6 feet bgs
Stickup: 3.80 feet
Type: Schedule 40 PVC
Diameter: 2 3/8 inch
SCREEN: 149.6 to 158.9 feet bgs
Type: Schedule 80 PVC
Slot Size: 0.02 inch

GROUT: 0 to 134.0 feet bgs
Type: Cement/Bentonite
Mix Used: 188 lbs cement, 4 lbs bentonite, 12 gal H2O
PLUG: 134.0 to 144.5 feet bgs
Type: Cetco Coated 1/4" Bentonite Pellets
Volume: 150 lbs
FILTER PACK: 144.5 to 161.0 feet bgs
Type: 10/20 Colorado Silica Sand
Volume: 350 lbs
SUMP: 158.9 to 161 feet bgs

RATHOLE: N/A
Type: None

DEVELOPMENT:
Method: Waterra Hydrolift II
Date: 9/10/2012 - 9/11/2012

HOLE COMPLETION NOTES:
Total Depth Drilled: 161 feet bgs
Total Depth of Well: 161 feet bgs
Depth to Water in Well: 52.75 feet btoc
DTW Time & Date: 9/10/2012 at 13:30

Comments:

2012 PEBBLE LOGS - SONIC 2012 BORING LOGS_FINAL.GPJ PEBBLE2.GPJ 4/16/13

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PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
15							GC **Clayey GRAVEL with Sand**, fine to coarse angular to subrounded gravel, fine to coarse grained sand, no structure, very loose, dark gray to olive gray	Unconsolidated Till (on a moraine) Subangular to subrounded gravel, 7-26 feet
20		SPT	7-13-10	14 / 18				Sample from 19-20.5 feet was analyzed by KP Particle Size Distribution: 50% Gravel, 29% Sand, 15.3% Silt, 5.7% Clay; LL = 28, PI = 11
		GB						Sample from 22-23 feet was analyzed by KP Particle Size Distribution: 47.4% Gravel, 31.9% Sand, 15.1% Silt, 5.6% Clay; LL = 27, PI = 9
25	8 / 10							
								Angular to subangular gravel, 26-46 feet
30		SPT	22-23-19	13 / 18				Boulder encountered at 27.5-28.5 feet Slow and difficult drilling through very hard material past, 28.5-46.5 feet
35	9.5 / 10							

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PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
40		SPT	12-21-34	13 / 18			GC **Clayey GRAVEL with Sand**, fine to coarse angular to subrounded gravel, fine to coarse grained sand, no structure, very loose, dark gray to olive gray	
45							46.5 GC **Clayey GRAVEL with Sand**, fine to medium grained sand, homogeneous, blocky, moist, medium plasticity, olive gray	Grading to **Silty GRAVEL** by 48 feet
50		SPT	9-16-16	11 / 18			49.0 SP **SAND**, fine to coarse subangular to subrounded gravel, medium to coarse grained sand, homogeneous, mostly loose, blocky, moist, light brown to brown	Grades in and out of **Sandy GRAVEL** and 6 to 8 inch lenses of **Sandy SILT**
55	6.08 / 10							6 inch lense of dry medium grained sand to coarse gravel at 54 feet

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PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
60		SPT	20-22-20	14 / 18			SP **SAND**, fine to coarse subangular to subrounded gravel, medium to coarse grained sand, homogeneous, mostly loose, blocky, moist, light brown to brown	
	8 / 10							
65								
							69.0	
70		SPT	4-9-9	18 / 18			CL **Sandy Lean CLAY**, mostly fine grained sand, homogeneous, soft to medium stiff, wet to moist, olive gray	Increasing clay content with depth, 69-71 feet Sample from 69-70.5 feet was analyzed by KP Particle Size Distribution: 0% Gravel, 49.7% Sand, 40.4% Silt, 9.9% Clay; LL = 31, PI = 10 Ratio of silt to clay varies throughout unit with clay content increasing with depth; some sections contain trace medium grained sand, 71-129 feet
							71.0	
	8.17 / 10						CL **Lean CLAY to Lean CLAY with Sand**, homogeneous, medium to very stiff, medium plasticity, moist, olive gray	
75								
80		SPT	3-5-8	21 / 18				Sample from 79-80.5 feet was analyzed by KP Particle Size Distribution: 0% Gravel, 12.5% Sand, 59.2% Silt, 28.3% Clay; LL = 39, PI =

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PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
85	9.92 / 10						CL **Lean CLAY to Lean CLAY with Sand**, homogeneous, medium to very stiff, medium plasticity, moist, olive gray	22 Sample from 79.5-80.5 feet was analyzed by KP Particle Size Distribution: 0% Gravel, 24.8% Sand, 57.5% Silt, 17.7% Clay; LL = 33, PI = 13
							86.0 CL **Lean CLAY with Sand**, trace fine to coarse gravel, homogeneous, medium to very stiff, medium plasticity, moist, olive gray	Depth of contact uncertain between units 71-86 feet and 86-129 feet
90		ST						Collected Shelby Tube sample GH12-322S-91.5; 2.5 / 2.5 feet recovered, 89-91.5 feet
		SPT	3-5-9	22 / 18				Cored interval below Shelby Tube sample had suprisingly high recovery, 91.5-99 feet Sample from 91.5-93 feet was analyzed by KP Particle Size Distribution: 8.1% Gravel, 17.3% Sand, 53.9% Silt, 20.7% Clay; LL = 39, PI = 22
95	9.67 / 7.5							
100		SPT	17-16-20	13 / 18				

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PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
105	9.67 / 10						CL **Lean CLAY with Sand**, trace fine to coarse gravel, homogeneous, medium to very stiff, medium plasticity, moist, olive gray	
110		SPT	14-16-20	22 / 18				Sample from 109-110.5 feet was analyzed by KP Particle Size Distribution: 0.6% Gravel, 15.4% Sand, 64% Silt, 20% Clay; LL = 35, PI = 13
115	9.25 / 10							
120		SPT	16-27-34	0 / 18				
	10 / 10							

2012 PEBBLE LOGS - SONIC 2012 BORING LOGS_FINAL.GPJ PEBBLE2.GPJ 4/16/13

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PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
125							CL **Lean CLAY with Sand**, trace fine to coarse gravel, homogeneous, medium to very stiff, medium plasticity, moist, olive gray	
							129.0 CL **Lean CLAY**, stiff to very stiff, low to medium plasticity, olive gray	
130								
	10 / 10							Sample from 134-135 feet was analyzed by KP Particle Size Distribution: 0% Gravel, 8.1% Sand, 71% Silt, 20.9% Clay; LL = 37, PI = 17
135								
							137.0 CL **Sandy Lean CLAY**, stiff to very stiff, low to medium plasticity, olive gray	Depth of contact uncertain between units 129-137 feet and 137-150 feet Sandy layer at 138-139 feet
140		SPT	5-9-14	22 / 18				Sample from 139-140.5 feet was analyzed by KP Particle Size Distribution: 7.7% Gravel, 33.1% Sand, 43.6% Silt, 15.6% Clay; LL = 33, PI = 13
								Trace fine to medium subangular gravel, 142-143.5 feet
	10 / 10							Higher clay content, 144-147 feet
145								

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** MW12-16

DATE STARTED 8/5/12 | **COMPLETED** 8/6/12 | **GROUND ELEVATION** 1041.20 feet | **TOC ELEVATION** 1045.00 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405795.647 feet | **EASTING** 2157380.119 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (AJ, AP)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
150		SPT	33-29-41	11 / 18			CL **Sandy Lean CLAY**, stiff to very stiff, low to medium plasticity, olive gray	Trace gravel, 147-150 feet Silt changing to lighter brown, 148-150 feet
							150.0 ML **Gravely SILT**, fine to coarse angular to subangular gravel, low plasticity, olive gray	
	10.5 / 10						154.0 **BEDROCK (ANDESITE/DIORITE)**, chlorite-altered, porphyritic, plagioclase phenocrysts, competent, igneous, mafic biotite and hornblende, aphanitic, fine grained, very thin quartz veins, calcite and quartz crystals, dark green to black	Bedrock encountered at 154 feet Moderately to strongly magnetic, 154-161 feet
155								
160	2 / 2						161.0	

Bottom of hole at 161.0 feet.

GH12-334S

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0								
5	6 / 9						GP **Sandy GRAVEL**, subangular gravel, trace silt, loose, damp, brown	All soils were described in accordance with ASTM Method D2488 using the Visual-Manual Method. Soil classifications and additional information obtained from laboratory testing were used to update soil descriptions, as applicable. Bedrock lithology descriptions were compiled from SLR's field descriptions and PLP Geology Logs. First core advanced to 9 feet bgs Clasts up to 2 inches, 0-14 feet
10		SPT	9-7-40	2 / 18				
							14.0	
15	9 / 10							Clasts up to 3 inches; varying sand content within unit, 14-37 feet

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION:
Type: Steel
Diameter: 6 inch
WELL CASING: 0 to 116.5 feet bgs
Stickup: 3.2 feet
Type: Schedule 40 PVC
Diameter: 4 inch
SCREEN: 116.5 to 156.5 feet bgs
Type: Schedule 40 PVC
Slot Size: 0.02 inch

GROUT: 0 to 1 foot bgs
Type: Native Material
Mix Used: N/A
PLUG: 1 to 5 feet bgs
Type: Cetco Coated 1/4" Bentonite Pellets
Volume: 150 lbs
FILTER PACK: 5 to 159.5 feet bgs
Type: Native Material
Volume: N/A
SUMP: 156.5 to 159.5 feet bgs

RATHOLE: N/A
Type: None

DEVELOPMENT:
Method: Airlift
Date: 10/4/2012

HOLE COMPLETION NOTES:
Total Depth Drilled: 159.5 feet bgs
Total Depth of Well: 159.4 feet bgs
Depth to Water in Well: 54.27 feet btoc
DTW Time & Date: 10/4/2012 at 10:00

Comments: Used airlift to pack formation sand around screened interval

2012 PEBBLE LOGS - SONIC 2012 BORING LOGS_FINAL.GPJ PEBBLE2.GPJ 4/16/13

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
15							CL **Sandy Lean CLAY**, trace cobbles, subangular gravel, medium dense to dense, damp to wet, brown to gray	
20		SPT	6-9-12	14 / 18				Sample from 19-20.5 feet was analyzed by KP Particle Size Distribution: 14.4% Gravel, 31.5% Sand, 39.7% Silt, 14.4% Clay; LL = 32, PI = 15
25	10 / 10							
30		SPT	5-R-	0 / 18				SPT at 29 feet hit refusal during second 6 inch interval after 50 blows Wet, 29-32 feet
35	8 / 10							

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
40		SPT	11-12-50	11 / 18			37.0 GP-GM **GRAVEL with Silt and Sand**, subangular gravel, poorly graded, loose to medium dense, very moist, brown	Gravelly intervals (less than 1 foot), 37-49 feet
	8 / 10							
45								
50		SPT	19-25-50	13 / 18			49.0 GP **GRAVEL with Sand**, trace cobbles, subrounded gravel, poorly graded, wet, brown	
	9 / 10				▼			
55							58.0	Clasts up to 4 inches, 58-68 feet

2012 PEBBLE LOGS - SONIC 2012 BORING LOGS_FINAL.GPJ PEBBLE2.GPJ 4/16/13

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
60		SPT	16-20-25	13 / 18			SP-SM **Poorly Graded SAND with Silt**, subrounded gravel, loose to medium dense, wet, brown to orange/red	
		GB						Sample from 61.5-62.5 feet was analyzed by KP Particle Size Distribution: 10% Gravel, 78.2% Sand, 11.8% Silt, 0% Clay; LL = NV, PI = NP
	10 / 10							
65								
							68.0	
							SM **Silty SAND**, loose to medium dense, wet, brown	
70		SPT	5-9-10	15 / 18				Sample from 69-70.5 feet was analyzed by KP Particle Size Distribution: 0% Gravel, 81.9% Sand, 14.8% Silt, 3.3% Clay; LL = NV, PI = NP
	10 / 10							
							74.5	
75							MH **SILT**, elastic, dense, slightly moist, olive gray	
							79.0	
							CL **Sandy Lean CLAY**, subrounded gravel, dense, slightly moist, olive gray	
80		SPT	3-6-11	18 / 18				Sample from 79-80.5 feet was analyzed by KP Particle Size Distribution: 14.6% Gravel, 27.6% Sand, 40.5% Silt, 17.3% Clay; LL =

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
85	10 / 10						CL **Sandy Lean CLAY**, subrounded gravel, dense, slightly moist, olive gray	29, PI = 14 Clasts up to 2 inches, 79-100 feet
							89.0	
90		SPT	10-10-16	10 / 18			SP **SAND with Gravel**, subrounded gravel, poorly graded, loose, wet, brown	
95	10 / 10						97.0	
							ML **SILT with Gravel** , sparse gravel, dense, dry, olive gray	
100		SPT	8-12-19	0 / 18			100.0	
							GM **Silty GRAVEL with Cobbles**, subangular gravel and cobbles, dense, moist, olive gray	Clasts up to 3 inches, 100-113.5 feet

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
105	4 / 10						GM **Silty GRAVEL with Cobbles**, subangular gravel and cobbles, dense, moist, olive gray	
110		SPT	R--	0 / 18				SPT at 109 feet hit refusal during first 6 inch interval after 50 blows
							113.5	
115	10 / 10						SP-SM **SAND with Silt and Gravel**, sparse gravel, medium dense, moist to very moist, brown	
							118.0	
120		SPT	3-11-50	1.5 / 18			CL **Lean CLAY with Sand**, mostly fine grained sand, poorly graded, medium dense, slightly moist to moist, brown to gray	Sample from 119-120.5 feet was analyzed by KP Particle Size Distribution: 7.4% Gravel, 17.3% Sand, 55% Silt, 20.3% Clay; LL = 36, PI = 18
	10 / 10							

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
125							CL **Lean CLAY with Sand**, mostly fine grained sand, poorly graded, medium dense, slightly moist to moist, brown to gray	
130		SPT	3-R-	0 / 18				SPT at 129 feet hit refusal during second 6 inch interval after 50 blows
	10 / 10							
135								
140		SPT	3-10-20	16 / 18				
	10 / 10							
145							146.0	Clasts up to 4 inches, 146-155

THE pebble PARTNERSHIP

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** PW12-3

DATE STARTED 8/21/12 | **COMPLETED** 8/22/12 | **GROUND ELEVATION** 1043.18 feet | **TOC ELEVATION** 1046.38 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 1405787.89 feet | **EASTING** 2157448.908 feet

DRILLING METHOD Sonic (6 5/8" diameter) | **EQUIPMENT** RRD-100 | **LOGGER** SLR (DP, JH)

DEPTH BELOW SURFACE (ft)	CORE RECOVERY (FT)	SAMPLE TYPE	SPT RESULTS 6"-6"-6"	SPT RECOVERY (INCHES)	DEPTH TO WATER (FT BGS)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
							GP-GM **GRAVEL with Silt and Sand**, subangular gravel, poorly graded, loose, wet, olive gray to brown	feet
150		SPT		0 / 18				Increased density and moisture content, 149 feet
	9 / 10							
155							155.0 **BEDROCK (DACITE)**, porphyritic, with feldspar and hornblende sockets, phenocrysts, purple fluorite crystals, minor carbonate in fractures, angular clasts, pale green to gray, loose, wet	Clasts up to 2 inches, 155-156 feet
							156.0 **BEDROCK (DACITE)**, porphyritic, with feldspar and hornblende sockets, phenocrysts, purple fluorite crystals, minor carbonate in fractures, pale green to gray	
	0.5 / 0.5						159.5	

Bottom of hole at 159.5 feet.

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-36S

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05
GROUND ELEVATION 1011.81 feet **TOC ELEVATION** 1014.38 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642166.108 meters **EASTING** 372679.8 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					1.0 **Peat**	Air injection only.
5	GB				**Gravel with sand and silt** 40% 1/2"-diameter well-graded gravel, 40% medium to fine sand, 20% silt. 5.0	
					6.0 **Sand** Brown, coarse, <15% fines, dry.	Air injection only.
10	GB				**Sand** Brown, coarse to medium sand, 15% 1/2"-diameter subangular to subrounded gravel, <15% silt or fines, dry. 8.0	
					9.0 **Gravel with sand and silt** Well-graded gravel with small cobbles, medium sand, <15% fines, dry.	
					Gravel with sand and silt Well-graded gravel and small cobbles, coarse to medium sand, <15% fines, dry. 12.0	
15	GB				**Gravel with sand and silt** Well-graded gravel, coarse to medium sand, <15% fines, dry. 15.0	
					17.0 **Gravel with sand and silt** Brown, well-graded subangular to subrounded gravel, coarse to medium sand, <15% fines, dry.	Air injection only.
20	GB				**Sand with gravel** Brown, 80% coarse to medium sand, 20% poorly-graded gravel, <15% fines, dry. 20.0	
					Gravel with sand 50% well-graded, subangular to subrounded gravel, coarse to medium sand, dry. 22.0	
25	GB				**Sand with gravel** Brown, 80% coarse to medium sand, 20% 1/2"-diameter subangular to subrounded gravel, <15% silt, damp. 25.0	Show of water at 23' bgs, water drilling out of casing. Air injection only. Injected small amount of water.
					26.0 **Sand with gravel** Brown, coarse to medium sand, 20% subangular to subrounded small gravel, damp. 27.0	
30	GB				**Silty gravel** Brown, 50% well-graded, 1/2"-diameter subangular gravel, 30% coarse to medium sand, 20% silt. 29.5 **Gravel with sand** 60% well-graded, 1/4"- to	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.57 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Oct., 2005
Purge Volume: 932 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 22.51 Date: 9/7/05 Time: 1815

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NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

GI-186

Pebble Project

NORTHERN DYNASTY MINES INC.

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05
GROUND ELEVATION 1011.81 feet **TOC ELEVATION** 1014.38 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642166.108 meters **EASTING** 372679.8 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30					31.0 1/2"-diameter subangular to subrounded gravel, 40% well-graded, coarse to medium sand, <15% fines.	
					Gravel and sand Brown, well-graded gravel, coarse to medium sand, 15% silt.	
					33.0 **Gravel and sand** Brown, coarse to medium sand, 15% silt.	Injected water to clean up hole and casing.
					34.0 **Sand** Light gray, fine, small clay lenses.	
					35.0 **Silt** Gray, elastic, dry.	
					Bottom of hole at 34.0 feet.	

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NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

G1-187

Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-36M

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05
GROUND ELEVATION 1012.17 feet **TOC ELEVATION** 1015.27 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642156.83 meters **EASTING** 372684.909 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					**No recovery**	No water added.
					4.0	
5					5.0 **Sand, silt and gravel** Brown, poorly-graded sand, dry.	
					Sand, silt and gravel Poorly-graded sand, subrounded gravel clasts, dry to moist.	
					8.5	
10	GB				**Sand with silt and gravel** Brown, well-graded sand, subrounded gravel, moist.	
					11.5	
15	GB				**Gravel with silt and sand** Light brown, well-graded, subrounded gravel clasts, moist.	
					15.0	
					Sand with silt and gravel Light brown, well-graded sand, <20% subrounded gravel, moist.	
					17.0 Increased gravel.	
20	GB				**Gravel with silt and sand** Brown, well-graded, subangular gravel, moist.	
					Decreased silt.	
					21.8	
					Gravel with sand Well-graded, subrounded to subangular gravel, wet.	
25	GB				25.0	
					Gravel Well-graded, subangular to subrounded, wet.	
			1		27.0 Increasing silt.	
			1		**Gravel with sand** Well-graded gravel, wet.	
30					30.0	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 3.10 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 5 Oct., 2005
Purge Volume: 1071 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (ftoc): 23.22 Date: 9/8/05 Time: 1805

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NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

GI-188

Pebble Project

NORTHERN DYNASTY MINES INC.

PROJECT LOCATION Iliamna, Alaska | **DRILL SITE** Pebble/Site AG

DATE STARTED 9/7/05 | **COMPLETED** 9/7/05 | **GROUND ELEVATION** 1012.17 feet | **TOC ELEVATION** 1015.27 feet

DRILLING CONTRACTOR Foundex | **NORTHING** 6642156.83 meters | **EASTING** 372684.909 meters

DRILLING METHOD Air Percussion | **EQUIPMENT** ODEX/HT700 | **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30	GB		1		**Gravel with sand** Brown, well-graded, subangular to subrounded gravel, wet.	No water added.
35	GB				35.0 **Gravel with sand** Well-graded gravel, wet. 35.5	
					36.8 **Silt with sand** Light brown.	Injected water. Added foam.
					38.0 **Clay with silt** Greenish gray.	Injected water/foam.
40	GB				40.0 **Clay with silt** Greenish gray, trace sand. Trace gravel.	
					43.5 **Silt with sand and gravel** Greenish gray.	Injected water/foam. Cuttings very foamy. Added water.
45	GB				45.0 **Silt with sand and gravel** Gray, plastic, trace gravel.	Added water/foam.
50	GB				50.0 **Silt with sand and gravel** Gray, medium plasticity.	Added water/foam.
					51.8 52.8 **Silt with sand and gravel** Gray.	Added water/foam.
55	GB				55.0 **Silt with sand and gravel** Increased coarse-grained, angular sand.	Added water/foam.
60	GB				60.3 **Silty sand** Gray, coarse, subangular sand. 61.5	Drill advancing much faster. Added water.
65	GB				**Silty sand and gravel** Well-graded, subrounded gravel. 65.0	Added water. Sands heaving severe.
70	GB				**Gravel with sand** Well-graded gravel, subrounded sand. 70.0	Add water/foam. Heaving sands. Added water/foam. Added water/foam. Drill in heaving sand.
	GB				**Sand with gravel** Well-graded sand, <15% subrounded gravel. 73.0 **Sand**	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

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Pebble Project

P-05-36M

NORTHERN DYNASTY MINES INC.

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/7/05 **COMPLETED** 9/7/05
GROUND ELEVATION 1012.17 feet **TOC ELEVATION** 1015.27 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642156.83 meters **EASTING** 372684.909 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75					**Sand**	Injected foam/water.
					77.0	
	GB				**Sand** Gray, medium to fine, wet.	Driller cleaned casing and got heave under control. Heave is back in casing, even when water was added to casing to control heave. Injected foam and water.
80					80.0	
					Sand Coarse.	
					82.0	
	GB				**Sand** Coarse, little to no fines.	Fines may have been washed out of sample by water used to control heaving sand. Inject foam and water.
85					85.5	
					86.5 **Sand with gravel** Medium to fine sand, 5% to 10% 1/2"-diameter gravel.	Injected moderate amount of foam and water.
					87.5 **Gravel with sand** Well-graded gravel, coarse to medium sand, little to no fines.	
	GB				89.0 **Sand** Coarse to medium sand, 10% to 20% gravel, little to no fines.	
90					90.5 **Silty gravel** Rock chips are black siltstone, maybe a large cobble. Gray, 20% gravel.	Sand heave 8' into casing, installed piezometer, removed piezometer and drilled deeper.
	GB				Bottom of hole at 90.8 feet.	

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NORTHERN DYNASTY_PEBBLE2.GPJ_PEBBLE2.GPJ 5/30/06

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Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-36D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05
GROUND ELEVATION 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
0					0.5 **Peat**	Air injection only.
					2.0 **Silty sand** Light brown, medium to fine sand, damp.	
	GB				3.0 **Silty sand** Light brown, 50% silt, 50% medium to fine sand, damp.	
5					4.0 **Silty gravel** Poorly-graded gravel, medium to coarse sand, dry.	
					5.0 **Silty sand** Coarse to medium sand, 15% silt, damp.	Air injection only.
					7.0 **Silty gravel** Poorly graded.	
	GB				**Silty sand** Brown, 75% medium to fine sand, 15% silt, 10% gravel, damp.	
10					9.0	
					10.5 **Sandy gravel** Poorly-graded, subangular gravel, coarse to medium sand, dry to damp.	
					Gravel and sand Dry.	
	GB				12.0	
					Gravel and sand 50% well-graded, 1/4"- to 1/2"-diameter subangular gravel, 40% coarse to fine sand, 10% silt, dry.	
15					15.0	
					Gravel with sand Well-graded gravel, coarse to fine sand, damp to dry.	Air injection only.
					17.0	
	GB				**Gravel with sand** 45% well-graded, 1/4"- to 1/2"-diameter gravel, 45% coarse to fine sand, 10% silt.	
20					19.0	
					20.0 **Sand** Light brown, coarse to medium sand, 10% gravel, dry.	
					Gravel and sand Well-graded, subangular gravel, coarse to medium sand, dry.	
					22.0	
	GB		1/8		23.0 **Sand** Coarse to medium sand, 10% subangular to subrounded gravel, <15% fines, damp to wet.	First show of water.
					24.0 **Sand** Coarse to medium sand, increasing gravel.	No significant flow.
25					**Gravel** Well-graded, subangular gravel, coarse to medium sand, increasing silt.	Air injection only.
					26.5	
					Gravel with silt and sand Brown, 45% well-graded gravel, 40% coarse to medium sand, 15% silt, damp.	
	GB				29.0	Flow out of cyclone at drill break. Flow immediately stops drilling air injection.
30					**Gravel** Poorly-graded pea gravel, wet.	

WELL COMPLETION INFORMATION

WELLHEAD PROTECTION
Type: Steel
Diameter: 6 inch

WELL CASING
Stickup: 2.30 feet
Type: Schedule 80 PVC
Diameter: 2 inch

SURFACE SEAL
Mix Used: 10# grout, 100# cement, 10 gal H2O

GROUT
Type: PureGold
Method of Placement: Tremie

PLUG
Type: Cetco 1/4"coated tablets

SCREEN FILTER
Type: 10/20 silica sand

SCREEN
Type: Schedule 80 PVC
Slot Size: 0.020 inch

RATHOLE
Type: N/A

DEVELOPMENT
Method: Waterra pump,1" tubing (with/without surge block)
Date: 4 Oct., 2005
Purge Volume: 294 gallons

RESPONSE TEST
Response Method: 20', 1" OD Waterra Tube
Date: 15 Oct 2005

Comments: Static Water Depth is denoted by solid triangle (floc): 113.0 Date: 9/6/05 Time:0215

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NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

61-191

Pebble Project

NORTHERN DYNASTY MINES INC.

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05
GROUND ELEVATION 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
30			1/2		**Gravel** Poorly-graded pea gravel, wet.	
					32.0	
					33.0 **Gravel** 80% subangular to subrounded, poorly-graded gravel, 20% medium sand, <15% fines, wet.	Inject small amount of water.
35					35.0 **Gravel** Well-graded, subangular to subrounded gravel, coarse to medium sand.	Inject small amount of water.
					Silt Gray, elastic, dry.	
					38.0	
					Silt Gray, elastic, 5% coarse sand and small gravel, dry.	
40					42.0	
					Silt Gray, elastic, 5% to 10% coarse sand, small gravel.	
45					45.0	
					Silt Gray, 5% to 10% silt, dry.	Inject small amount of water.
					47.0	
					Silt Gray, elastic, 5% to 10% coarse sand and small gravel, dry.	
50					52.0	
					Silt Gray, elastic, 15% subangular to subrounded gravel, dry.	
55					55.0	
					Silt Gray, 15% coarse sand and gravel.	Inject small amount of water.
					56.5	
					57.0 **Gravel with sand and silt** Poorly-graded gravel, coarse sand.	
					58.0	
60					**Gravelly silt** Gray, 75% silt, 15% 1/4"- to 1/2"-diameter subrounded gravel, 10% coarse to medium sand.	
					Silt Gray, gravel and coarse sand.	
					62.0	
					Silt Gray, elastic, 10% to 5% coarse sand, dry.	
					63.5	
					64.5 **Gravel with sand** 70% coarse sand,	
65					65.0 30% poorly-graded pea gravel.	
					Sand Coarse to fine sand (probably wet).	Inject small amount of water.
					Sand Coarse to fine sand.	
					67.0 **Sand with gravel** 70% coarse to medium sand, 30% 1/4"-diameter subangular to subrounded pea gravel, wet (maybe).	Heaving sands. Inject small amount of water.
70					70.0	
					Sand with gravel Coarse to medium sand, 20% gravel.	
					72.0	
					Sand Medium to fine sand.	

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

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Anchorage, Alaska 99503
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Fax: 907.222.1113

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Pebble Project

NORTHERN DYNASTY MINES INC.

P-05-36D

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05
GROUND ELEVATION 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
75				**Sand** Medium to fine sand.	
				77.0	
				Sand 80% coarse sand, 20% pea gravel.	
				78.5	
80				**Gravel with sand** Well-graded gravel, <20% coarse subrounded sand, wet.	
	GB			80.5	
				Sand and gravel Well-graded sand.	Added foam.
					Added foam.
					Filled casing with water.
85				85.0	
	GB			**Sand and gravel** Well-graded sand.	
				86.5	
				Sand with silt and gravel Well-graded sand.	Added foam.
				88.5 Increased silt.	Added foam.
90				**Silt with sand**	
	GB			90.0	
				Silt with sand and gravel Light brown, moist.	
					Added water/foam.
				94.5	
95				95.0 **Silt with gravel** Black, angular.	Driller says bedrock.
	GB			96.0 **Silt with gravel** Black.	Driller says bedrock.
				96.5 **Silt with sand and gravel**	
			1/8	**Silt with gravel** Black.	
				Boulder.	Waited 10 min., let hole stabilize.
100				99.5	Change out rods, drilled with 4" bit open hole.
	GB			**Silt with gravel and cobbles** Light brown.	Added water.
					Added water/foam.
					Added water/lots of foam.
105				105.0	
	GB			**Silt with sand and gravel** Light brown, stiff.	Added foam.
				108.0	
				Gravel with silt and sand Subangular to angular.	Added water.
110					
	GB				Added water.
115				115.0	
	GB			**Gravel with silt and sand** Tan, subangular to angular gravel, coarse, rounded to subangular sand grains.	Added water.
					Driller says it drills like clay.
					Added water.
				119.5	Added water/foam.

NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

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Pebble Project

P-05-36D
PAGE 4 OF 4

NORTHERN DYNASTY MINES INC.

PROJECT LOCATION Iliamna, Alaska
DRILL SITE Pebble/Site AG
DATE STARTED 9/6/05 **COMPLETED** 9/6/05
GROUND ELEVATION 1012.13 feet **TOC ELEVATION** 1014.43 feet
DRILLING CONTRACTOR Foundex
NORTHING 6642161.263 meters **EASTING** 372682.372 meters
DRILLING METHOD Air Percussion
EQUIPMENT ODEX/HT700 **LOGGER** Daigle/Hagen

DEPTH BELOW SURFACE (ft)	SAMPLE TYPE	DEPTH TO WATER (ft bgs)	FLOW TEST (gpm)	GRAPHIC LOG	SOIL DESCRIPTION	WELL DIAGRAM / COMMENTS
120	GB				**Silt with sand and gravel** Black, angular to subrounded grains, stiff silt.	Applying lots of water/foam. Gauge is bouncing.
					124.5	Added water/foam. "Drilling like clay."
125	GB				125.0 **Bedrock** Gray, conglomerate.	Added water/lots of foam.
			<1		**Bedrock** Gray, conglomerate.	
130	GB					Added water/foam.
135	GB				135.0	
			3/4		**Bedrock** Gray, conglomerate.	No water added.
			3/4			No water added.
140			6			
			6-8			Changed from 6" to 4" hammer, drilled open hole.
145					145.0	
			8-10		**Bedrock** Gray, conglomerate.	
150			8-10			
			8-10		151.0	
					Bottom of hole at 151.0 feet.	

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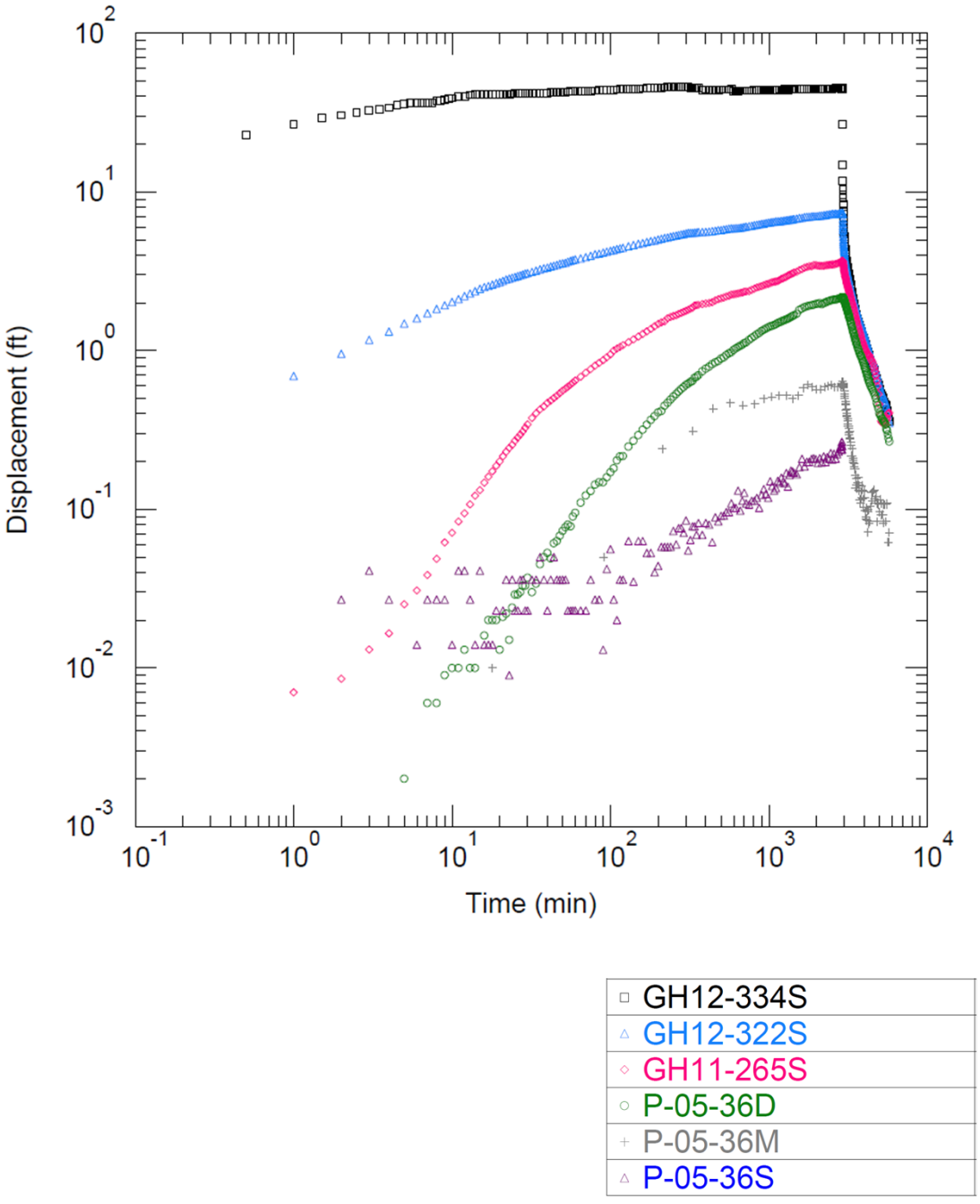
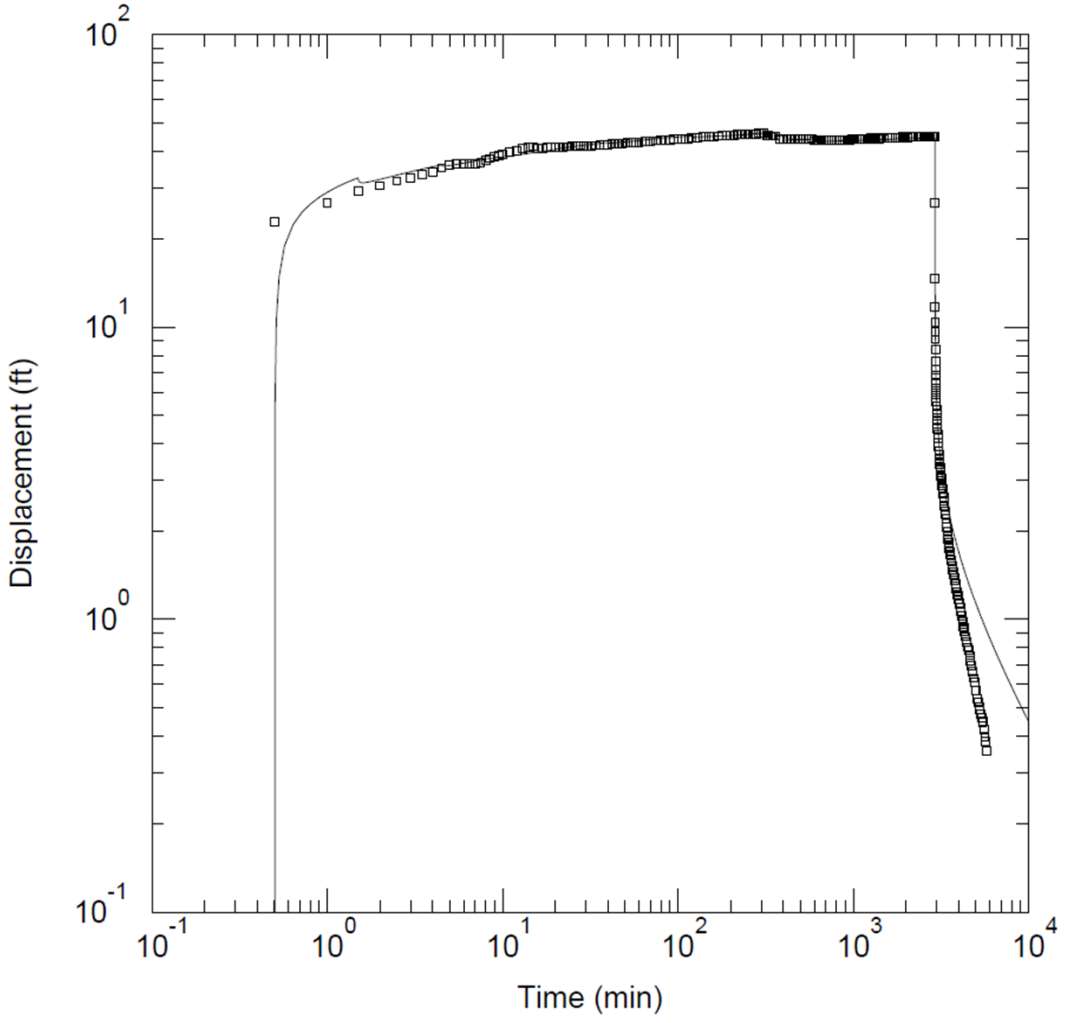
NORTHERN DYNASTY PEBBLE2.GPJ PEBBLE2.GPJ 5/30/06

GI-194

APPENDIX B
AQTESOLV PLOTS



Appendix B- 1 **Displacement (ft) vs. time (min) for pumping well GH12-334S and all monitoring wells.**



SOLUTION

Aquifer Model: Confined

Solution Method: Theis

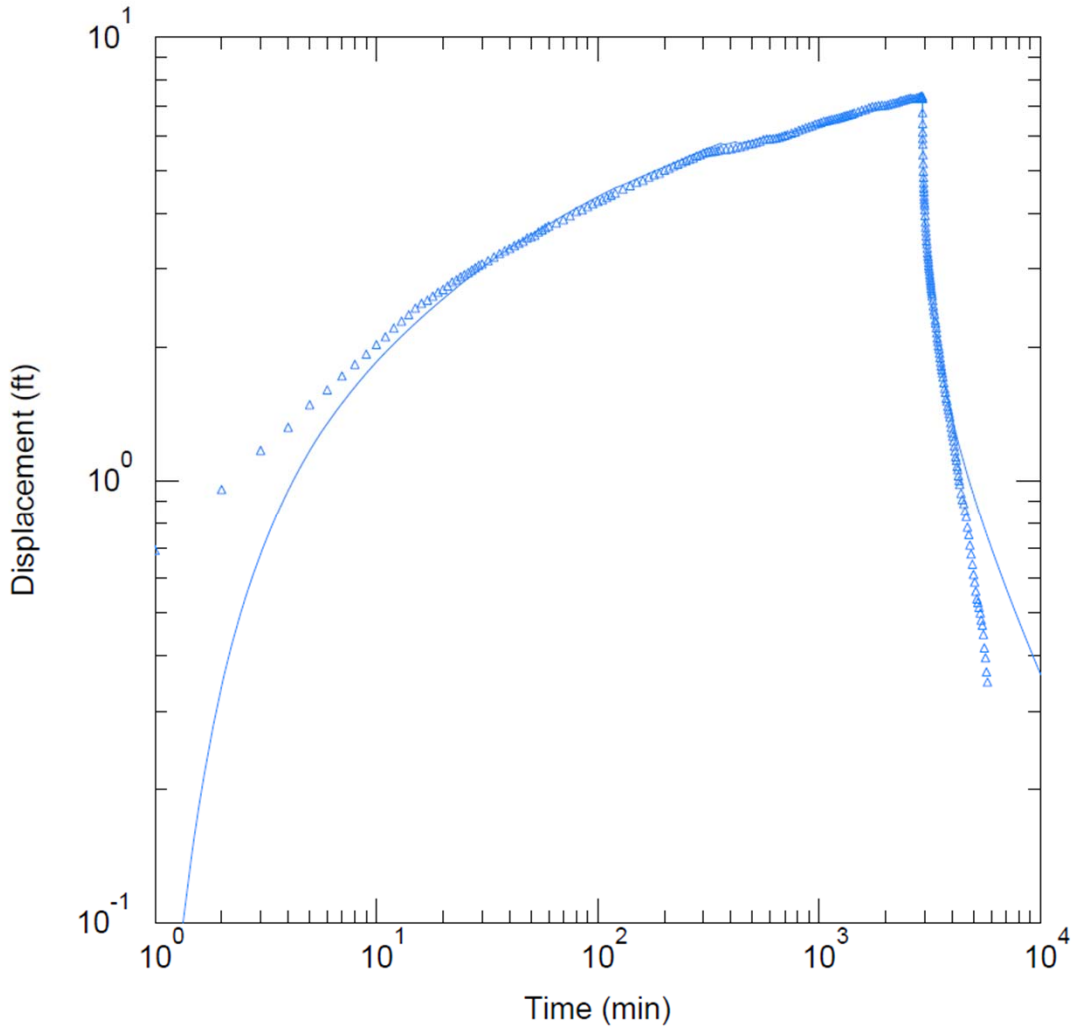
S = 0.01935

T = 174.4 ft^2/day

Kz/Kr = 1.

- GH12-334S
- GH12-322S
- GH11-265S
- P-05-36D
- P-05-36M
- P-05-36S

Appendix B- 2 Pumping Well GH12-334S.



SOLUTION

Aquifer Model: Confined

Solution Method: Theis

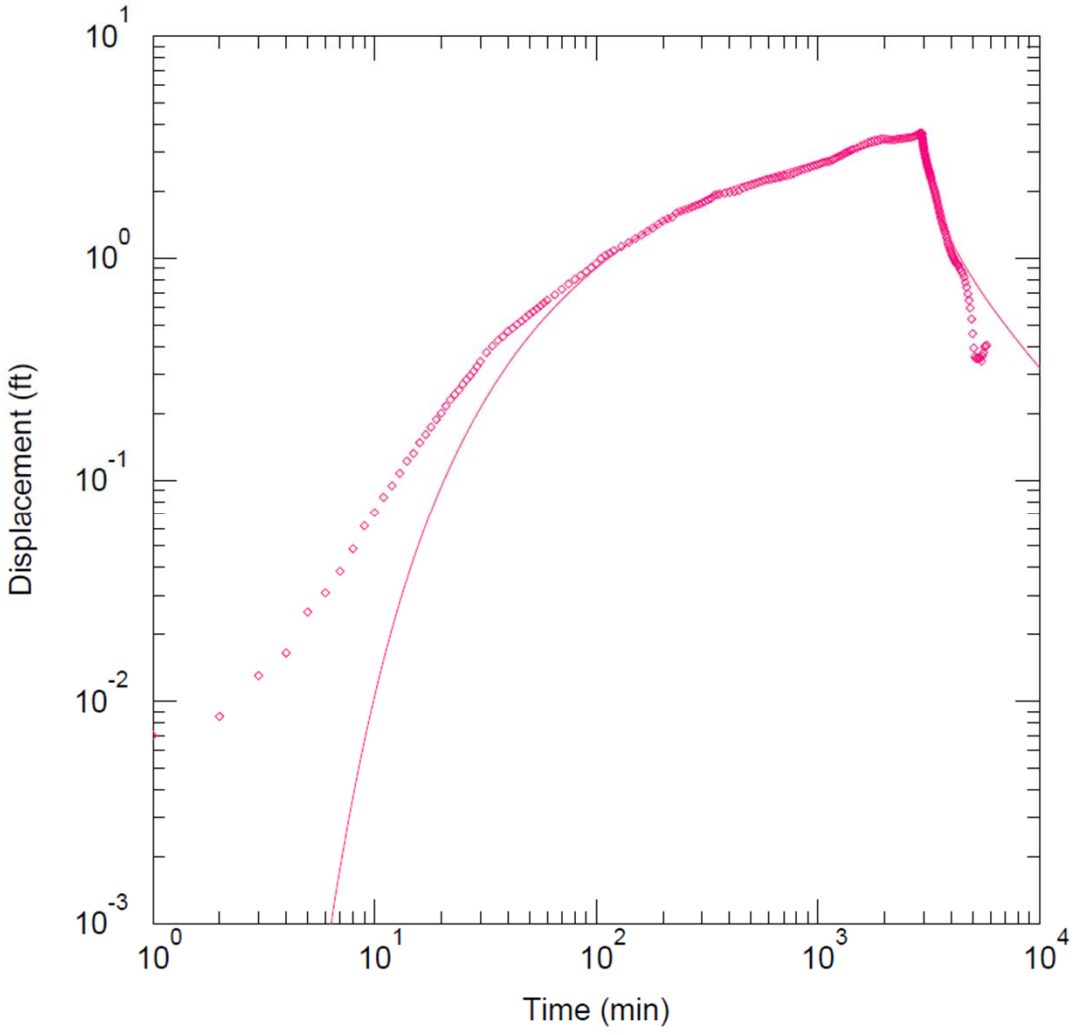
S = 0.0002014

T = 214.9 ft^2/day

Kz/Kr = 1.

GH12-334S
GH12-322S
GH11-265S
P-05-36D
P-05-36M
P-05-36S

Appendix B- 3 Monitoring Well GH12-322S.



SOLUTION

Aquifer Model: Confined

Solution Method: Theis

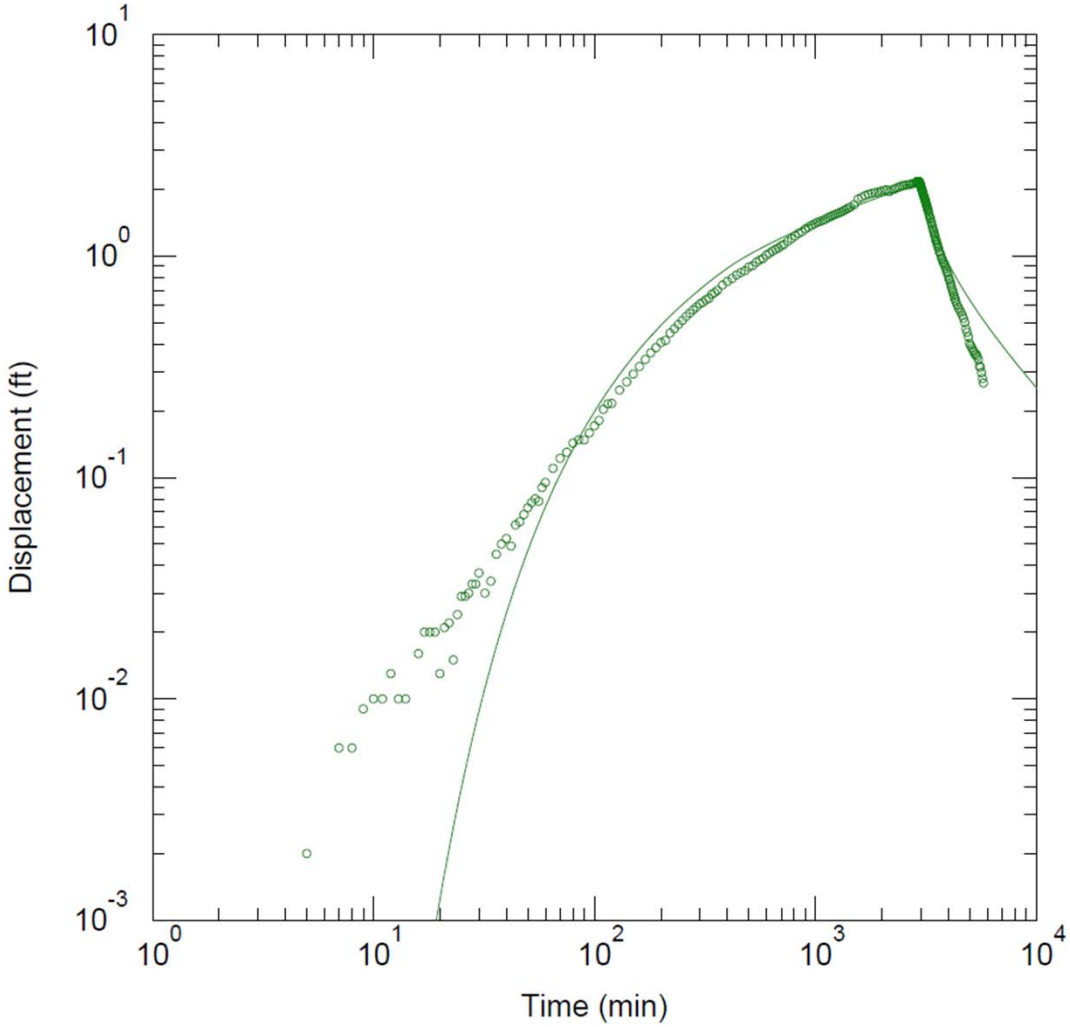
S = 0.0001847

T = 243.3 ft^2/day

Kz/Kr = 1.

- GH12-334S
- GH12-322S
- GH11-265S
- P-05-36D
- P-05-36M
- P-05-36S

Appendix B- 4 Monitoring Well GH11-265S.



SOLUTION

Aquifer Model: Confined

Solution Method: Theis

S = 0.0004877

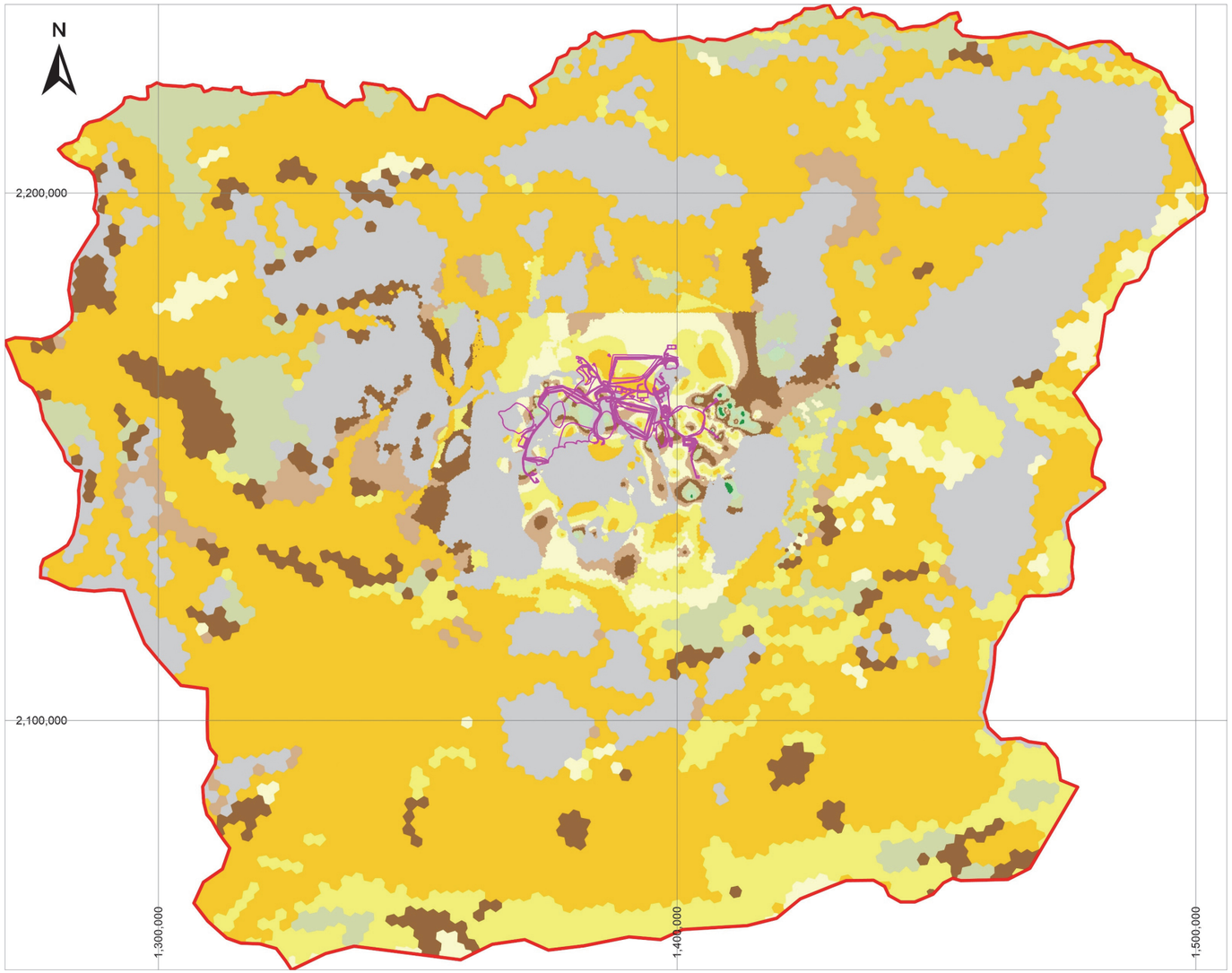
T = 304.6 ft^2/day

Kz/Kr = 1.

- GH12-334S
- GH12-322S
- GH11-265S
- P-05-36D
- P-05-36M
- P-05-36S

Appendix B- 5 Monitoring Well P-05-36D.

APPENDIX C
DISTRIBUTION OF HYDROGEOLOGIC UNITS BY MODEL LAYER



GENERAL ARRANGEMENT
MODEL DOMAIN
OVERBURDEN (MODEL LAYERS 1 TO 3)
SAND AND GRAVEL
SILTY SAND AND GRAVEL
CLAYEY/SILTY SAND AND GRAVEL
CLAYEY SAND AND GRAVEL
SANDY/GRAVELLY SILT
CLAYEY/SANDY SILT
SILT
CLAYEY SILT/SILTY CLAY
CLAY
WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
UNDIFFERENTIATED
REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
JURASSIC PLUTONIC (Jlmgr)
JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
CRETACEOUS GRANITIC (Klgr)
CRETACEOUS GRANITIC (Kmgr)
TERTIARY BASALT AND GREENSTONE (Trmb)
TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)
PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
CRETACEOUS GRANODIORITE SILL
CRETACEOUS GRANODIORITE PLUTON
CRETACEOUS DIORITE SILL
CRETACEOUS MEGA BRECCIA
CRETACEOUS GABBRO
CRETACEOUS SEDIMENTARY XENOLITHS
TERTIARY/CRETACEOUS UNDIFFERENTIATED
TERTIARY BASALT
TERTIARY COBBLE CONGLOMERATE
TERTIARY WACKE
TERTIARY MUDSTONE-SILTSTONE
TERTIARY PEBBLE CONGLOMERATE
TERTIARY RHYOLITE
TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. PROJECT AREA GEOLOGY FROM GEOLOGICAL MODEL FILES RECEIVED FROM PLP SEPTEMBER 12, 2018. REGIONAL GEOLOGY FROM WILSON ET AL. (2012).
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PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 1
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-1

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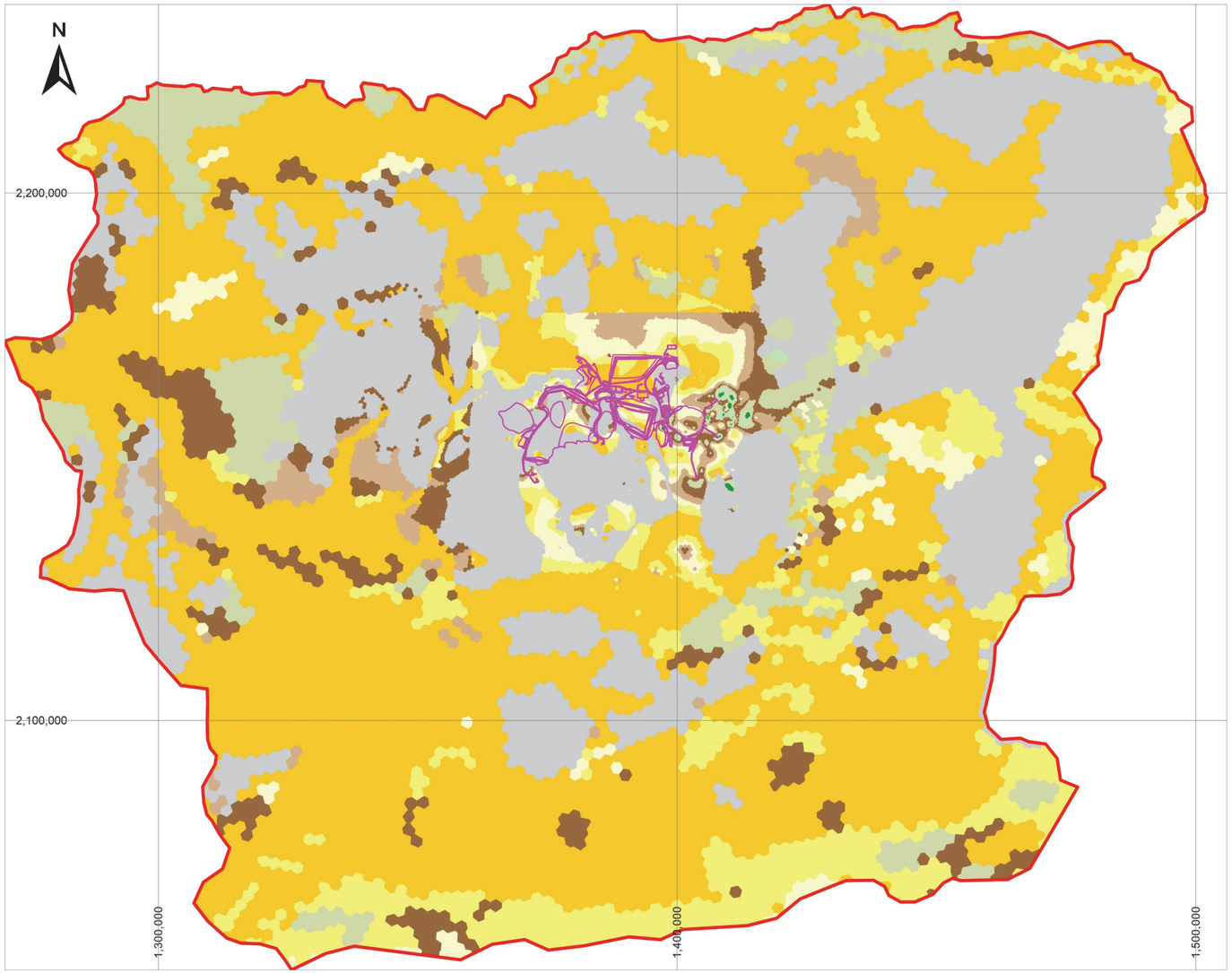

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
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PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 2
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-2

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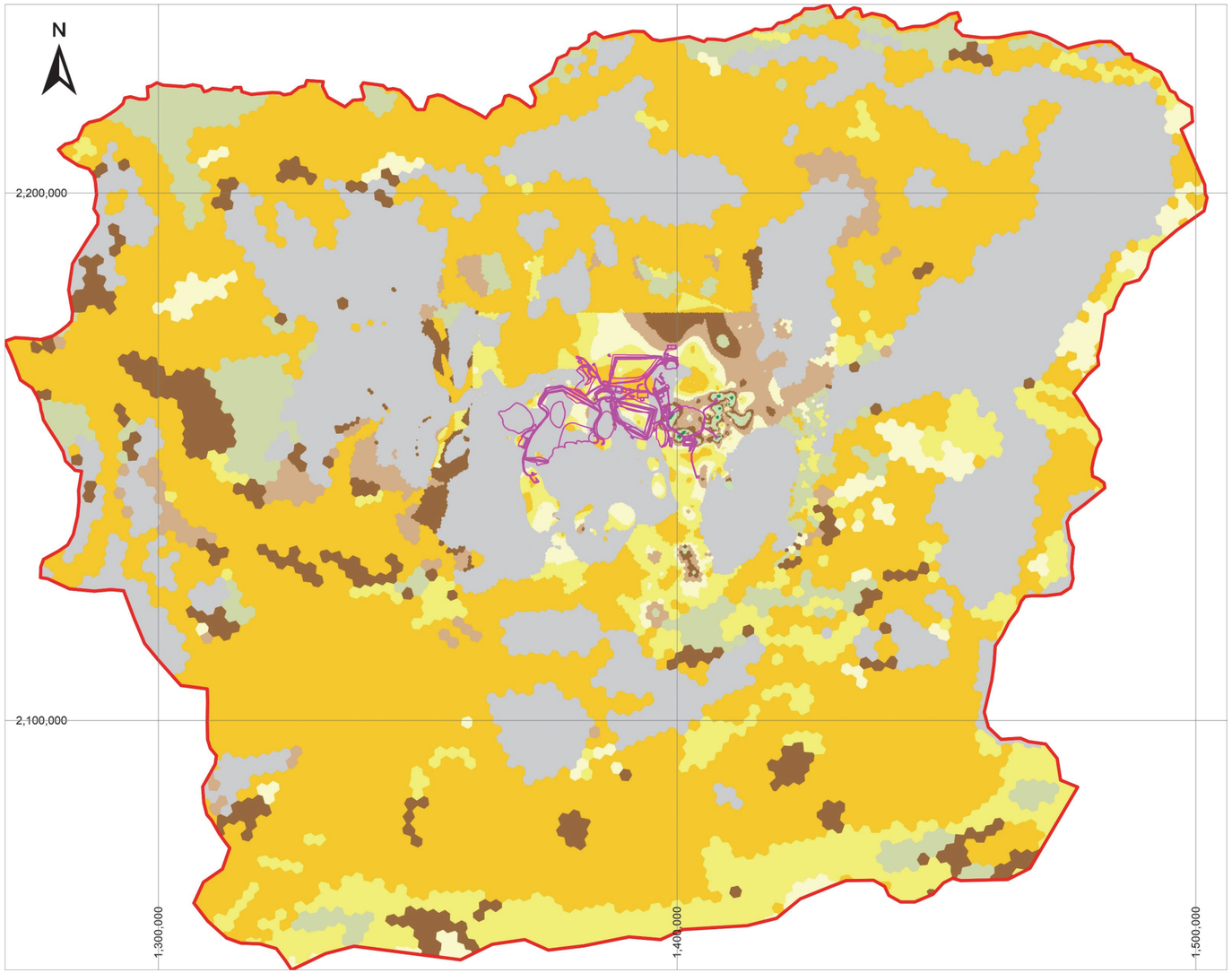

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
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PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 3
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-3

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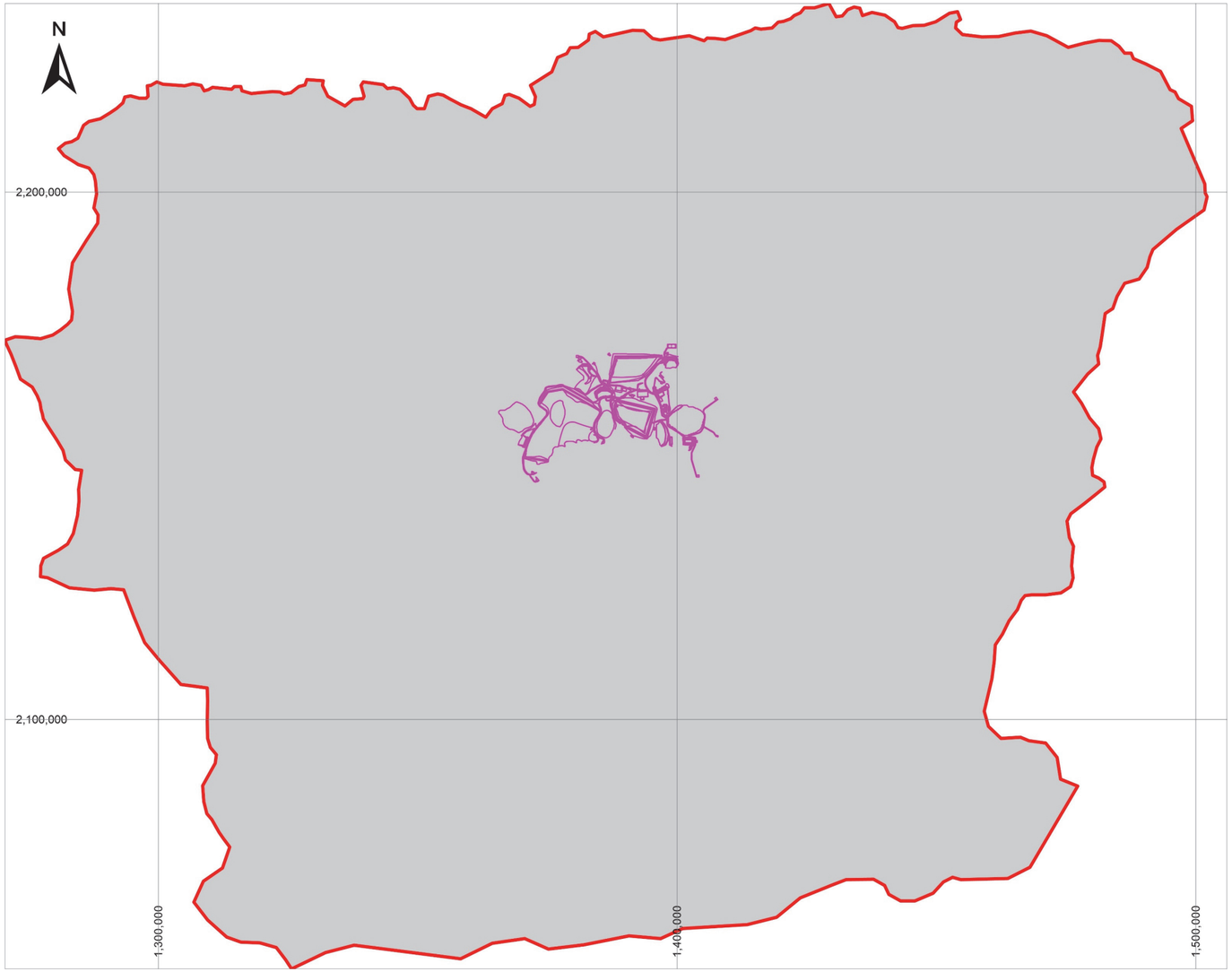

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
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APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-4

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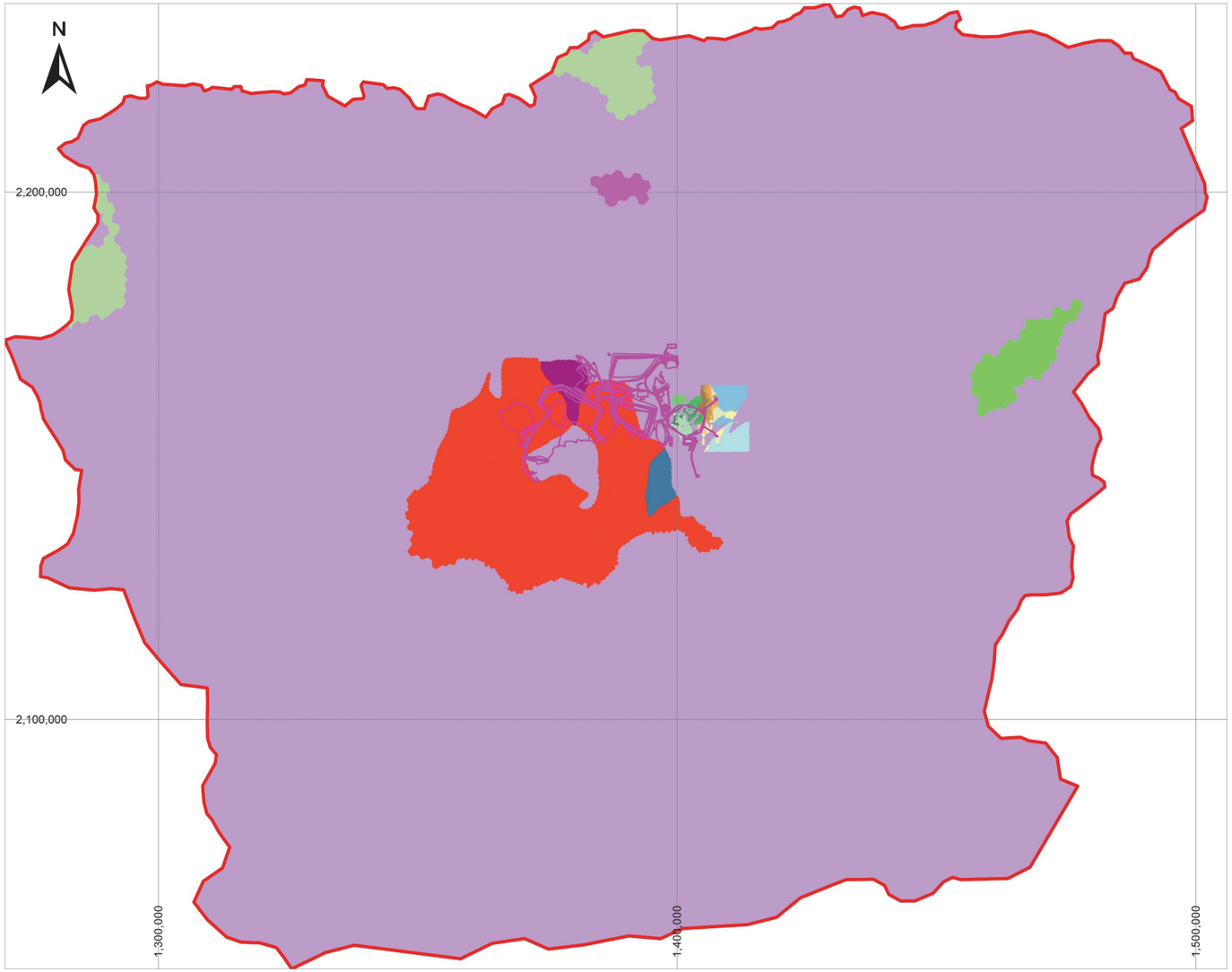

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. PROJECT AREA GEOLOGY FROM GEOLOGICAL MODEL FILES RECEIVED FROM PLP SEPTEMBER 12, 2018. REGIONAL GEOLOGY FROM WILSON ET AL. (2012).
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 5
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-5

THE pebble PARTNERSHIP

BGC

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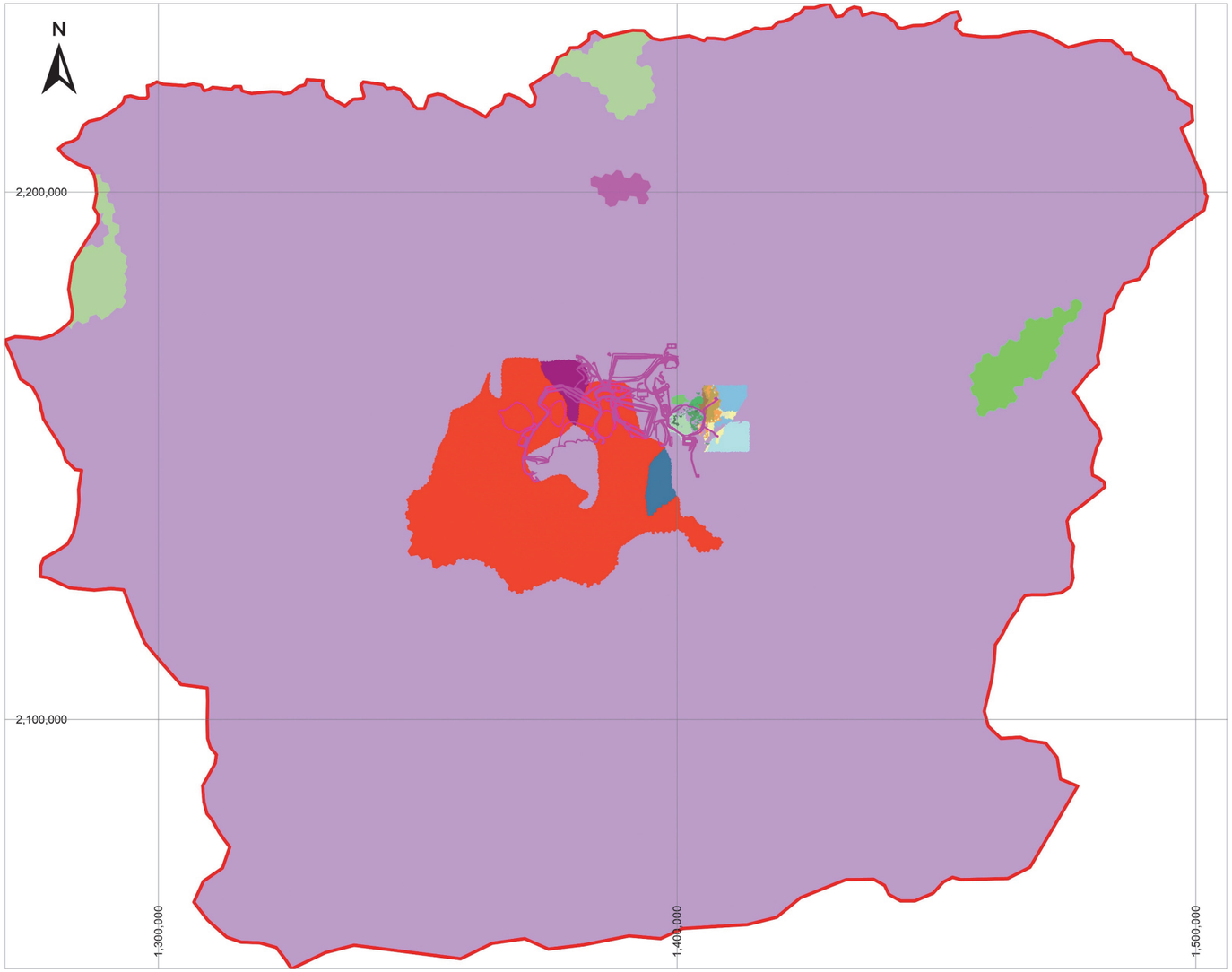

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: MODEL LAYER 6	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: C-6

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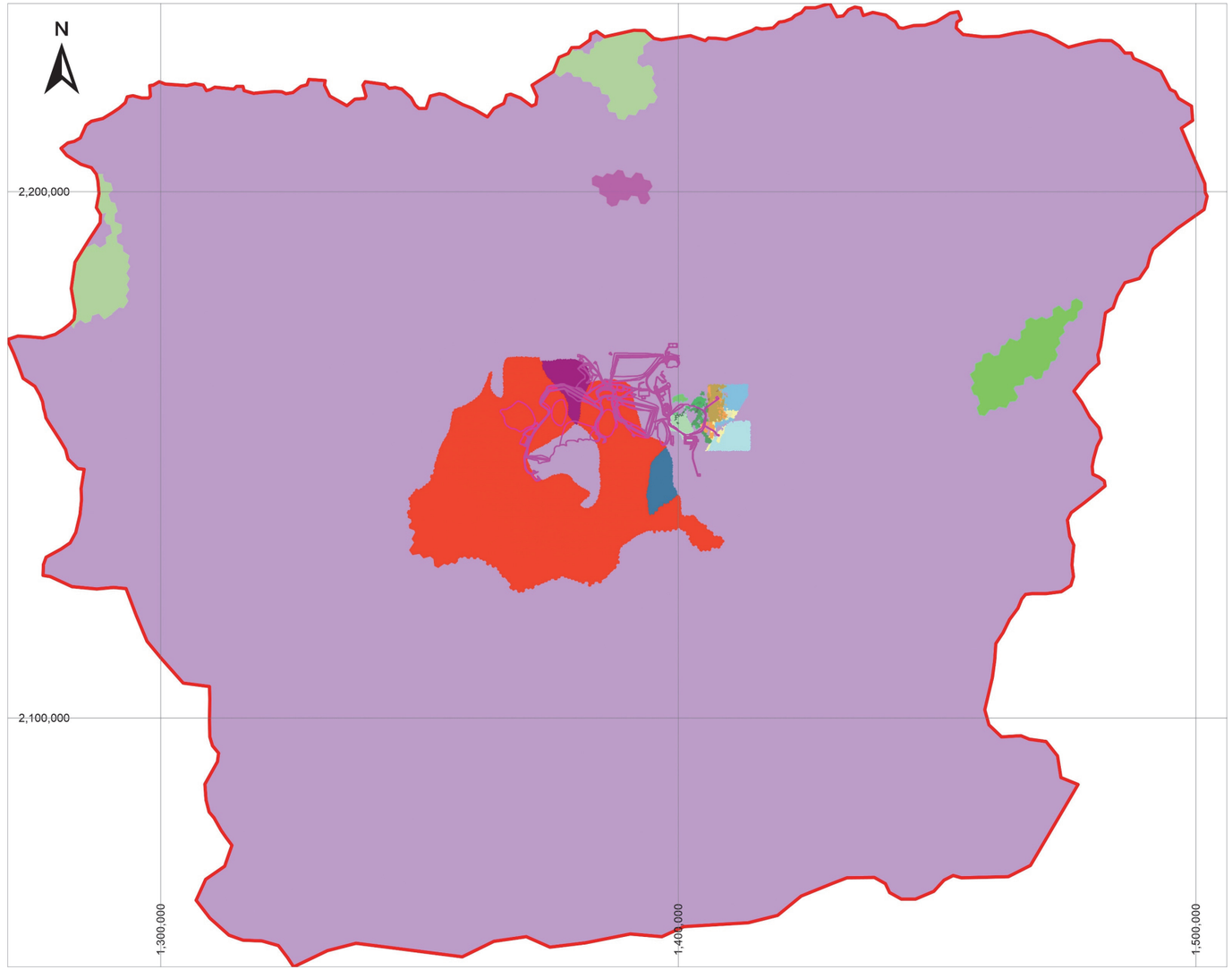

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: MODEL LAYER 7	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: C-7

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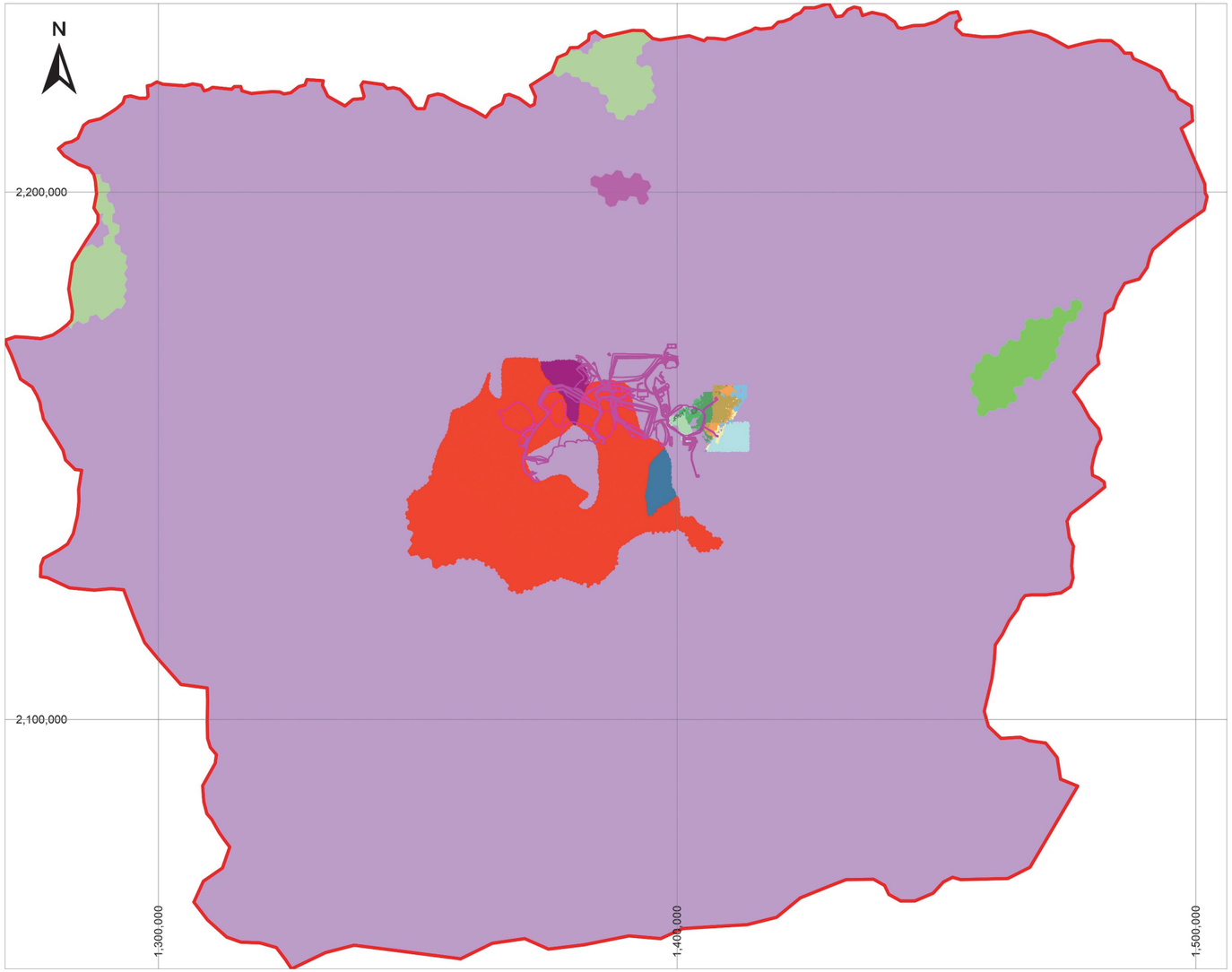

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
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SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: MODEL LAYER 8	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: C-8

THE pebble PARTNERSHIP

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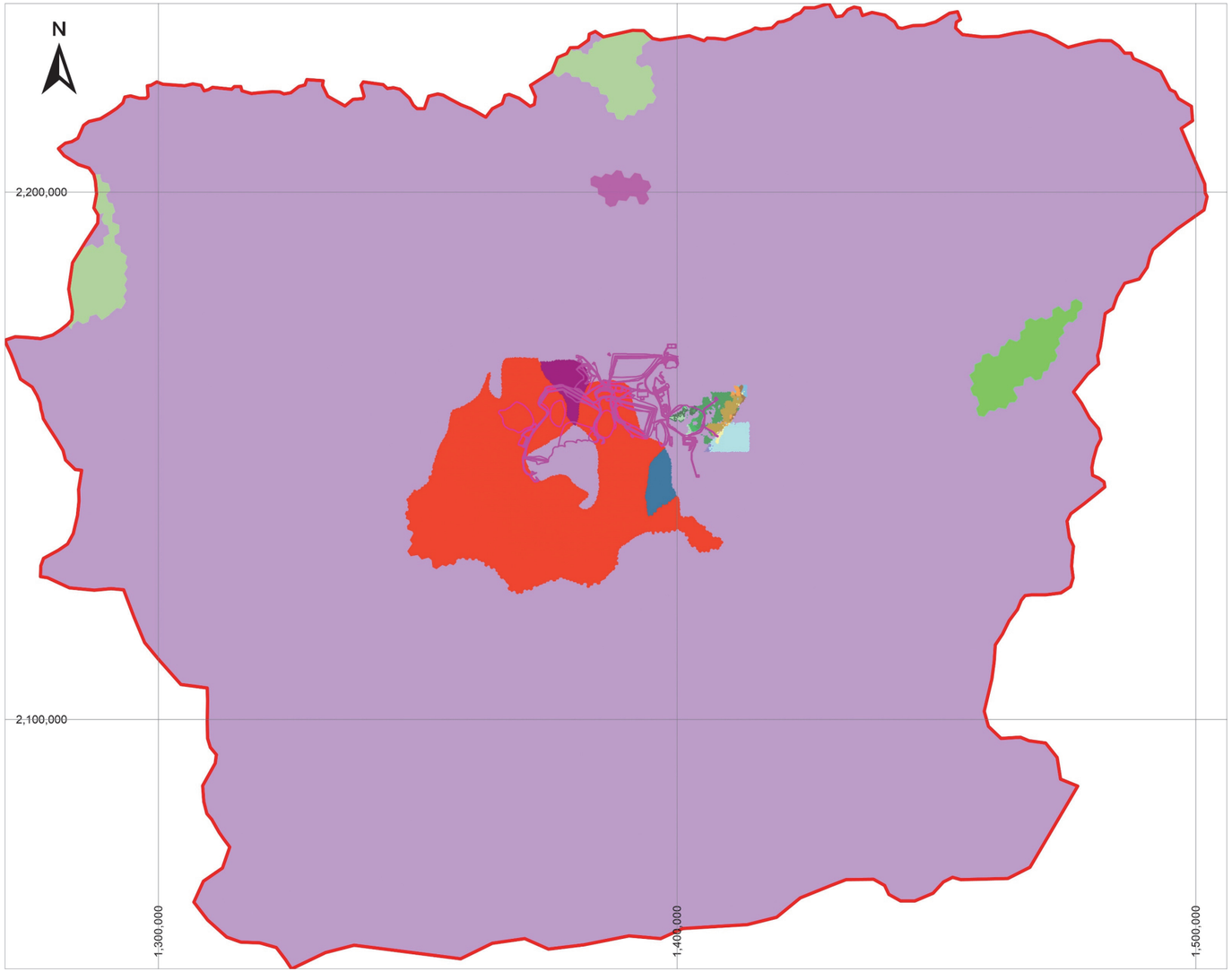

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 9
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-9

THE pebble PARTNERSHIP

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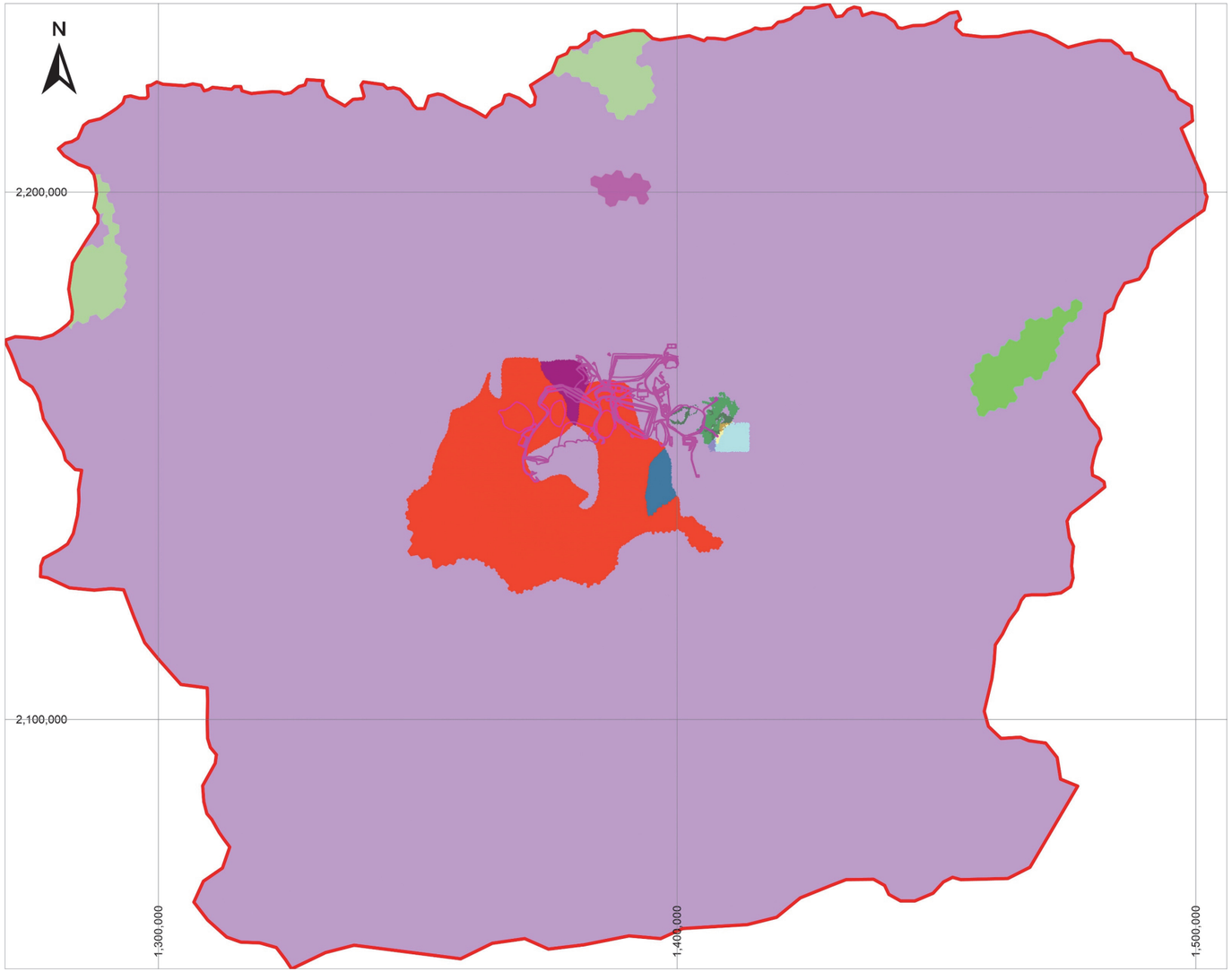

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 10
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-10

THE pebble PARTNERSHIP

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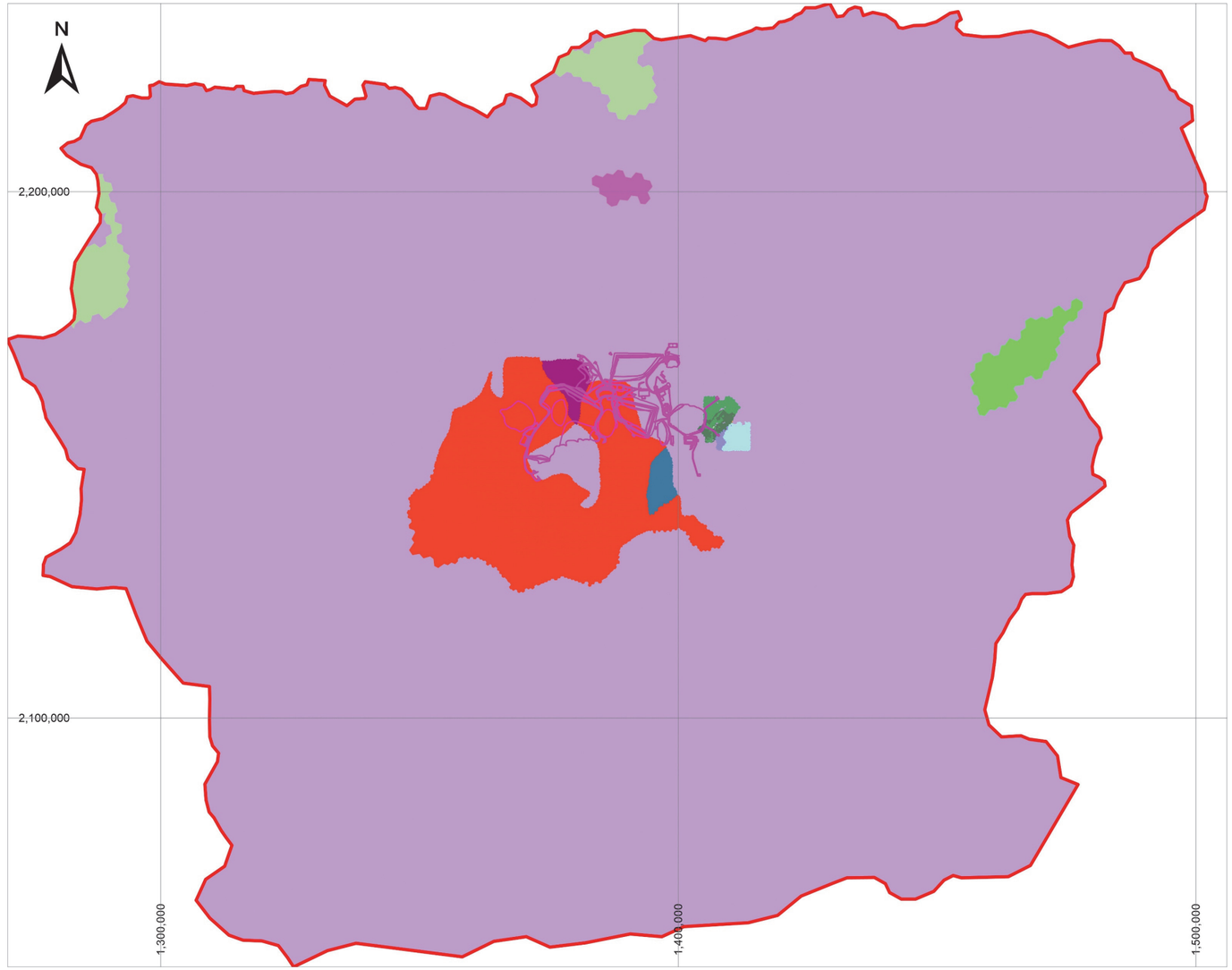

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: MODEL LAYER 11
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: C-11

THE pebble PARTNERSHIP

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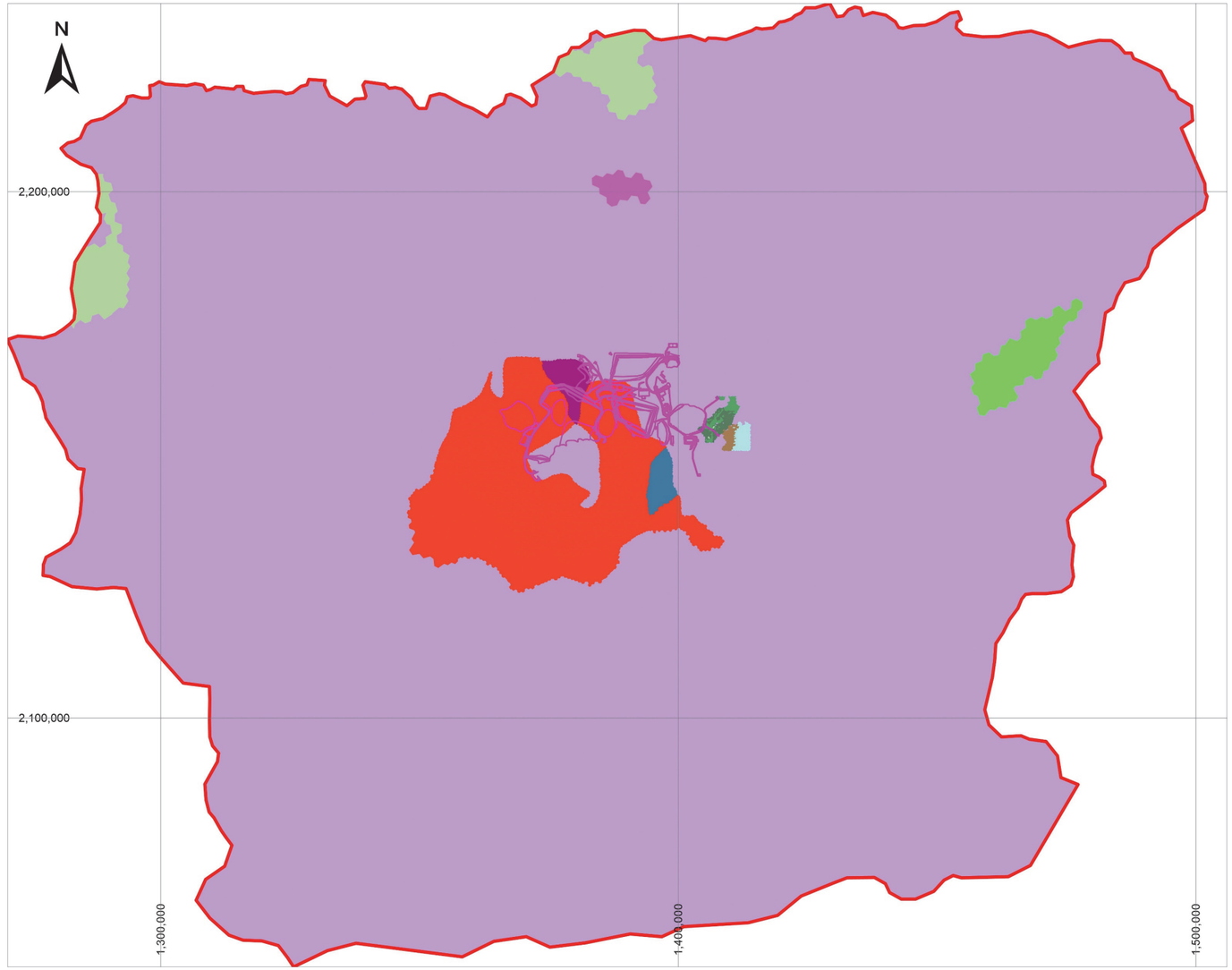

GENERAL ARRANGEMENT
MODEL DOMAIN

OVERBURDEN (MODEL LAYERS 1 TO 3)
- SAND AND GRAVEL
- SILTY SAND AND GRAVEL
- CLAYEY/SILTY SAND AND GRAVEL
- CLAYEY SAND AND GRAVEL
- SANDY/GRAVELLY SILT
- CLAYEY/SANDY SILT
- SILT
- CLAYEY SILT/SILTY CLAY
- CLAY

WEATHERED BEDROCK (MODEL LAYERS 1 TO 4)
- UNDIFFERENTIATED

REGIONAL BEDROCK (MODEL LAYERS 5 TO 12)
- JURASSIC PLUTONIC (Jlmgr)
- JURASSIC VOLCANIC FLOWS, BRECCIA, TUFF, AND AGGLOMERATE (Jtk)
- CRETACEOUS/JURASSIC MARINE GRAYWACKE AND MUDSTONE (KJgn)
- CRETACEOUS GRANITIC (Klgr)
- CRETACEOUS GRANITIC (Kmgr)
- TERTIARY BASALT AND GREENSTONE (Trmb)
- TERTIARY/CRETACEOUS VOLCANIC, UNDIVIDED (Tvme)

PROJECT AREA BEDROCK (MODEL LAYERS 5 TO 12)
- CRETACEOUS GRANODIORITE SILL
- CRETACEOUS GRANODIORITE PLUTON
- CRETACEOUS DIORITE SILL
- CRETACEOUS MEGA BRECCIA
- CRETACEOUS GABBRO
- CRETACEOUS SEDIMENTARY XENOLITHS
- TERTIARY/CRETACEOUS UNDIFFERENTIATED
- TERTIARY BASALT
- TERTIARY COBBLE CONGLOMERATE
- TERTIARY WACKE
- TERTIARY MUDSTONE-SILTSTONE
- TERTIARY PEBBLE CONGLOMERATE
- TERTIARY RHYOLITE
- TERTIARY FELSIC FRAGMENTAL

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. PROJECT AREA GEOLOGY FROM GEOLOGICAL MODEL FILES RECEIVED FROM PLP SEPTEMBER 12, 2018. REGIONAL GEOLOGY FROM WILSON ET AL. (2012).
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: MODEL LAYER 12	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: C-12

THE pebble PARTNERSHIP

BGC

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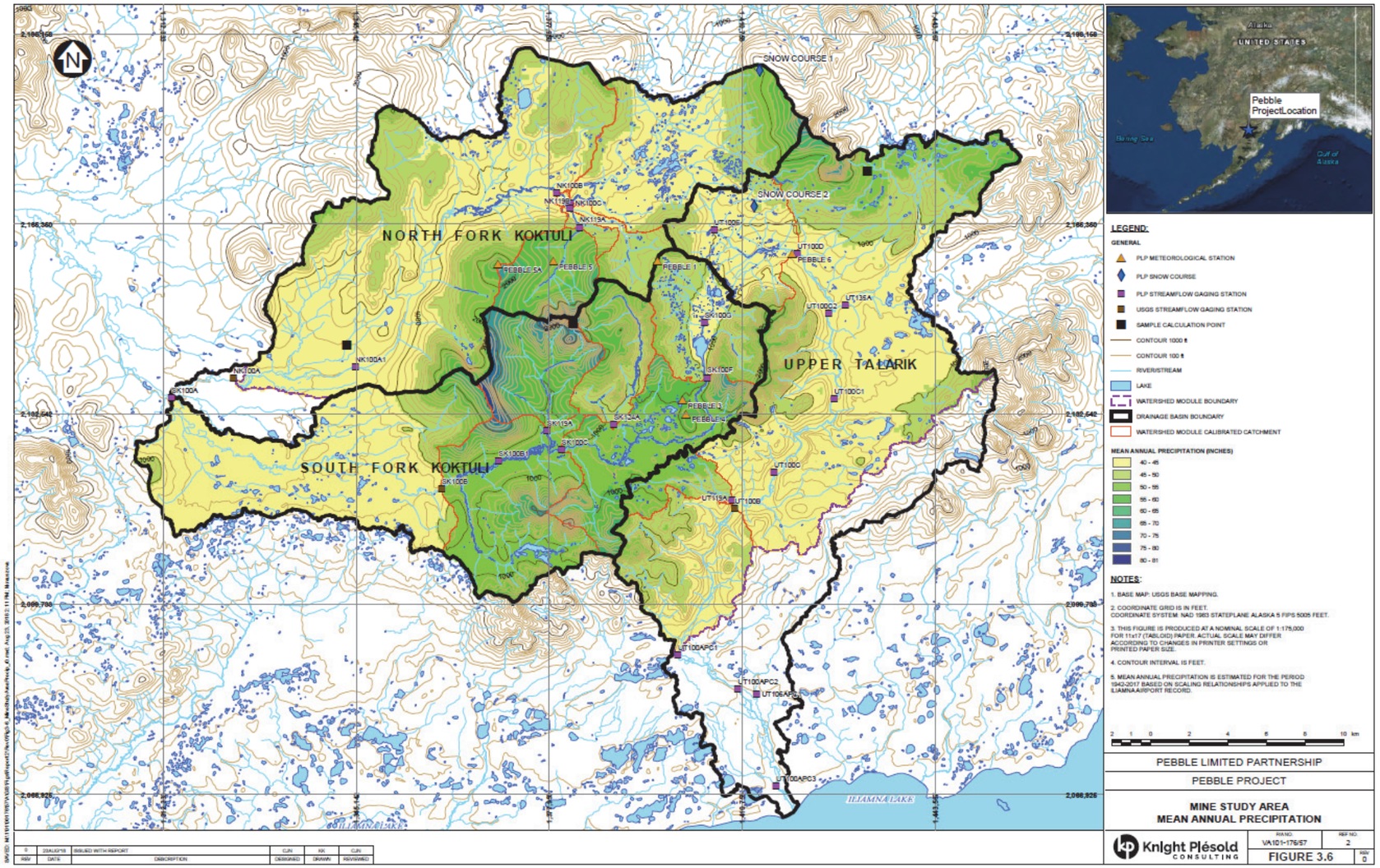
APPENDIX D
MEAN ANNUAL PRECIPITATION (KP, 2018a)



NOTES:
1. MODIFIED FROM KNIGHT PIESOLD (KP), 2018a, PEBBLE PROJECT, HYDROMETEOROLOGY REPORT. FINAL REPORT PREPARED FOR PEBBLE LIMITED PARTNERSHIP, SEPTEMBER 6, 2018, VA101-176/57-2.
2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC	BGC	FIGURE TITLE: FIGURE 3.6: MEAN ANNUAL PRECIPITATION FROM KP (2018a)
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: D-1

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APPENDIX E
LOCAL-SCALE MODEL FOR GH12-334S PUMPING TEST CALIBRATION

E.1. LOCAL-SCALE MODEL DEVELOPMENT AND CALIBRATION

E.1.1. Overview

A local-scale groundwater model was developed to assist in calibration of the Groundwater Model to the pumping test conducted at GH12-334S. MODFLOW-USG simulation times for the local-scale model were significantly reduced relative to the Groundwater Model (i.e., seconds vs. hours), which allowed a greater number of calibration simulations to be completed over a shorter period of time. Details of the local-scale model development and calibration results are provided in the following sections.

E.1.2. Model Domain and Discretization

The domain (Figure E-1) of the local-scale model was defined along drainages and surface water divides in headwater tributaries of SFK and UTC. The model grid (Figure E-1) consisted of 77,808 Voronoi cells per layer covering and area of approximately 3.4 square miles. Model cells were specified to be approximately 1 ft in the vicinity of GH12-334S. Outside this area, model cells were expanded progressively in size to a maximum of 500 ft. Vertically, the model was discretized consistent with the Groundwater Model, with the top of the model set to topography and the model base set to a uniform elevation of -5,500 ft.

E.1.3. Hydrogeologic Units and Boundary Conditions

Hydrogeologic units simulated within the local-scale model were defined to be consistent with the Groundwater Model. Boundary conditions (Figure E-2) were also generally consistent with the Groundwater Model, including:

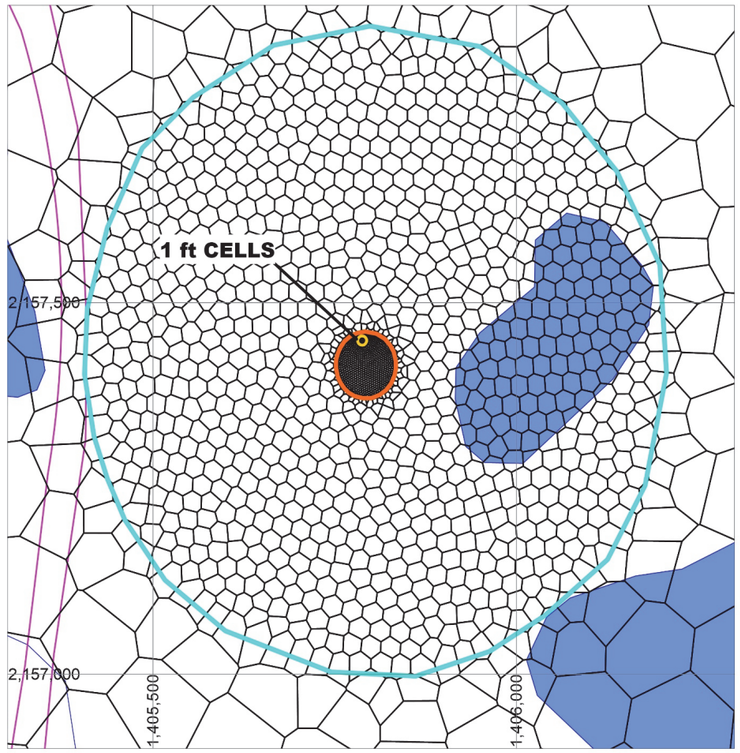
- The Recharge (RCH) and evapotranspiration (EVT) packages were used to simulate groundwater recharge and groundwater evapotranspiration, with both set to average annual rates.
- The Drain (DRN) package was used to simulate surface seeps throughout the model domain, with the discharge elevation set to 1 ft above ground surface.
- Lakes and ponds within the model domain were simulated with the General Head Boundary (GHB) package.
- No flow boundaries were assumed to be present in all layers at surface water divides and below drainages. The base of the model was also assumed to represent a no flow boundary.
- The Well (WEL) and Connect Linear Network (CLN) packages were used to simulate pumping at GH12-334S.

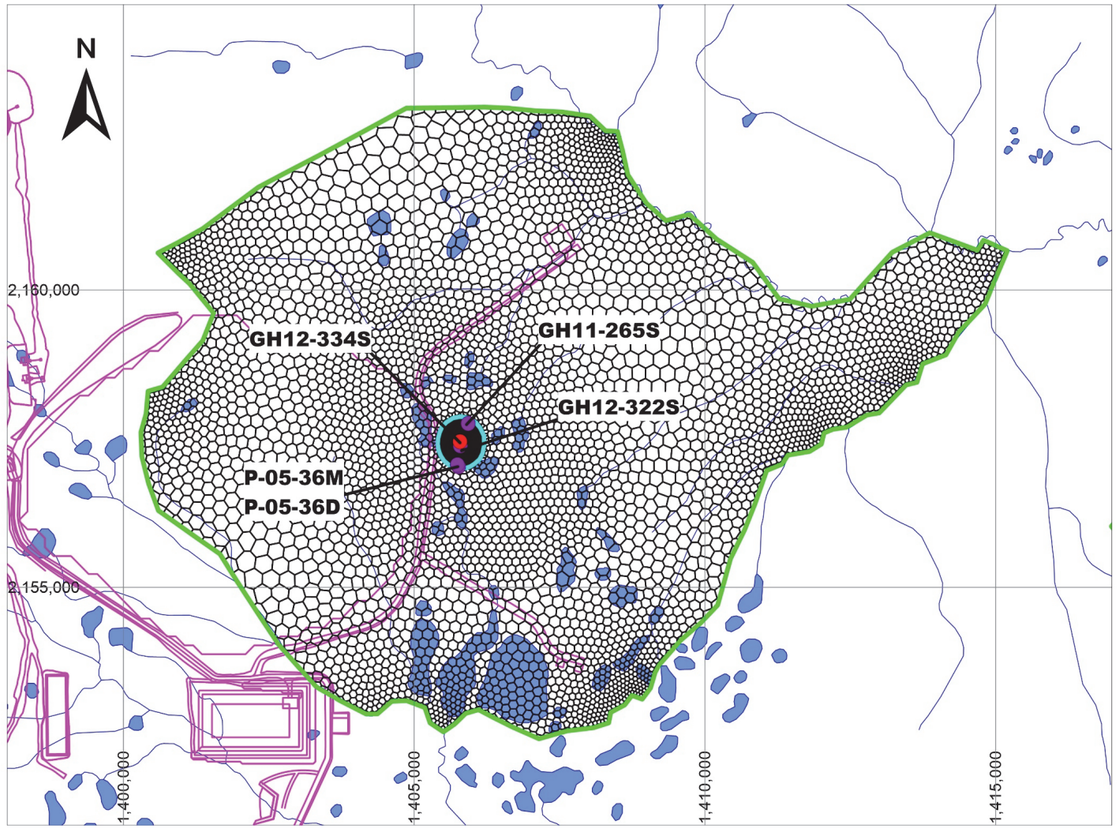
Differences in boundary implementation between the local-scale model and Groundwater Model include:

- The GHB package was used to simulate drainages within the SFK and UTC watersheds instead of the Streamflow-Routing (SFR) package. GHB boundaries were specified instead of SFR boundaries to reduce the setup and computational time of the local-scale model.

E.1.4. Results

Simulated and observed drawdown at pumping well GH12-334S and surrounding observation wells are shown in Figure E-3. The results indicate that the observed timing and magnitude of the response to pumping was generally well-replicated. At the pumping well, the maximum drawdown was underpredicted by approximately 15 ft. At the observation wells, the simulated maximum drawdown ranged from being underpredicted by 1.7 ft at GH11-265S to being overpredicted by 1.5 ft at GH12-322S.





HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
LOCAL MODEL DOMAIN
PUMPING WELL
MONITORING WELLS
LOCAL-SCALE MODEL DOMAIN
50 ft CELLS
5 ft CELLS
1 ft CELLS

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: LOCAL-SCALE MODEL GRID
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: E-1

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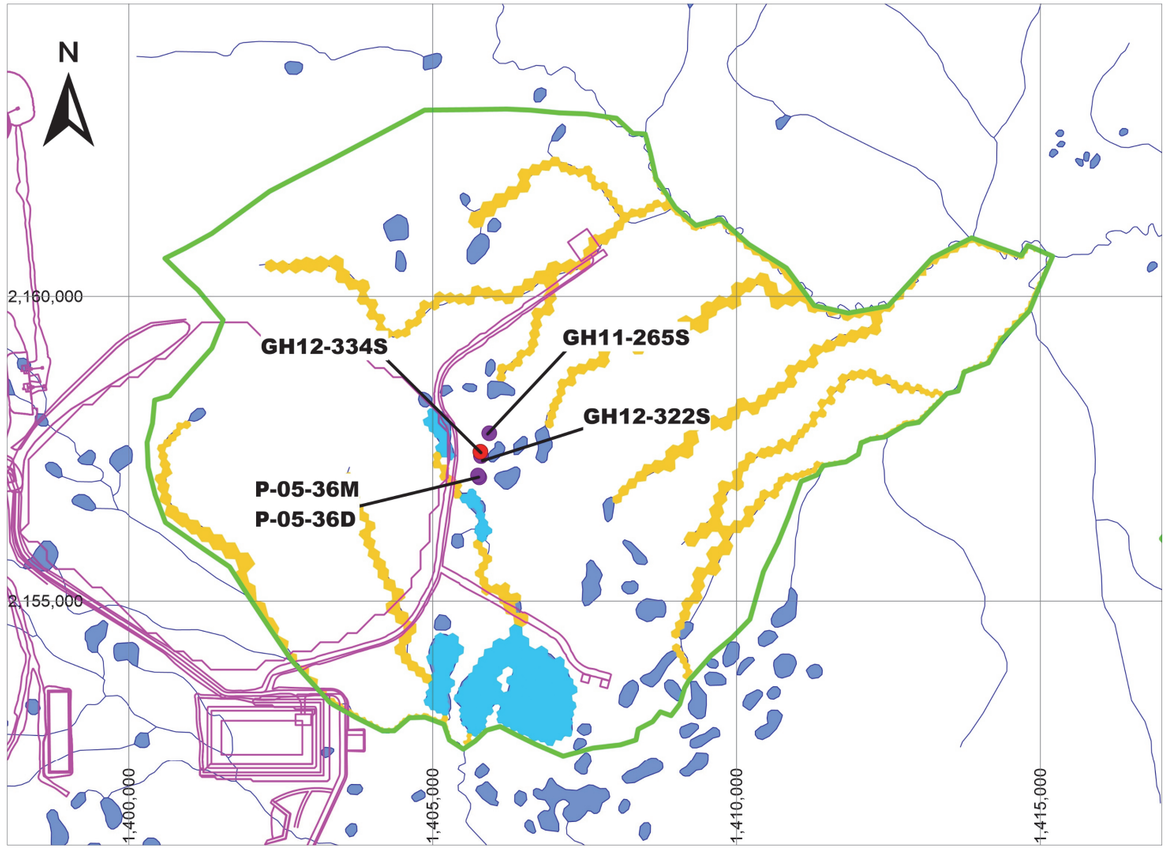

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
LOCAL MODEL DOMAIN
PUMPING WELL
MONITORING WELLS
GHB BOUNDARIES
STREAMS
LAKES

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: LOCAL-SCALE MODEL BOUNDARY CONDITIONS	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: E-2

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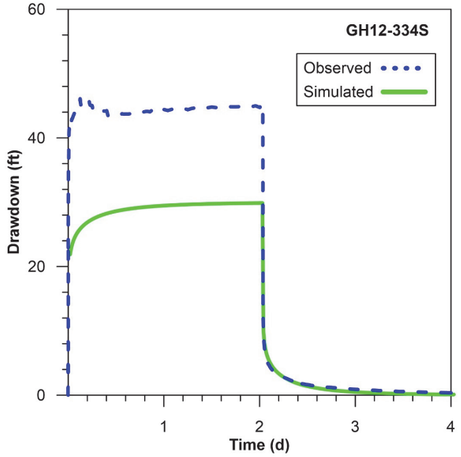

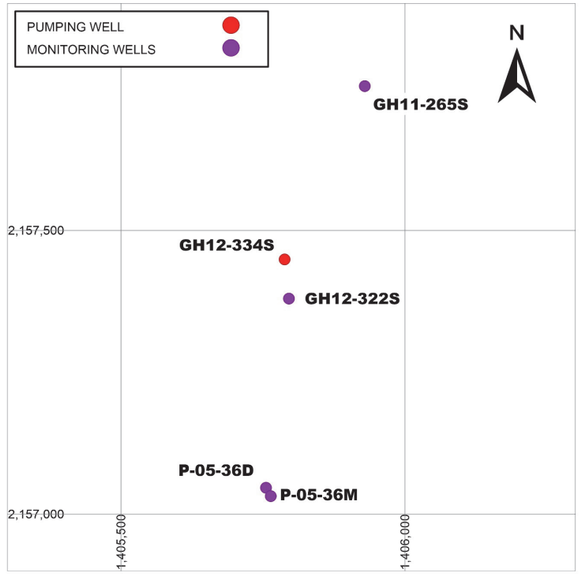

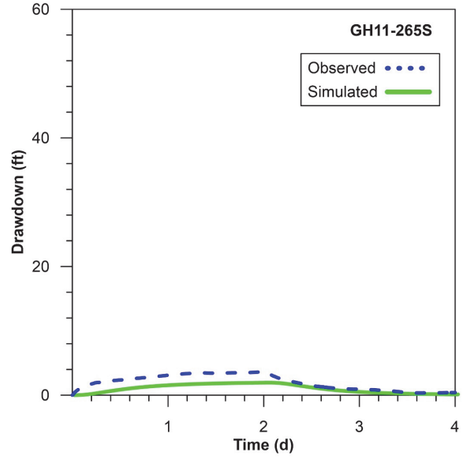

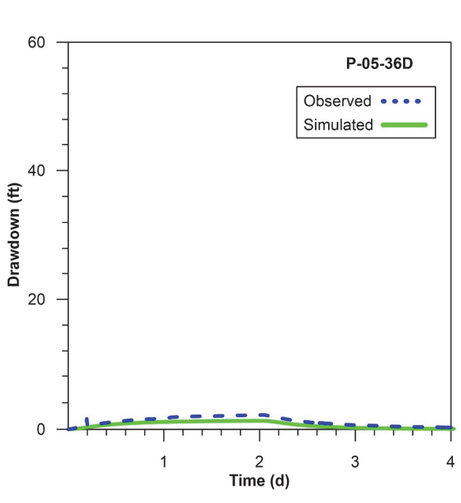

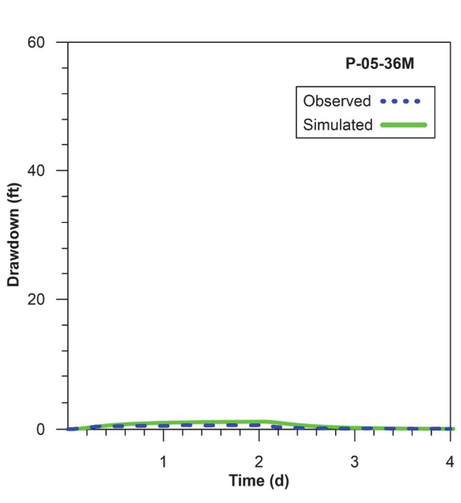

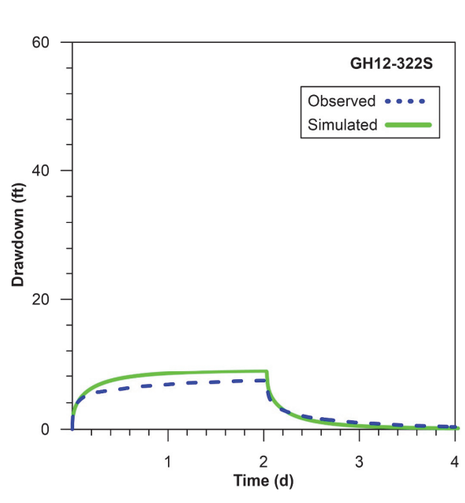

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. SEE FIGURE E-1 FOR PLAN MAP LOCATION.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: LOCAL-SCALE MODEL RESULTS
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: E-3

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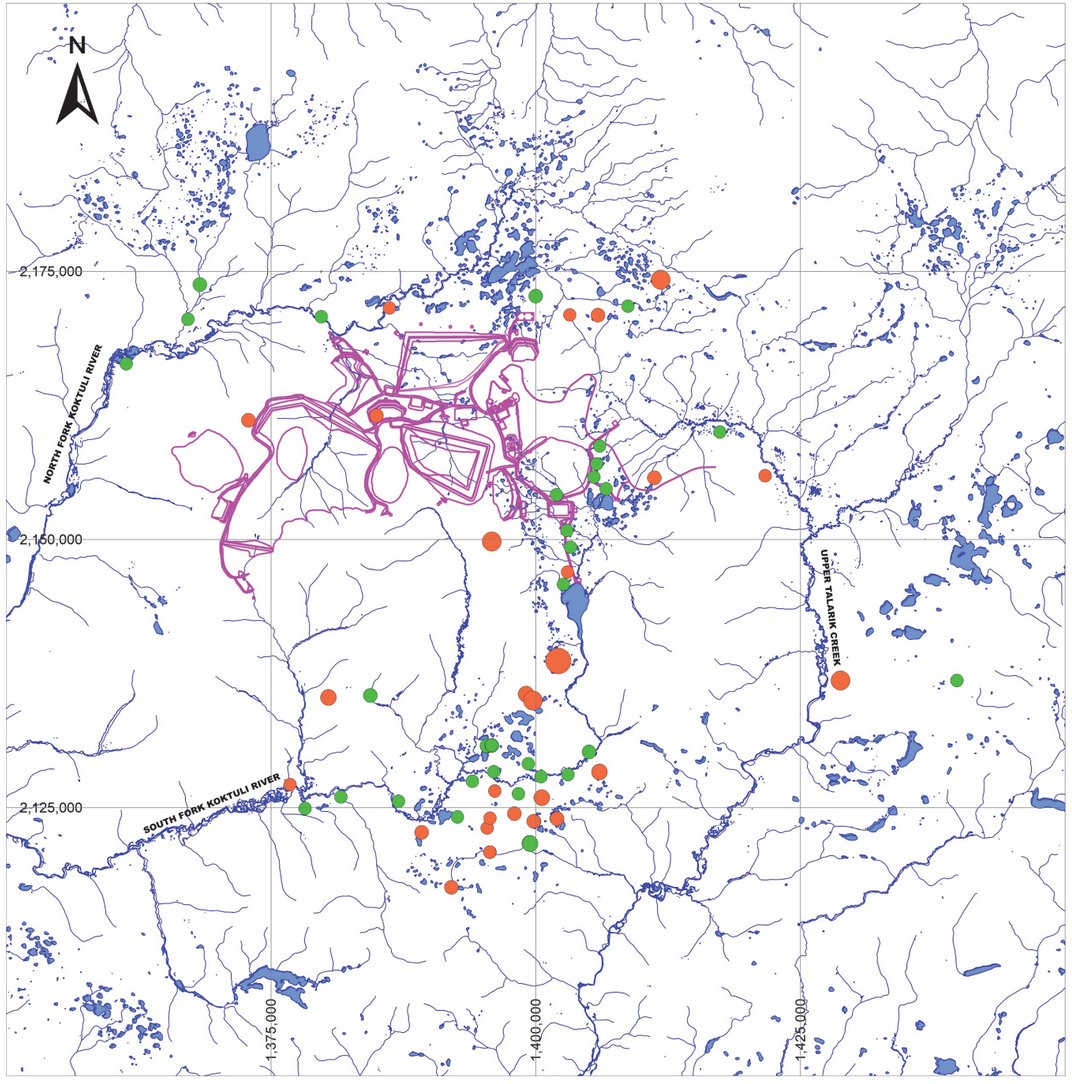
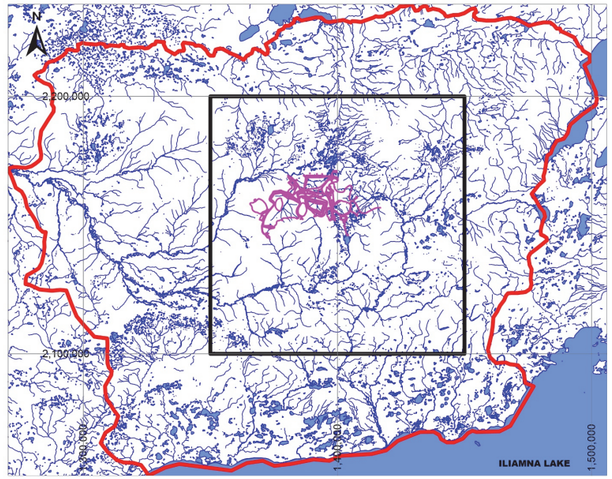
APPENDIX F
SPATIAL DISTRIBUTION OF SIMULATED GROUNDWATER LEVEL RESIDUALS FOR STEADY-STATE CALIBRATION





HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 1
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: F-1

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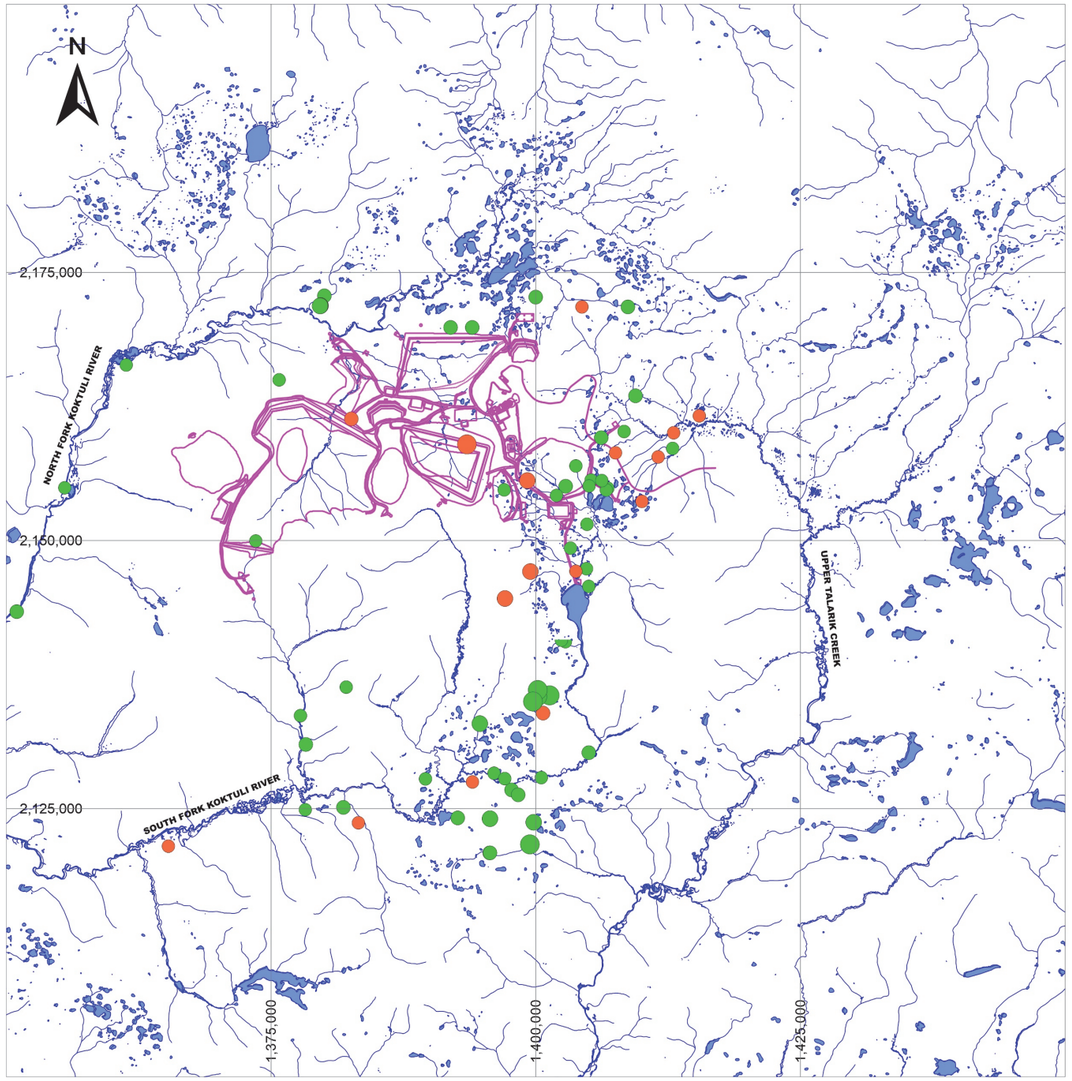

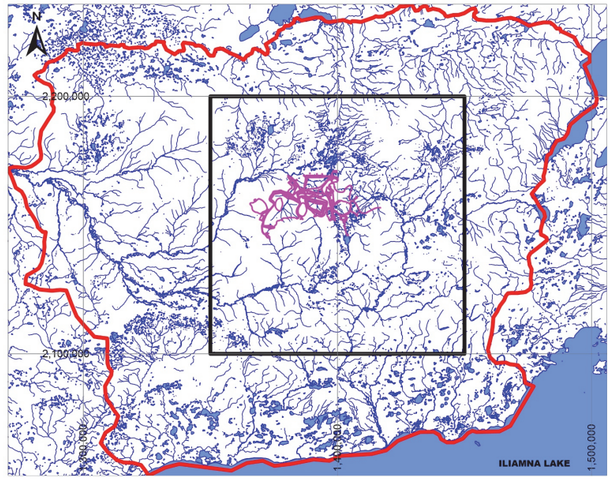

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 2
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: F-2

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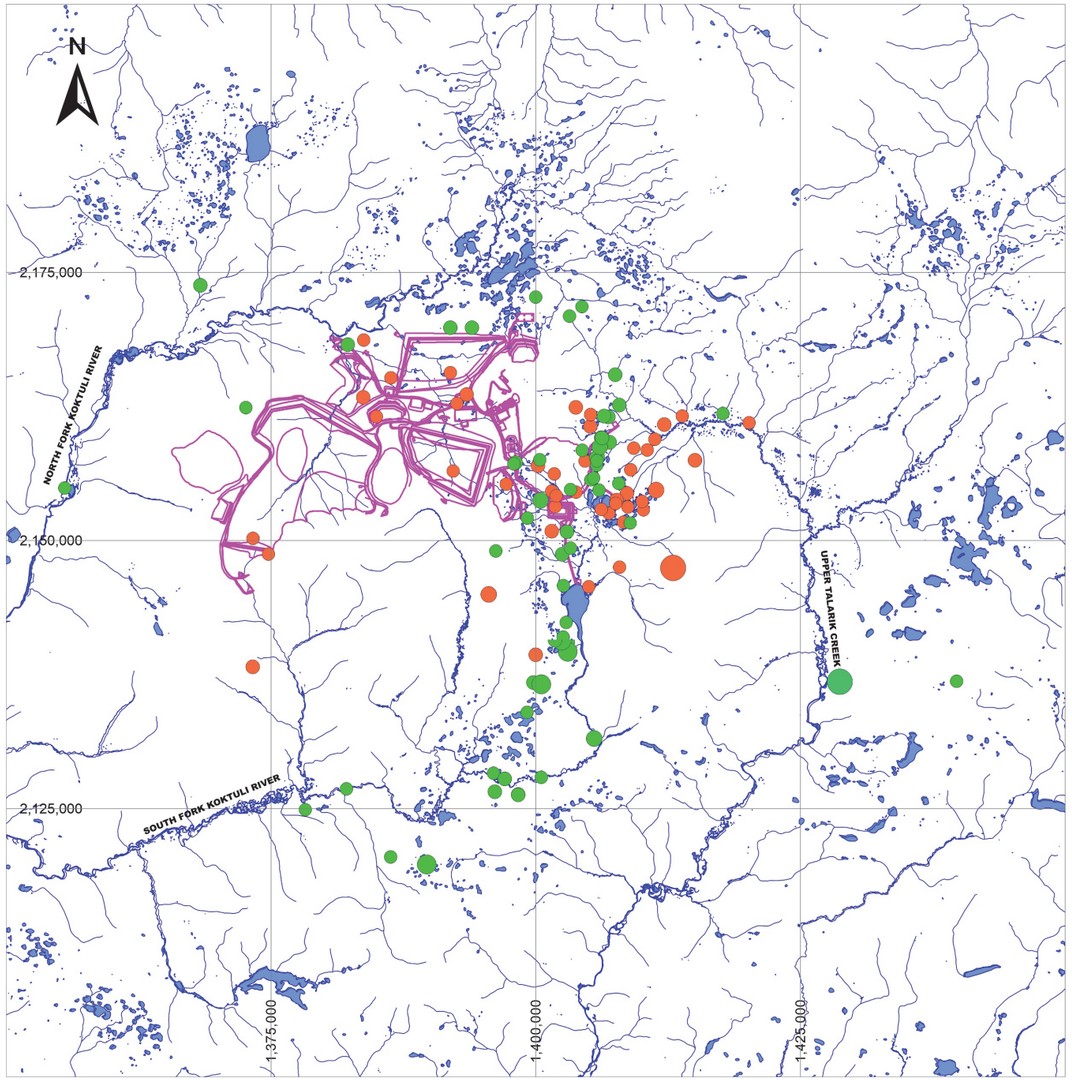

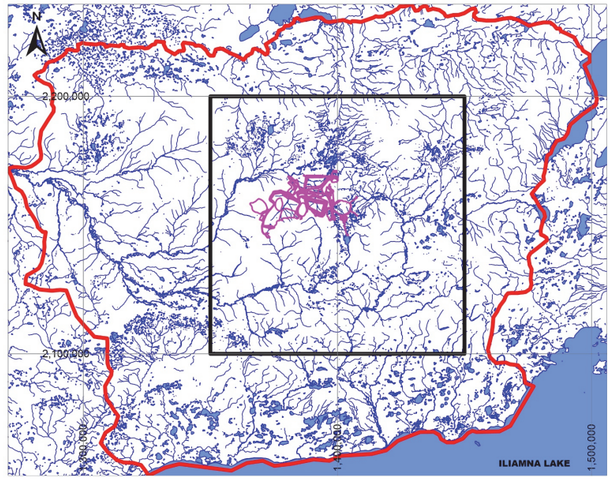

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 3	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: F-3

THE pebble PARTNERSHIP

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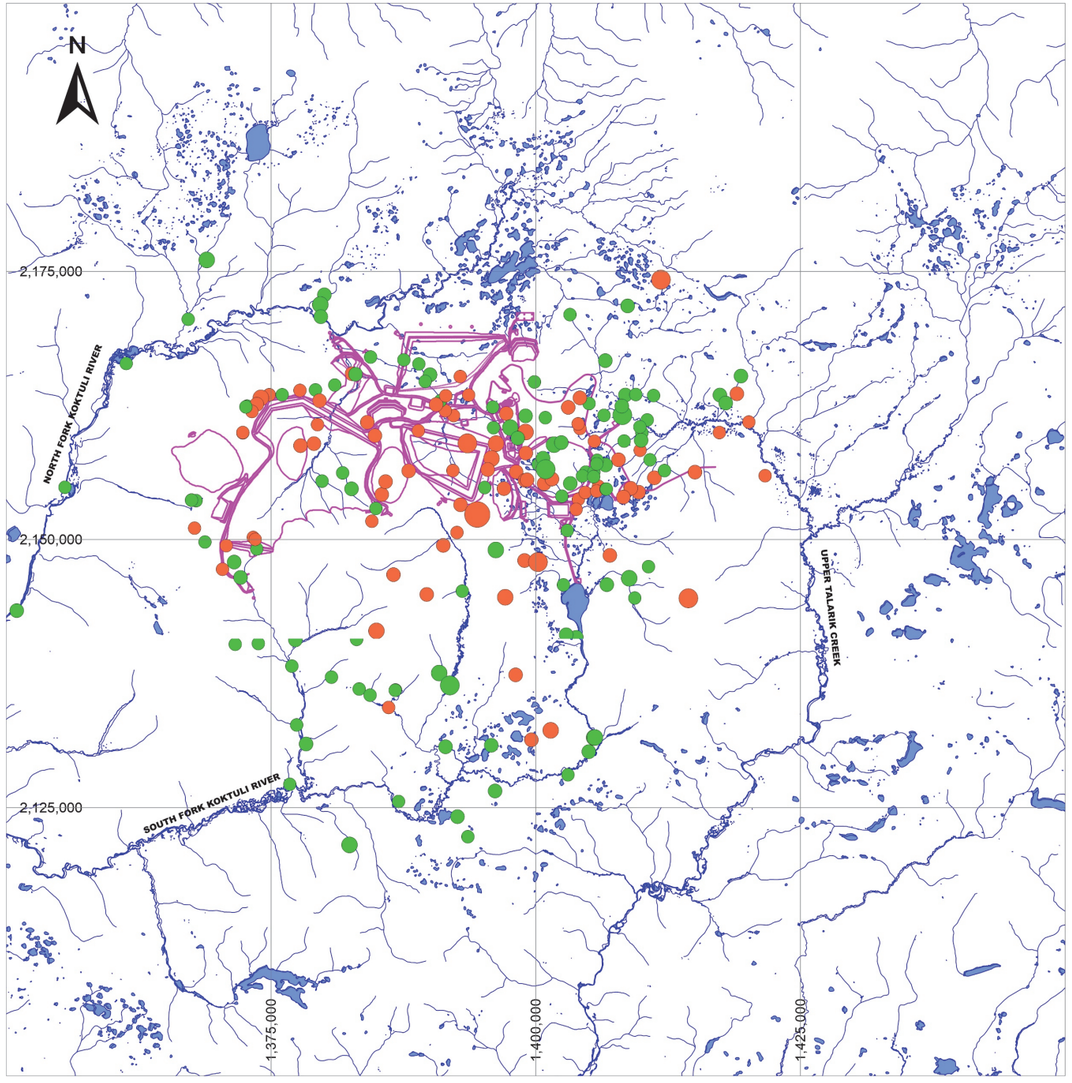

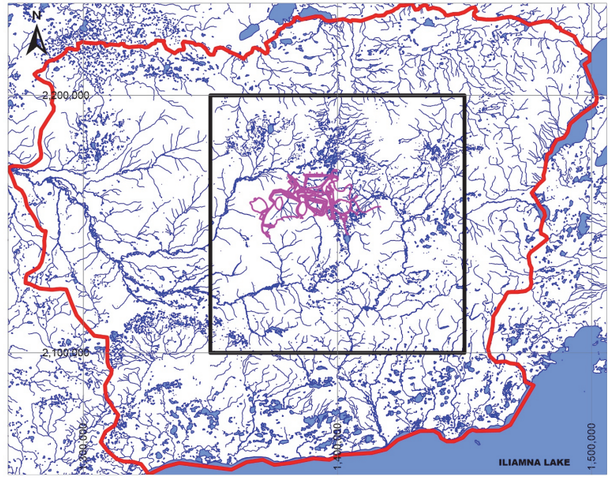

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 4
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: F-4

THE pebble PARTNERSHIP

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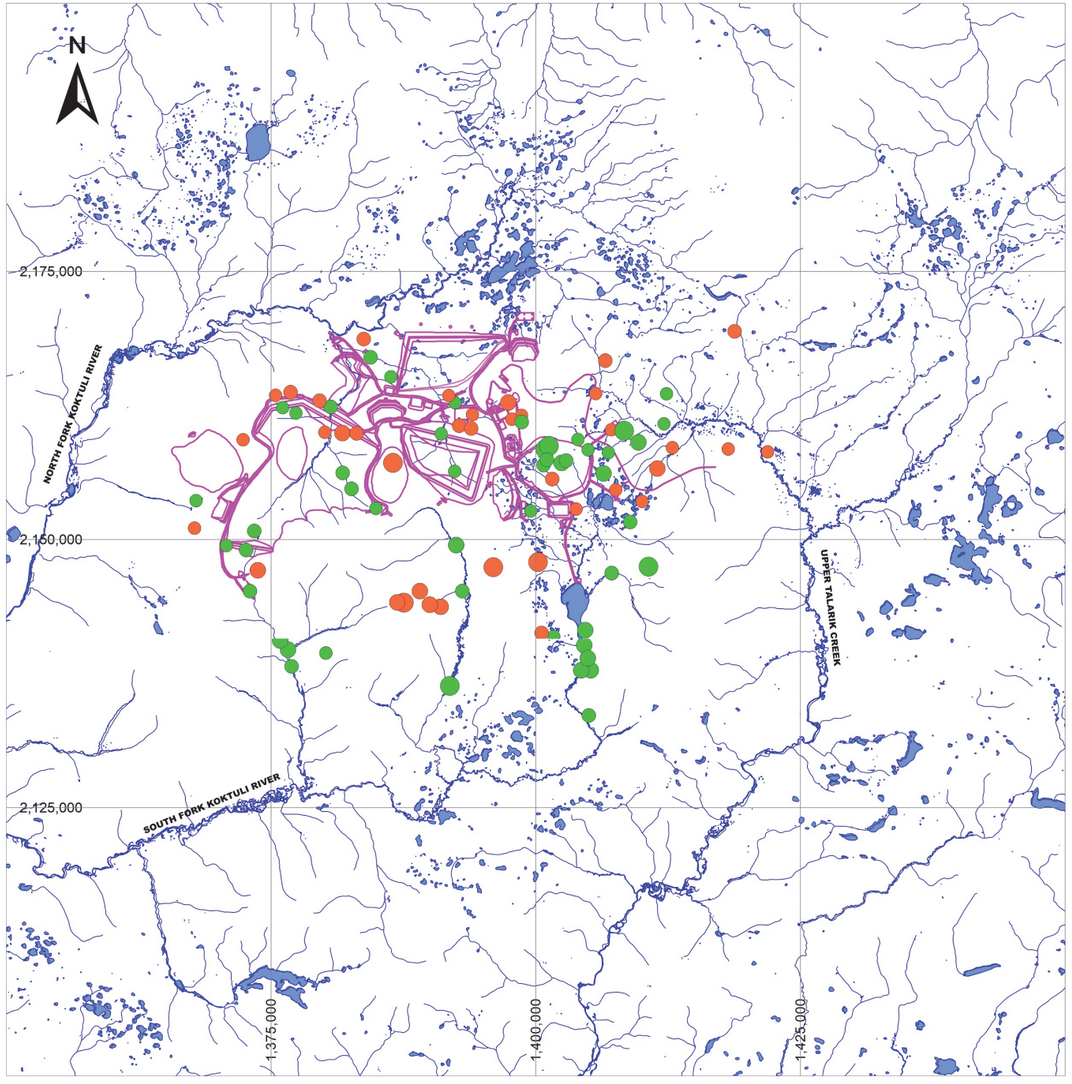

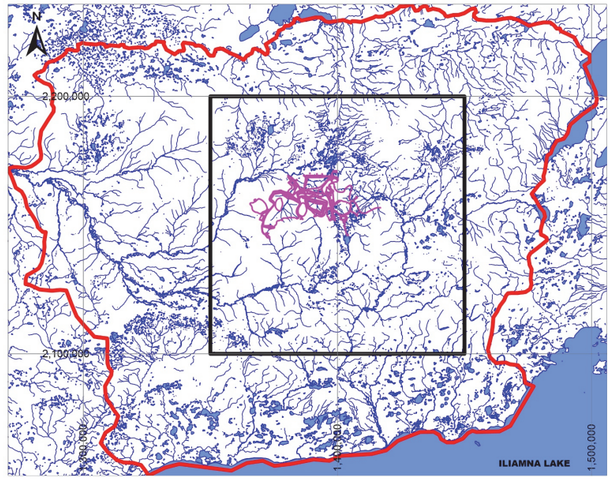

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 5
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: F-5

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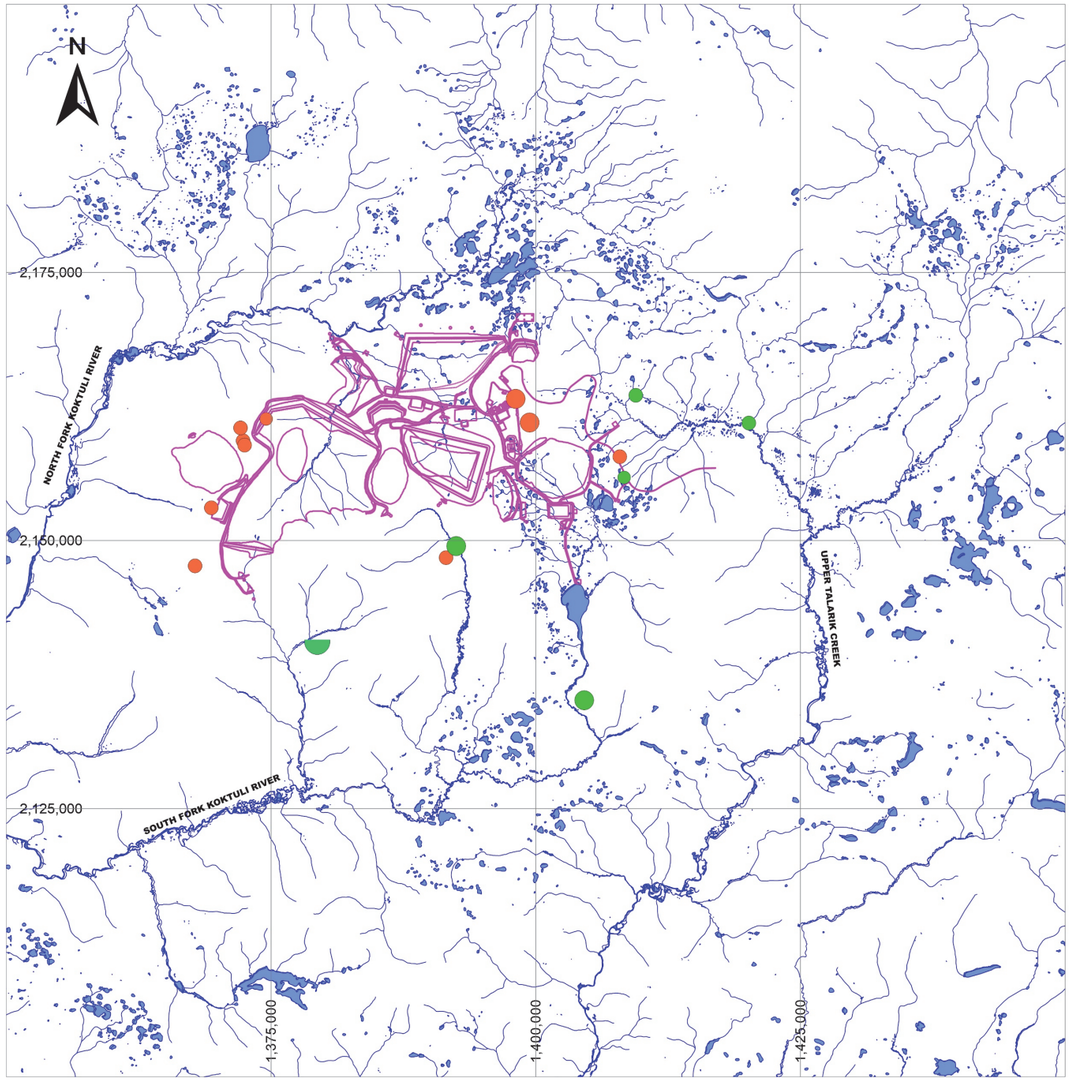

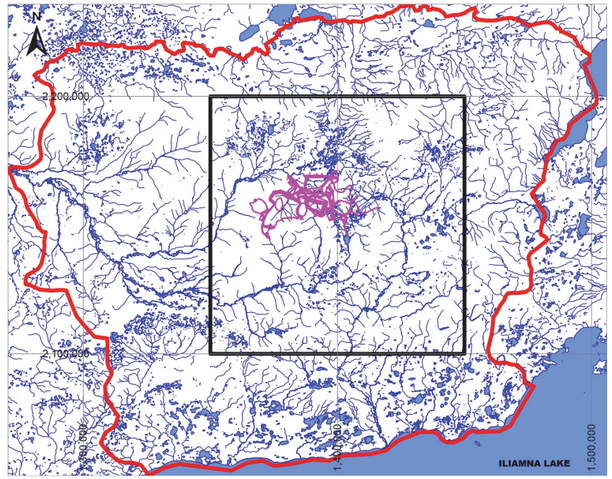

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
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SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 6	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: F-6

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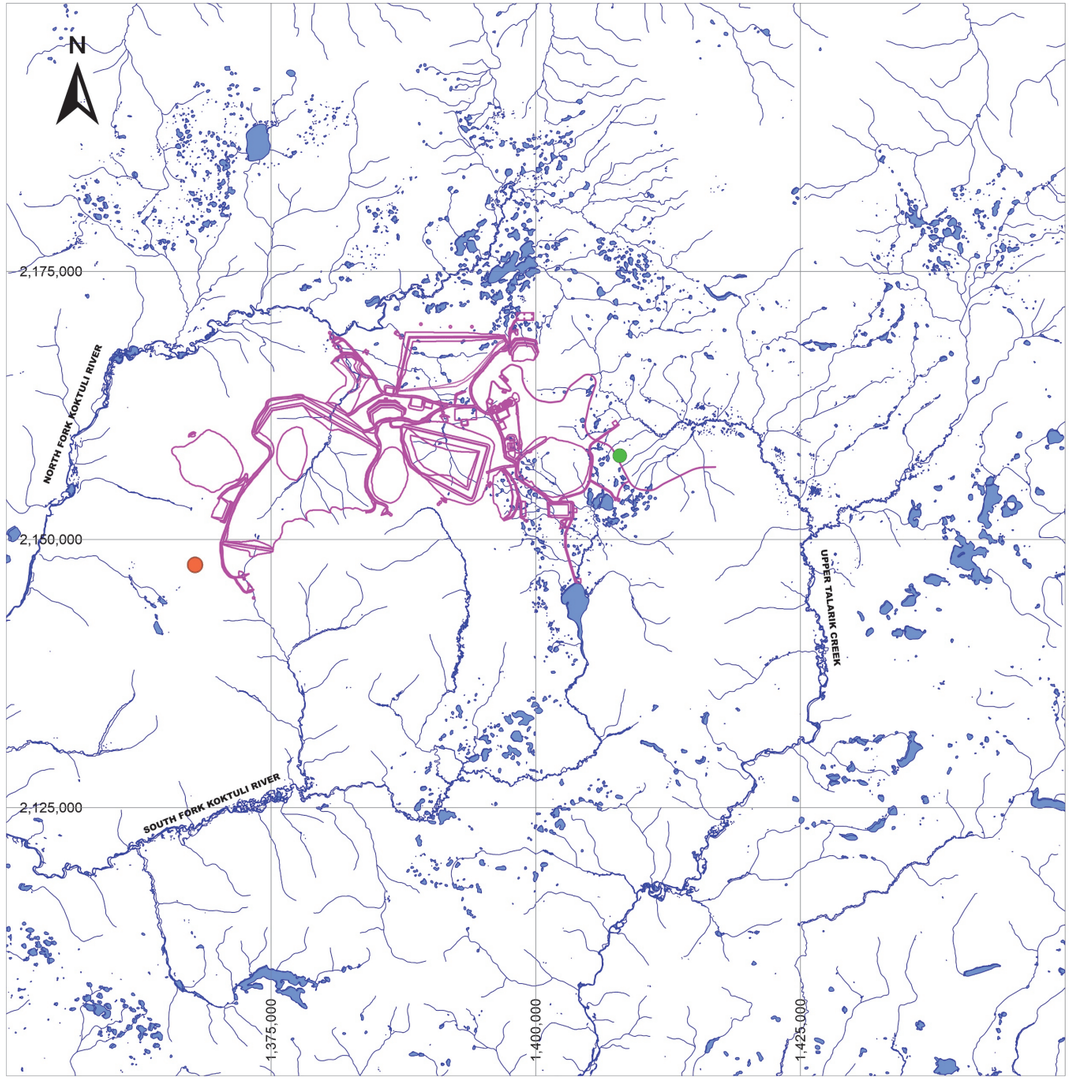

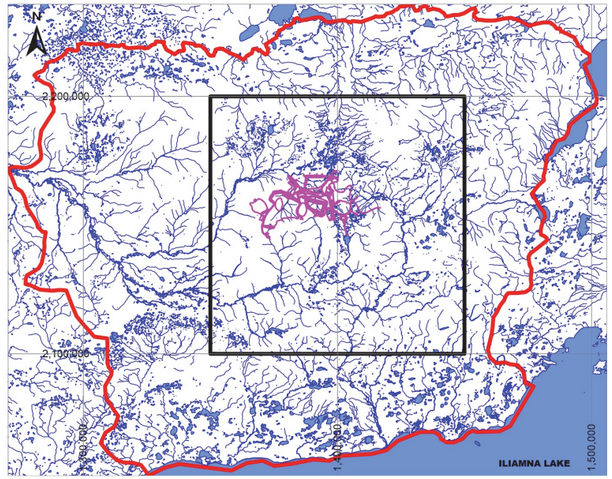

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
3. GROUNDWATER LEVEL RESIDUALS (i.e., OBSERVED – SIMULATED) SHOWN FOR STAGE 1 STEADY-STATE CALIBRATION.
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SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 7	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: F-7

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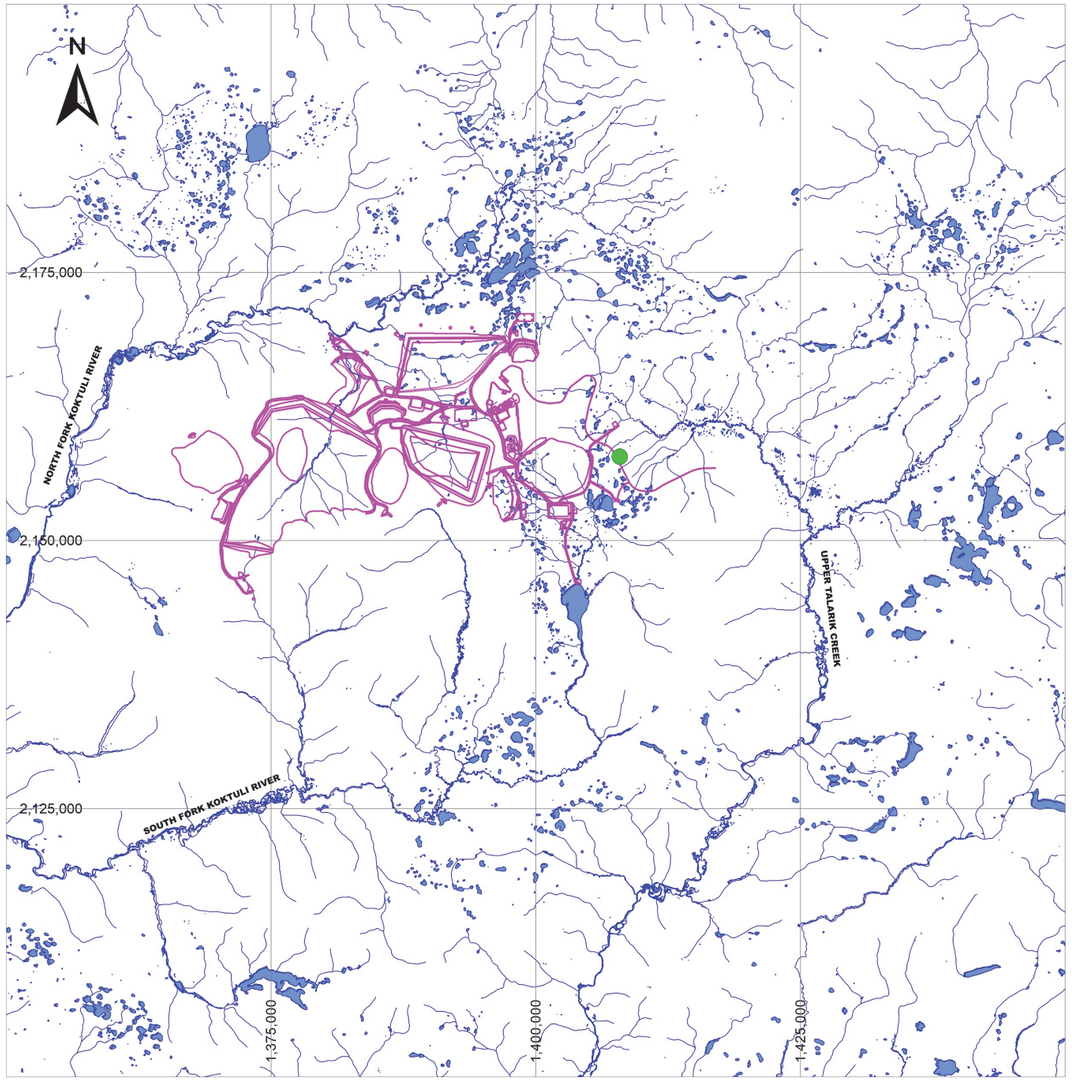

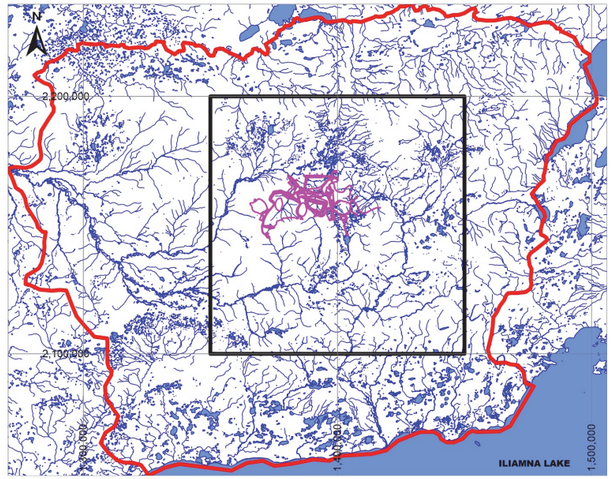

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
INSET MAP BOUNDARY

GROUNDWATER LEVEL RESIDUAL (ft)

- <-200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to -10
- -10 to -1
- -1 to 0
- 0 to 1
- 1 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 200
- >200

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
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SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: SIMULATED GROUNDWATER LEVEL RESIDUAL: MODEL LAYER 8	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: F-8

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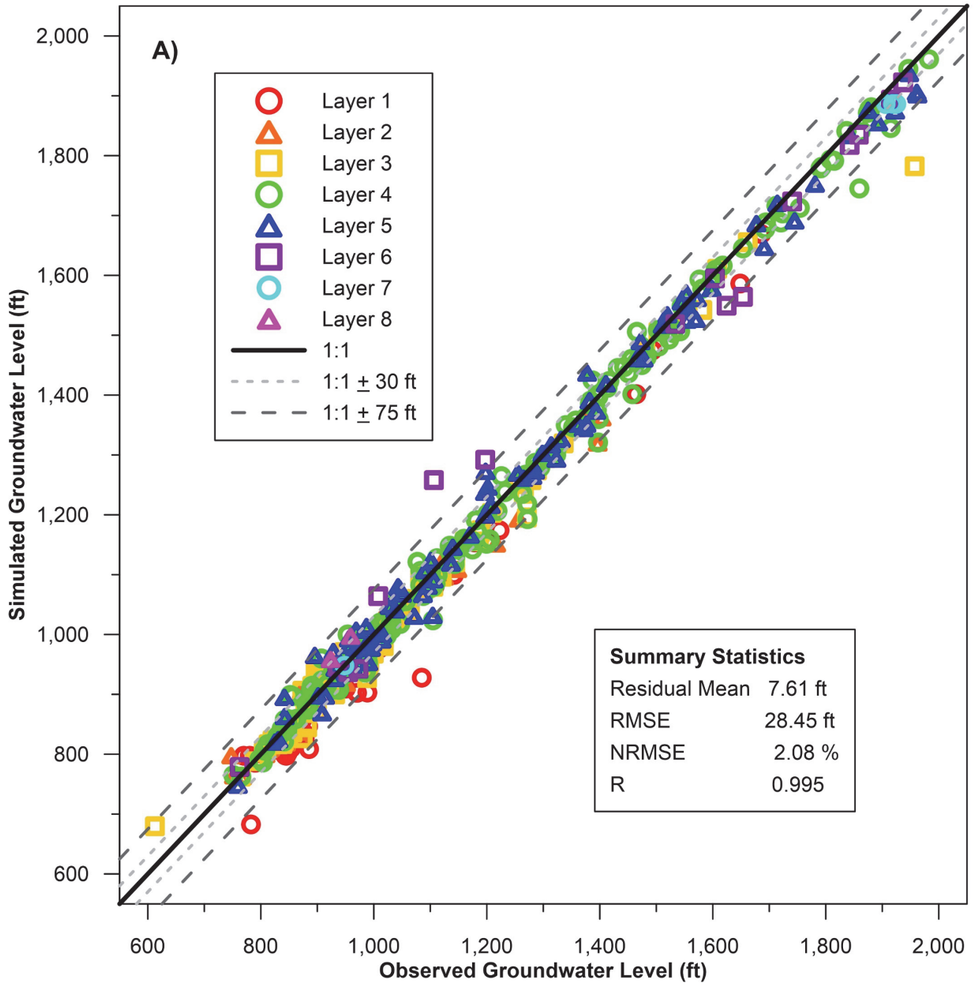
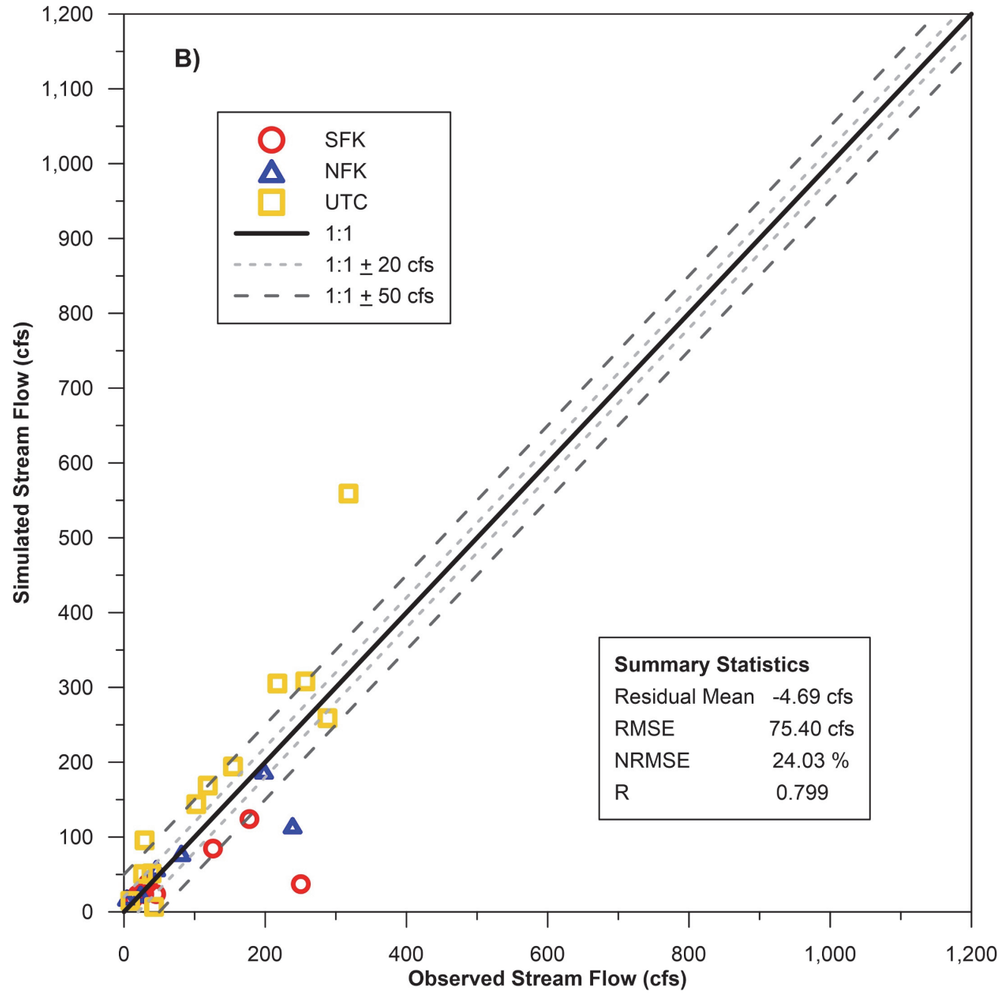
APPENDIX G
SENSITIVITY ANALYSIS: STEADY-STATE CALIBRATION





NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S1
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-1

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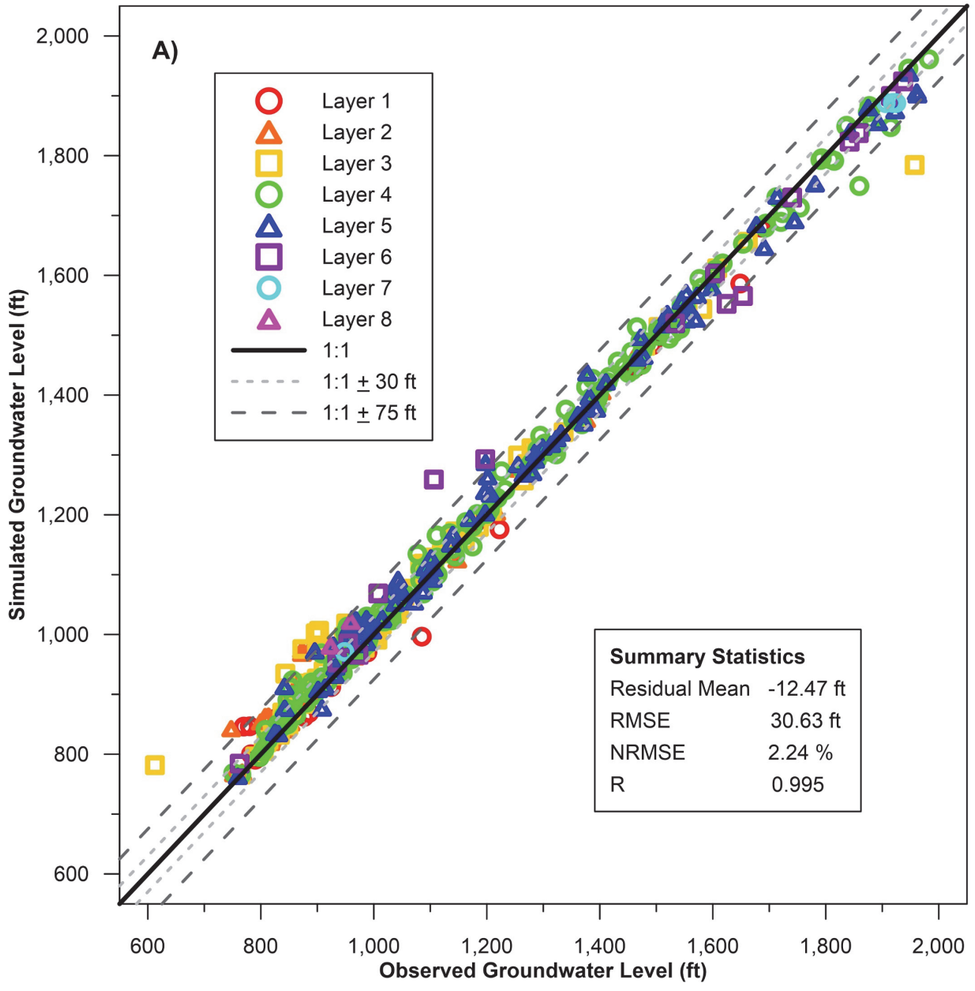

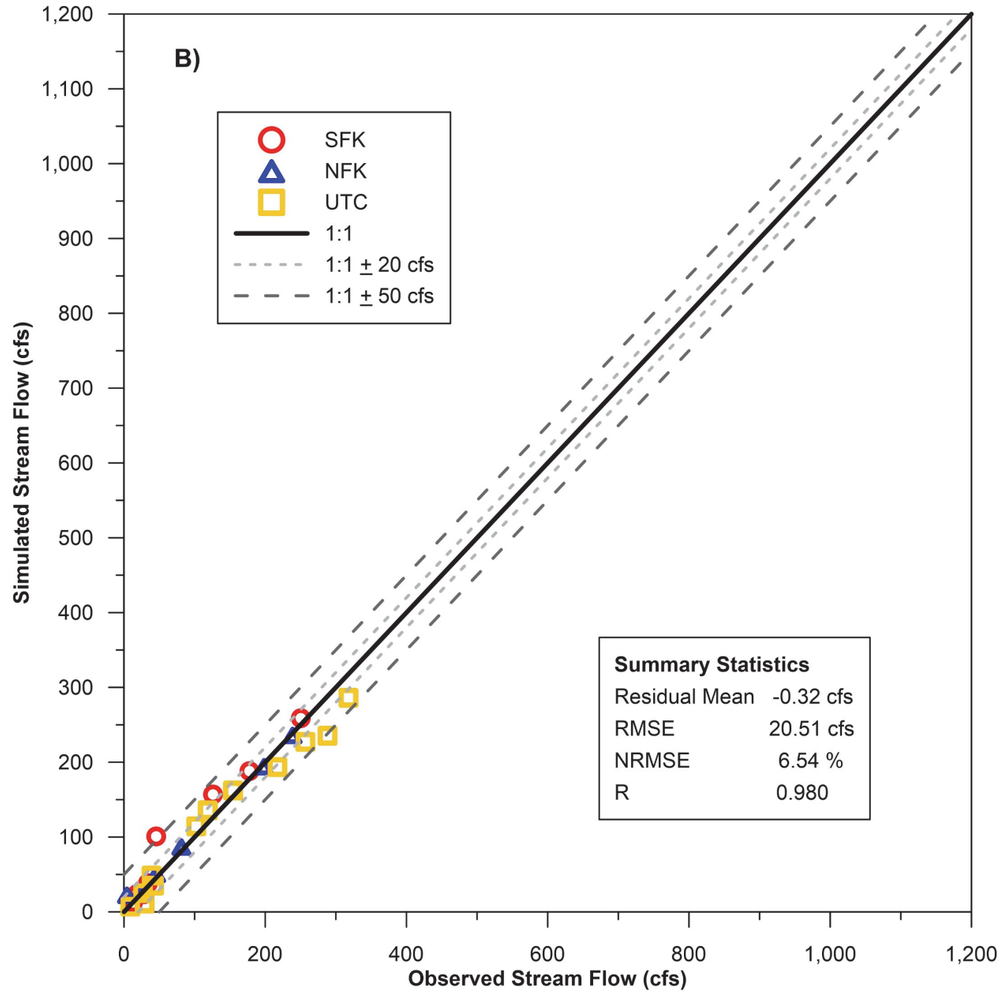

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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S2
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: G-2

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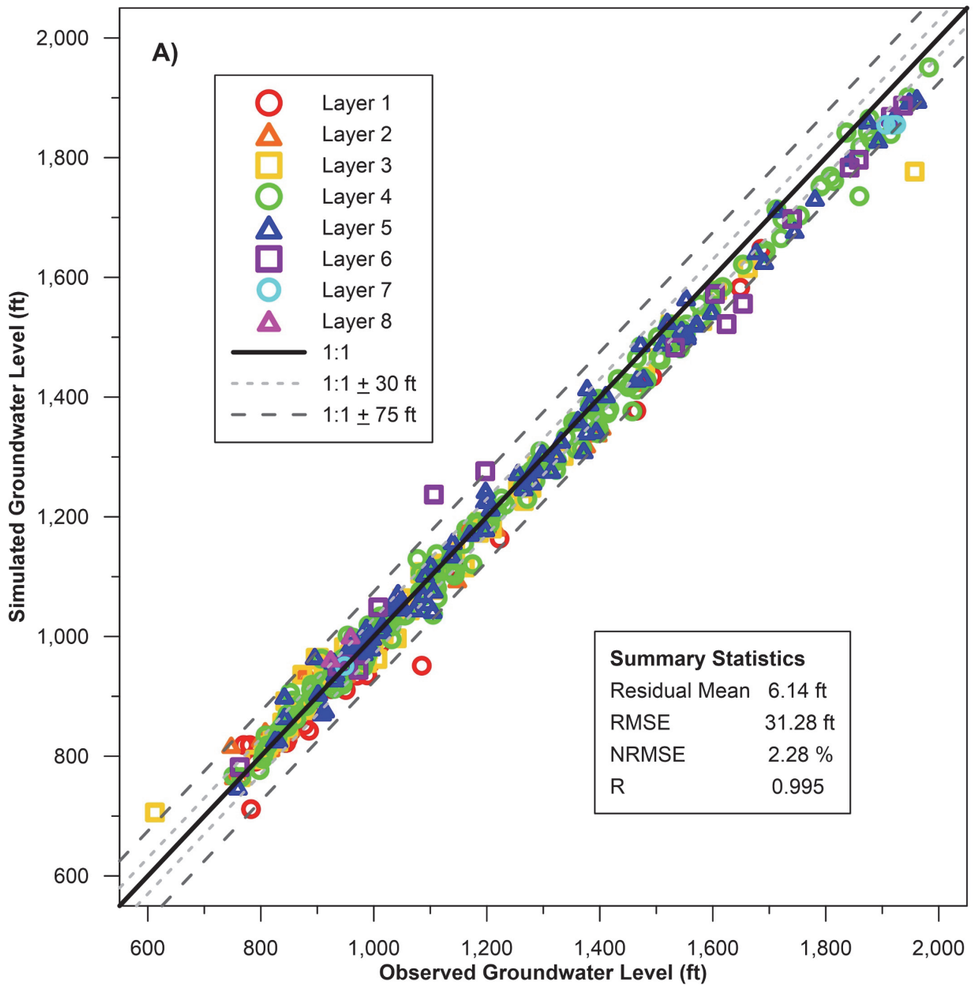

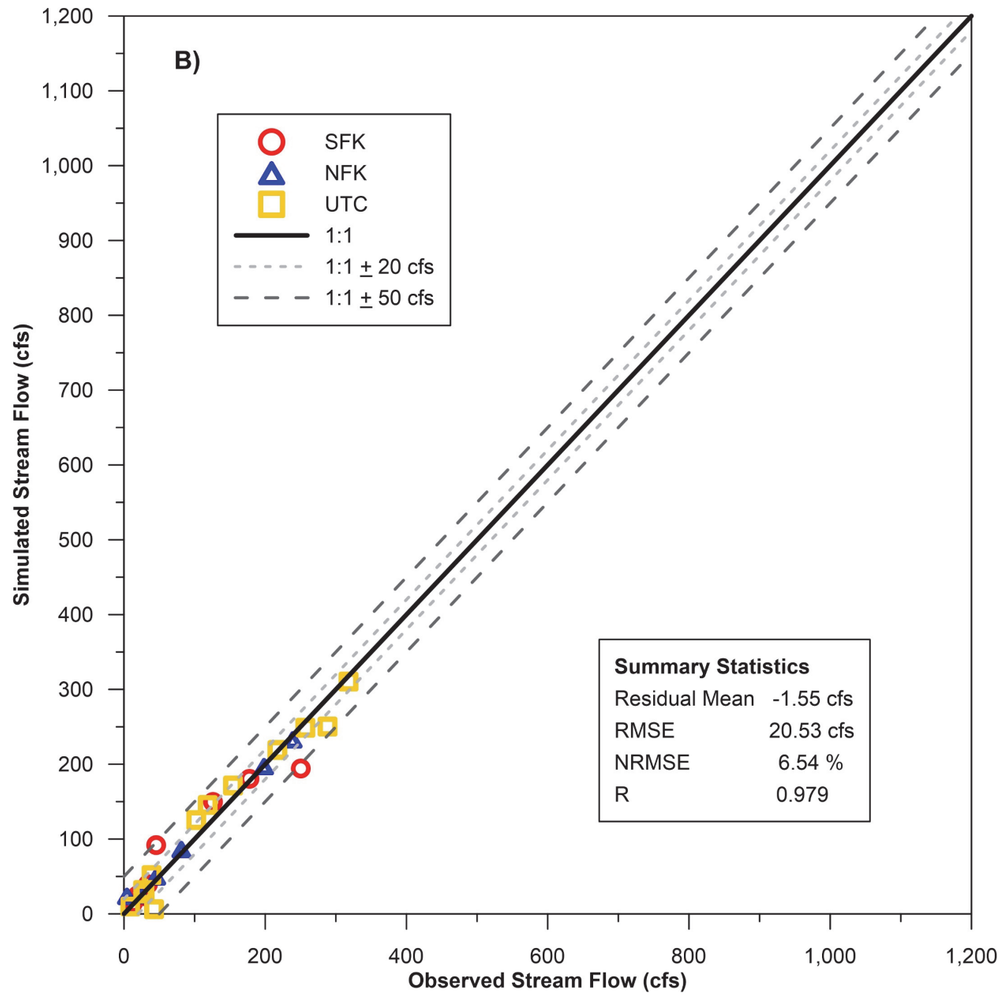

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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S3
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-3

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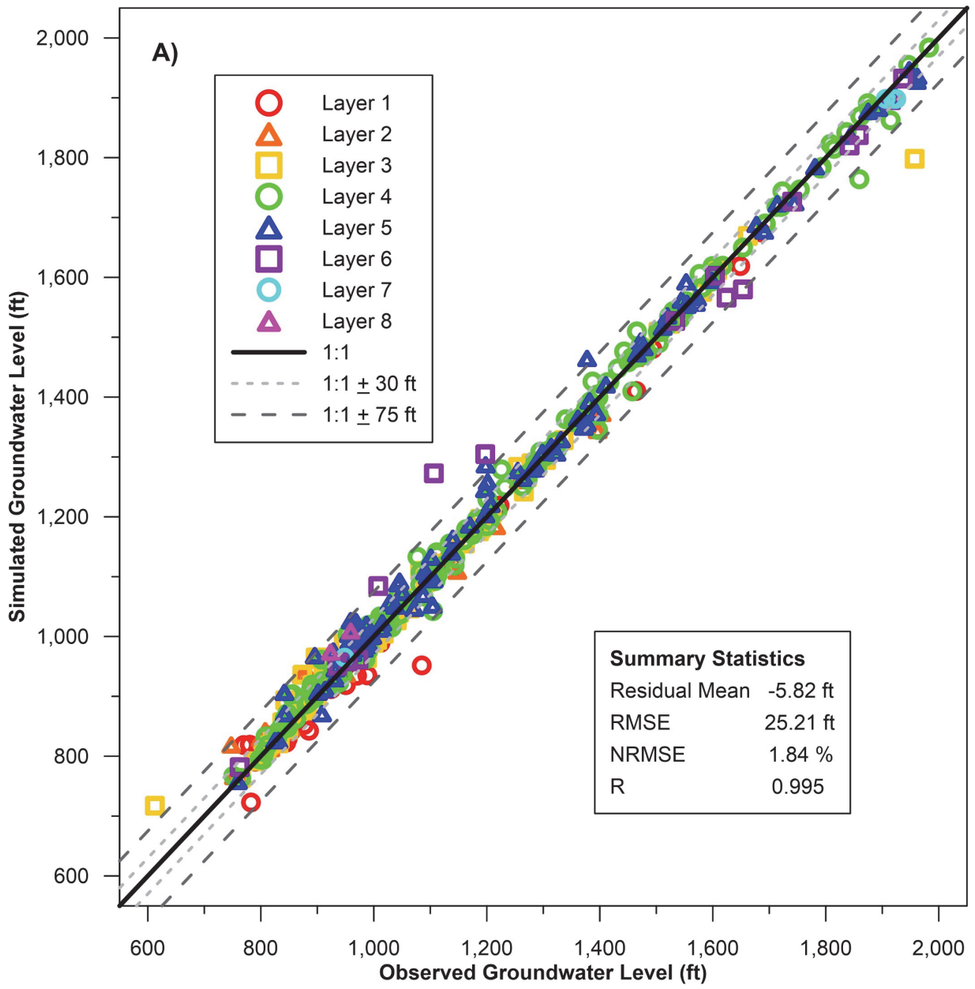

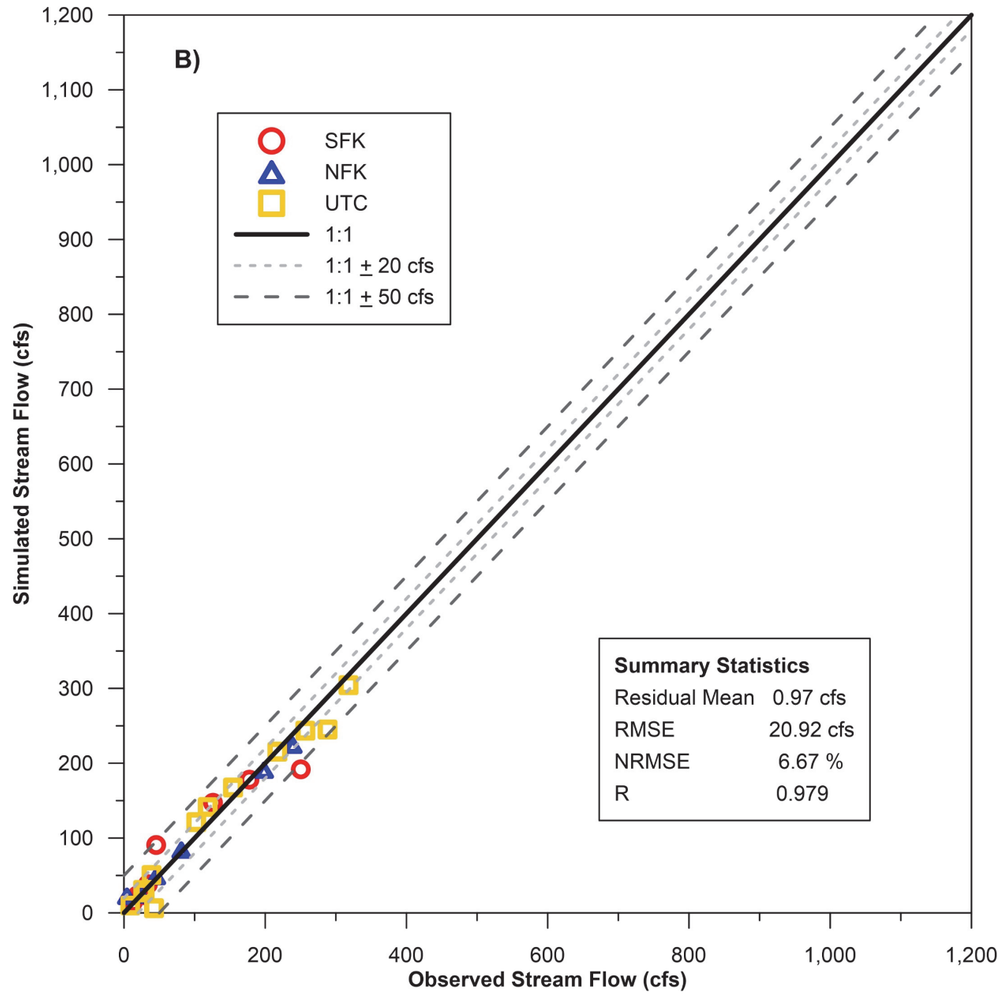

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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S4
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-4

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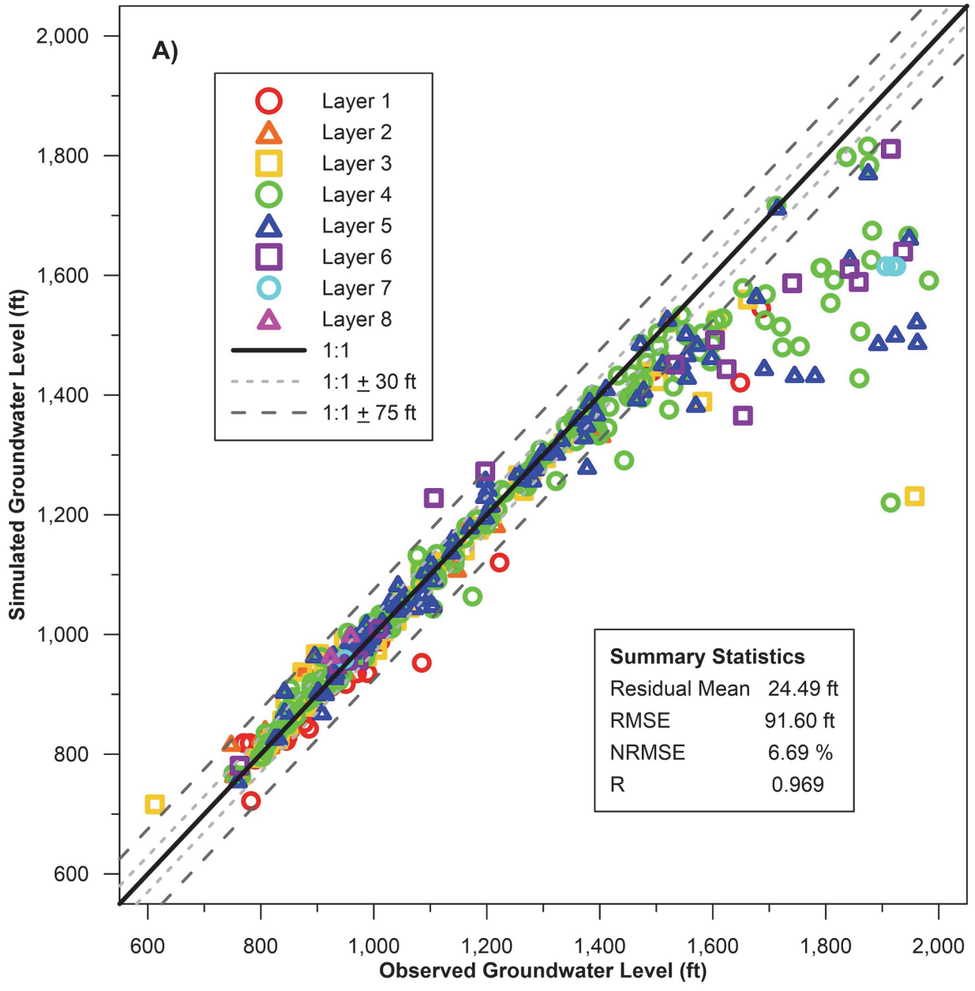

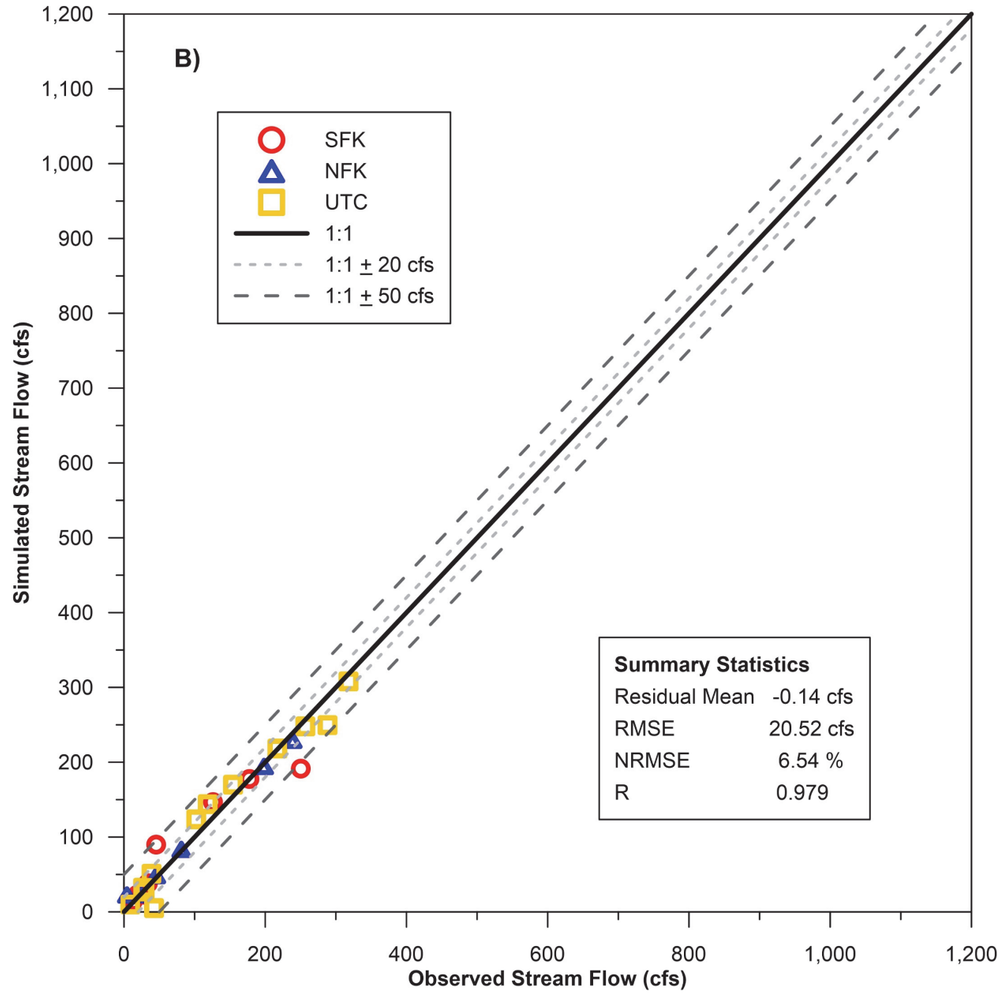

NOTES:
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SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S5
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: G-5

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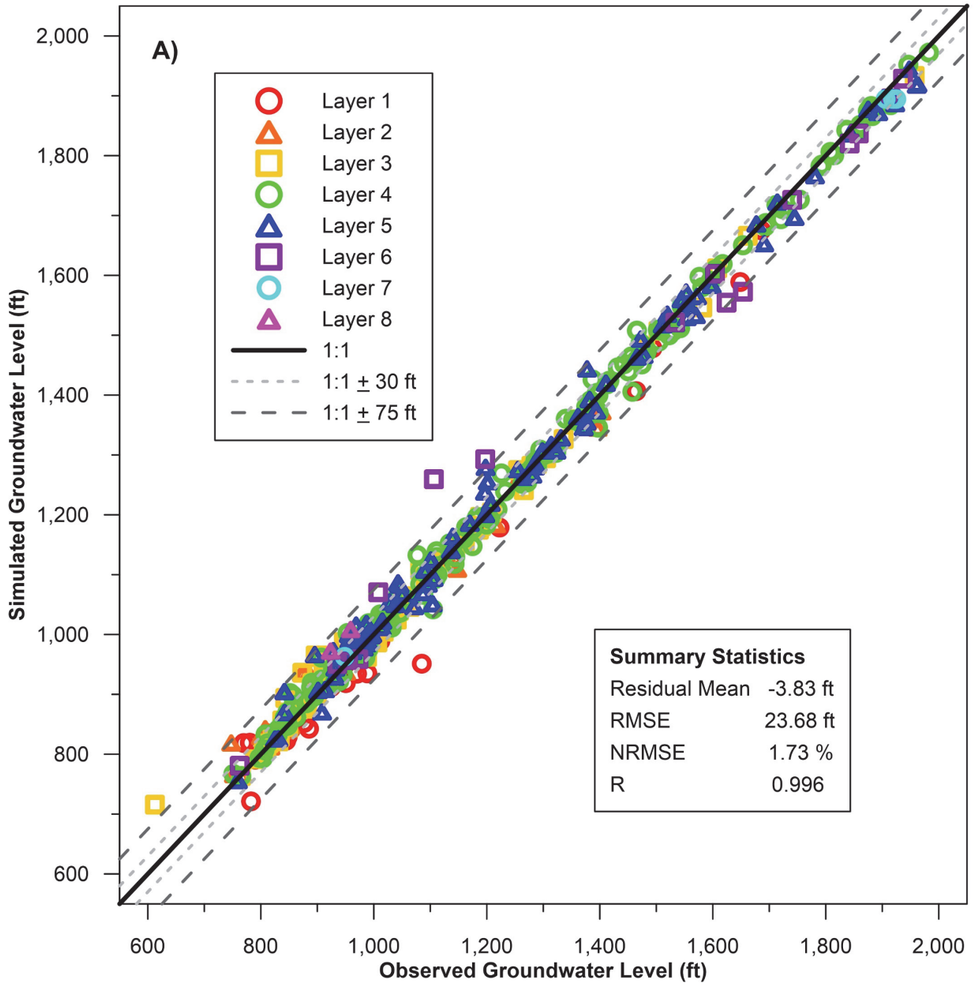

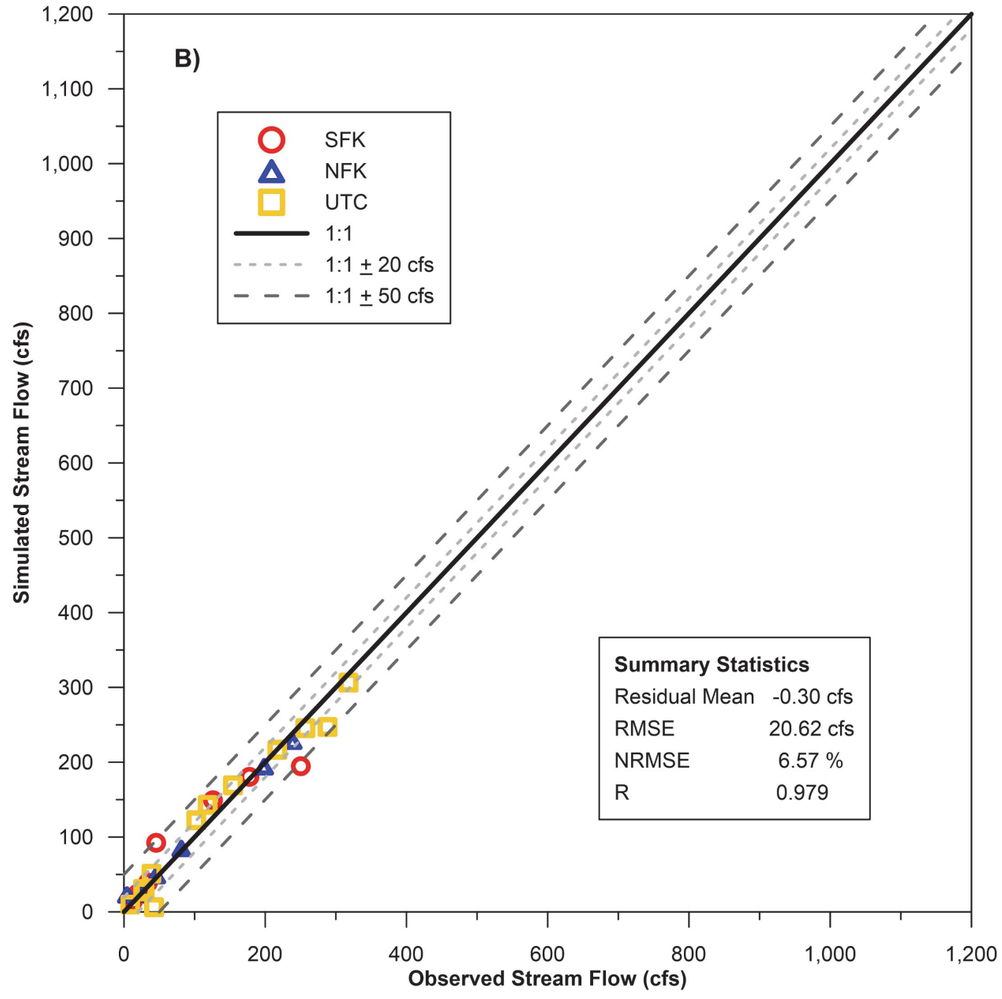

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1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S6
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-6

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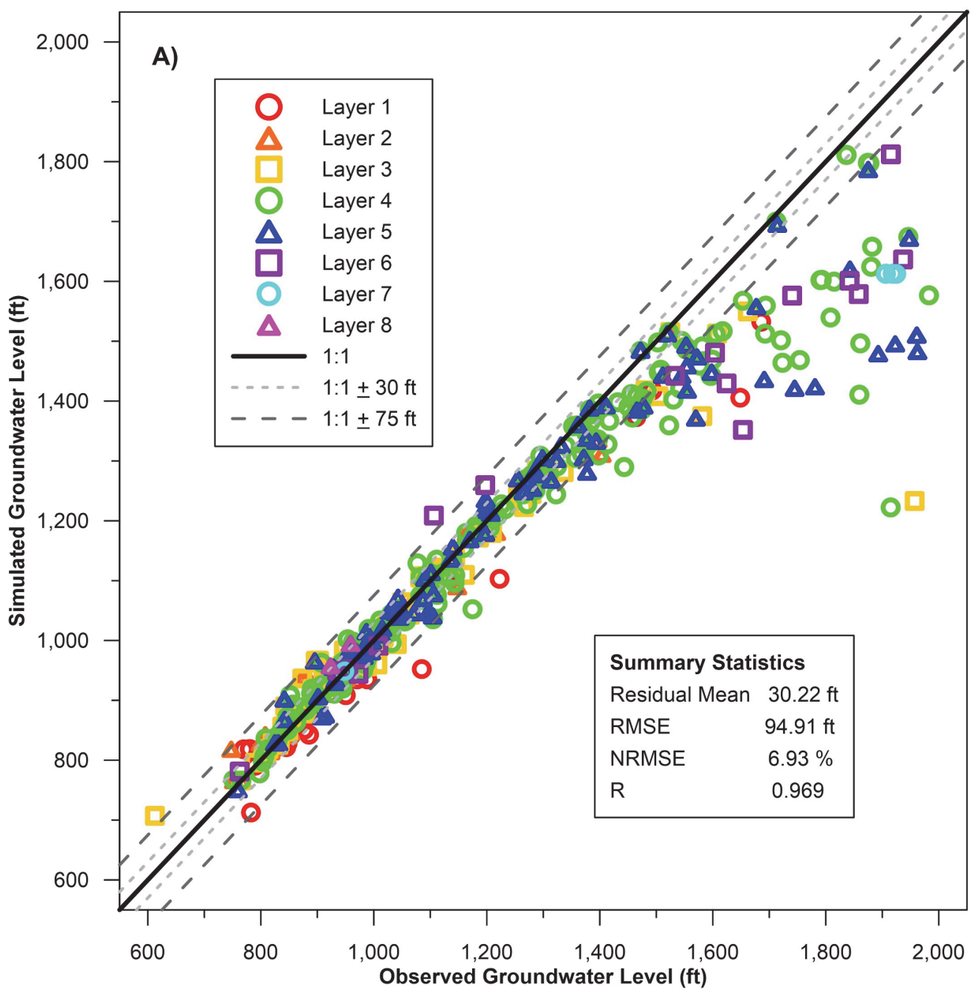

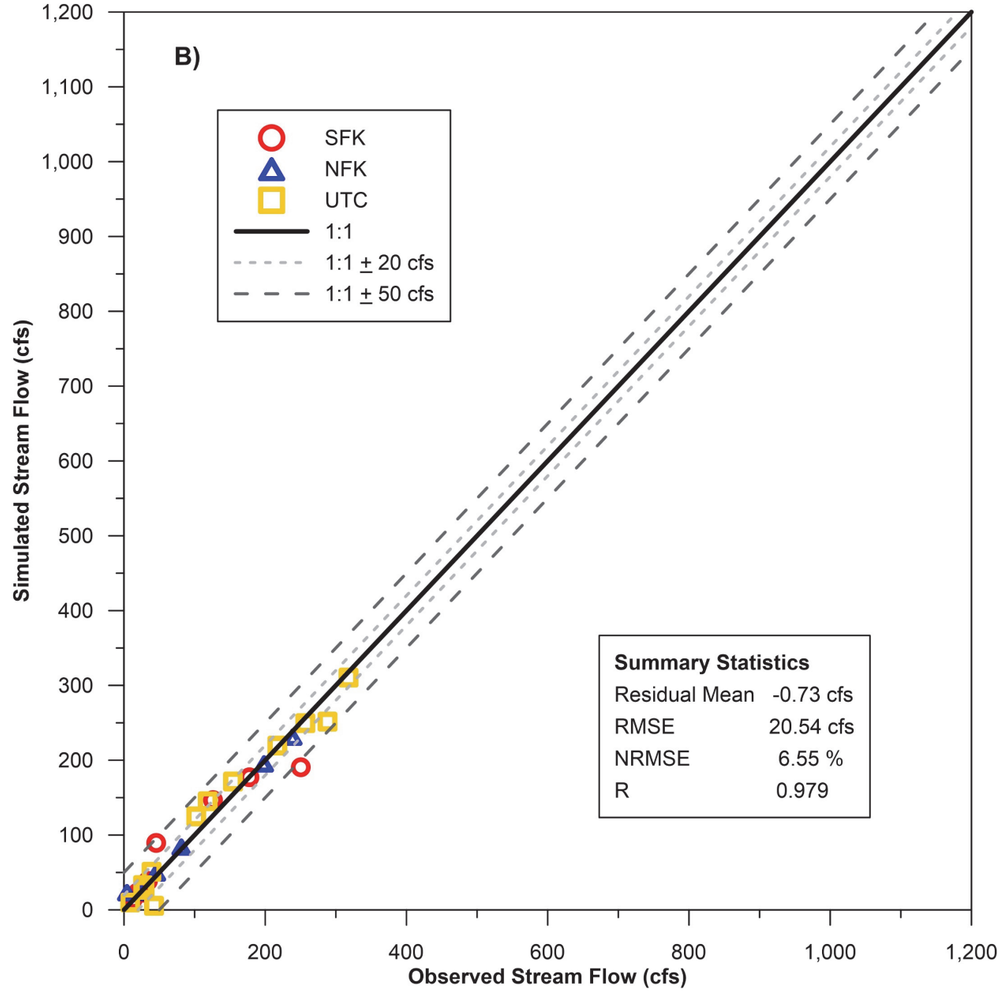

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SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S7	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: G-7

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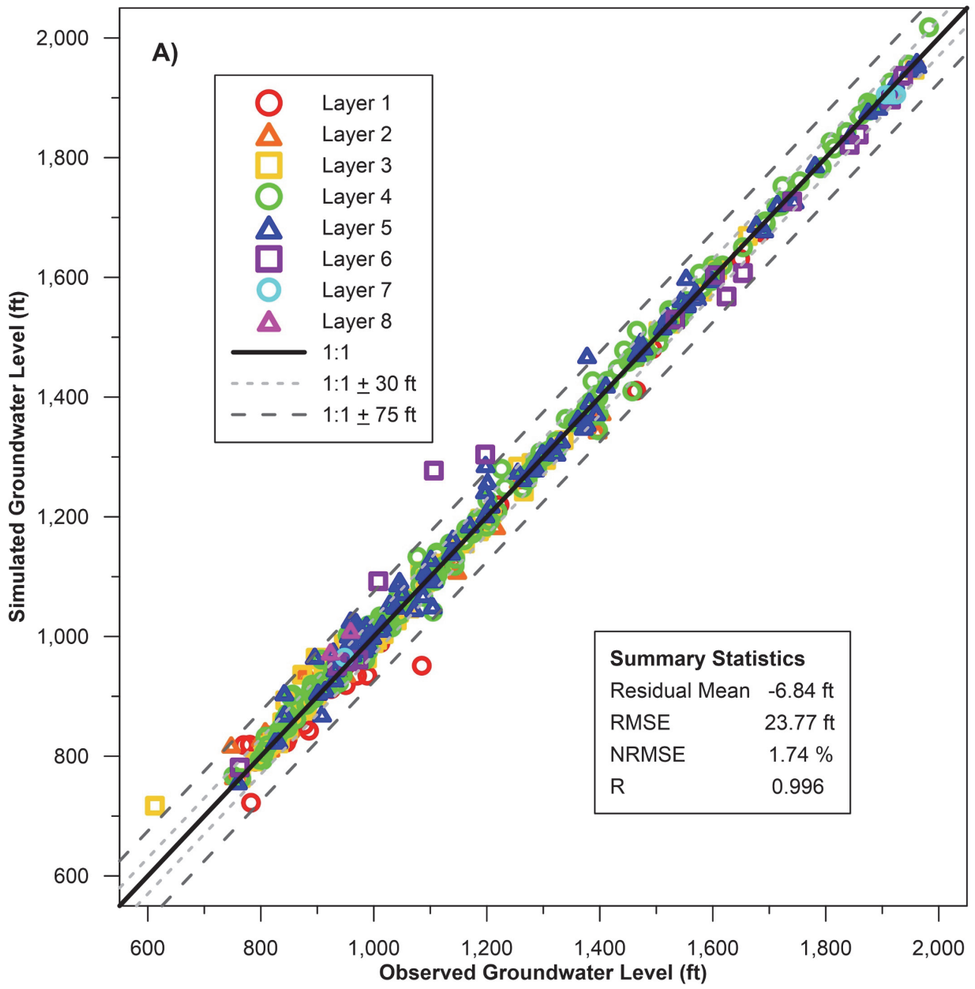

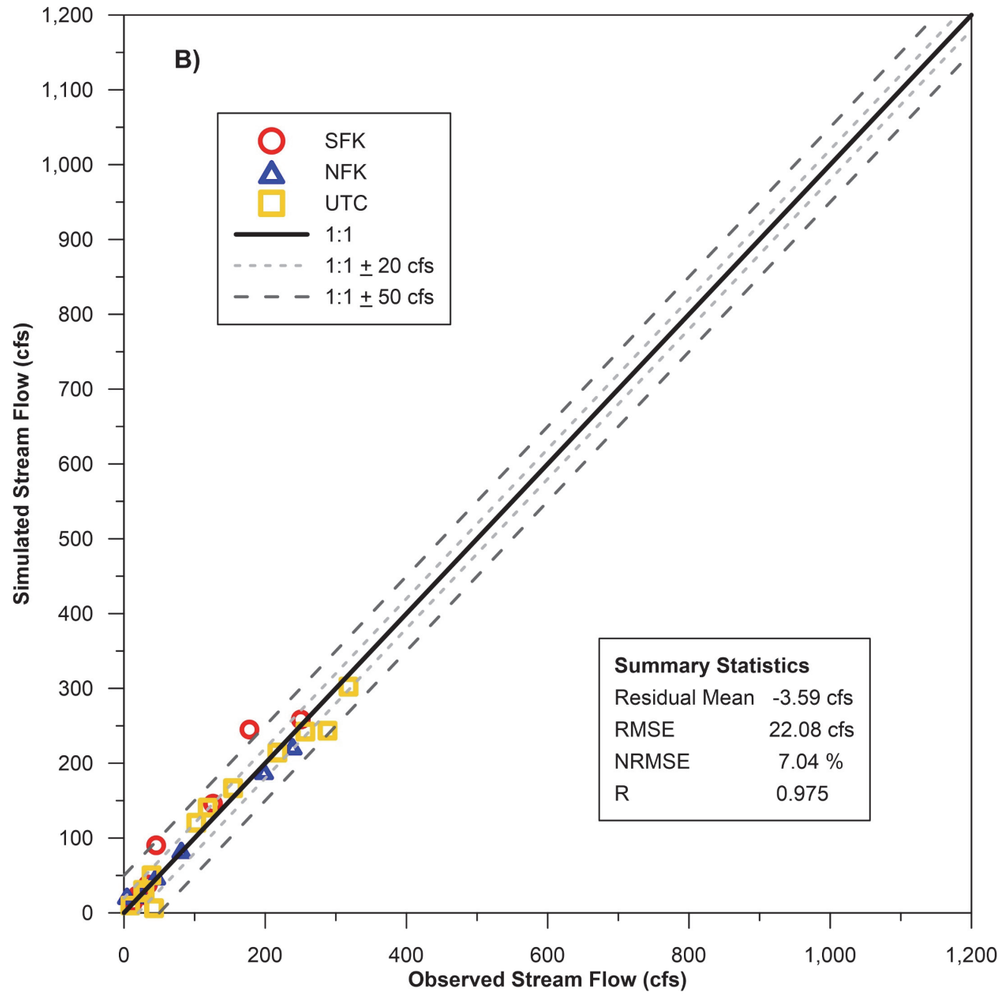

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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S8
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-8

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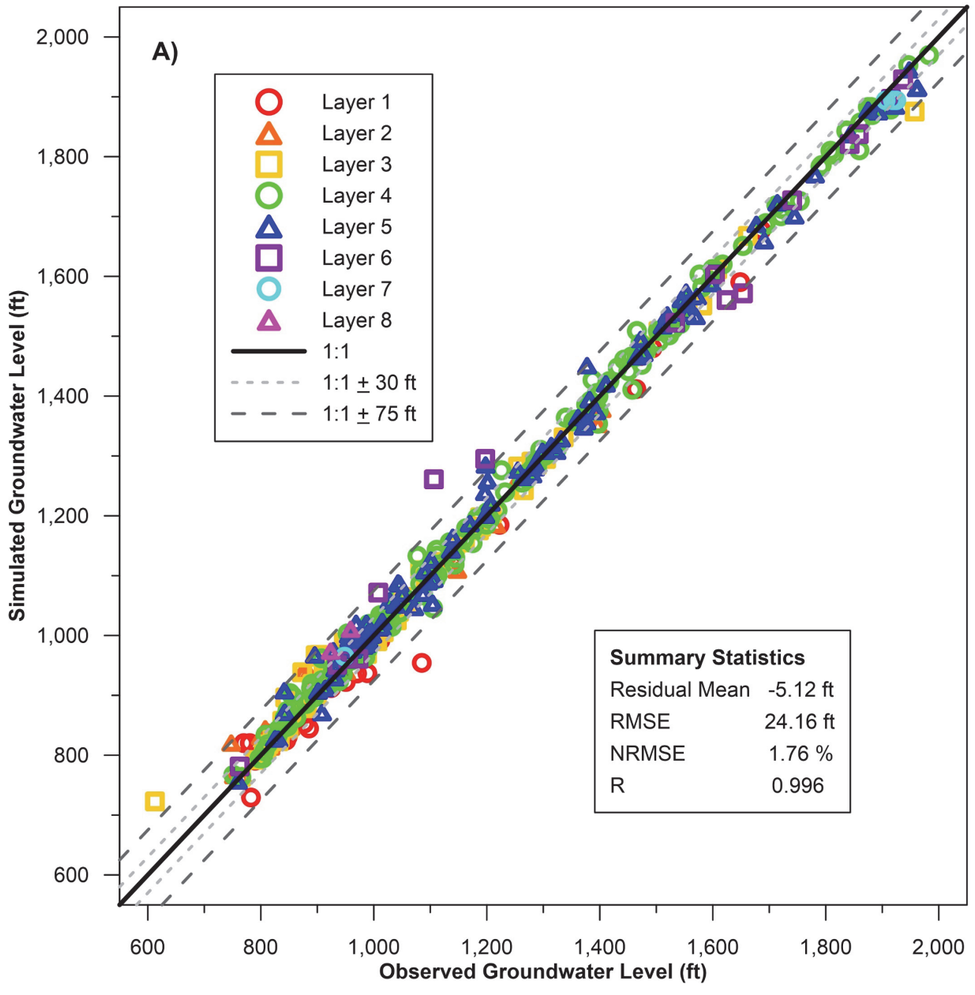

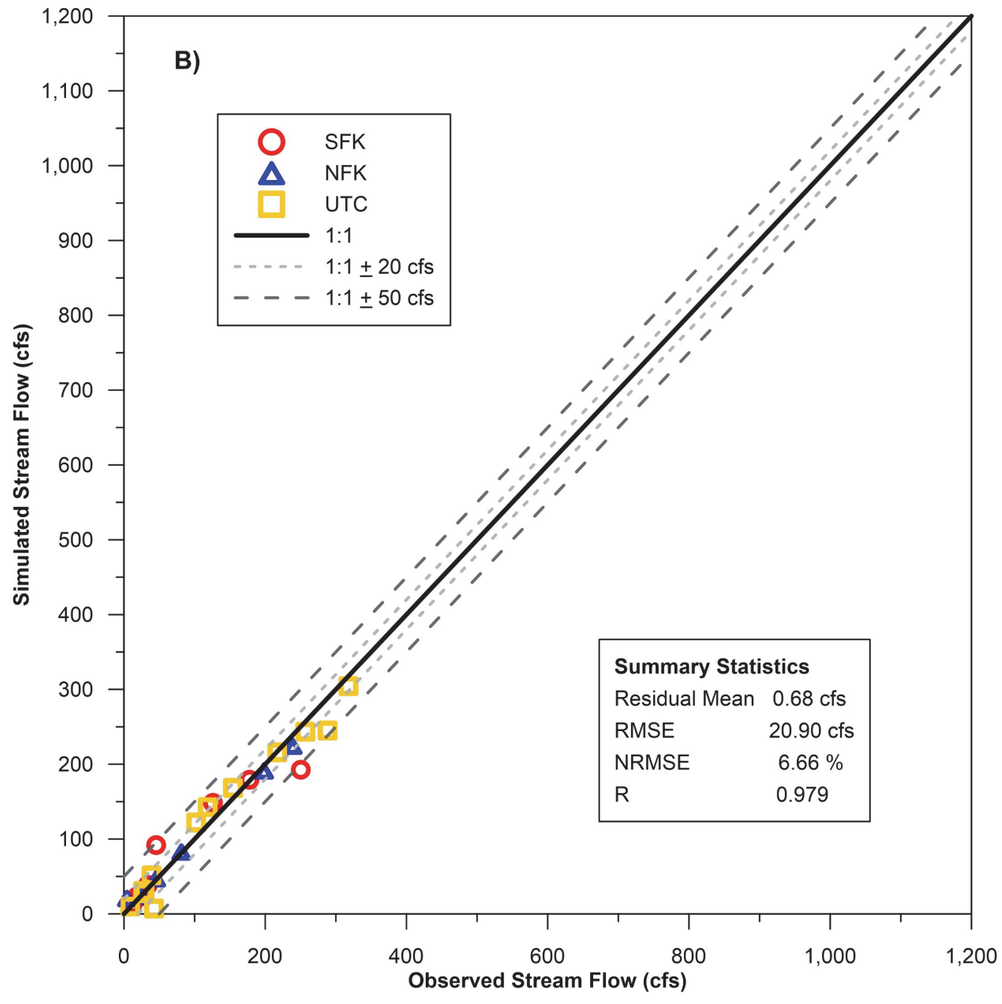

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S9
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: G-9

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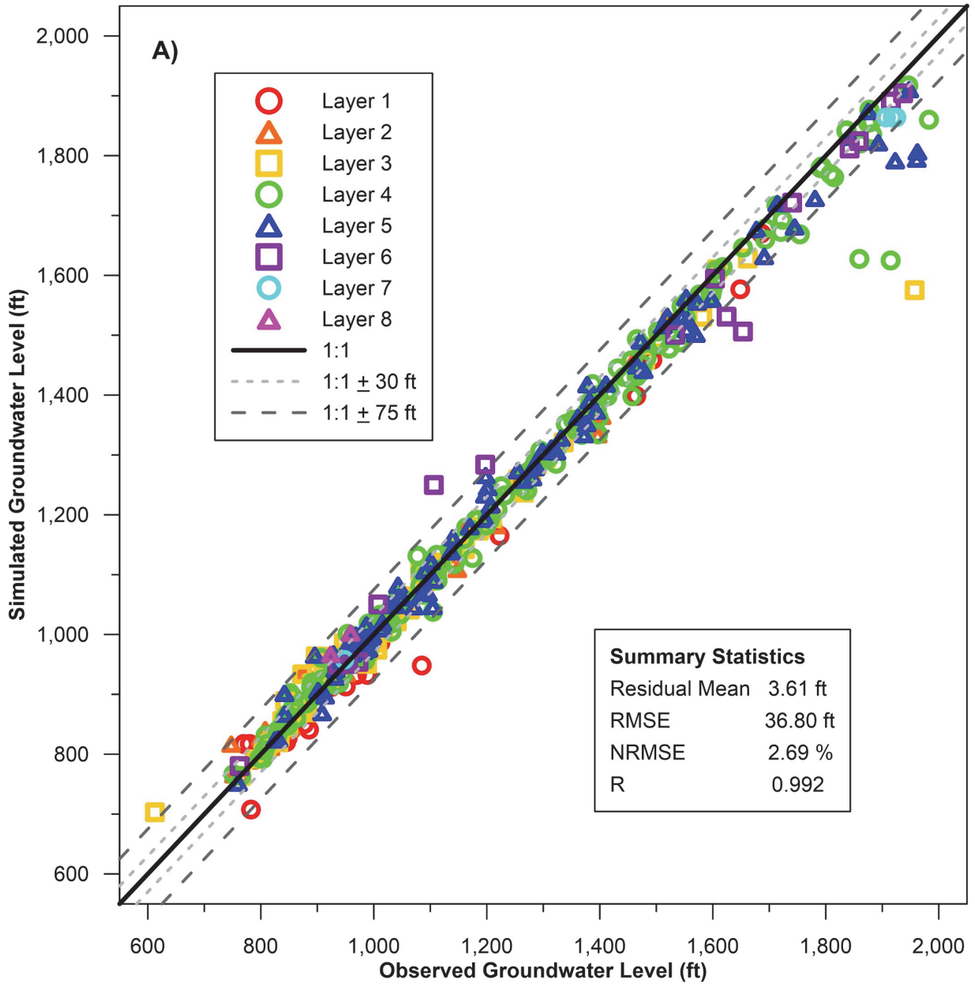

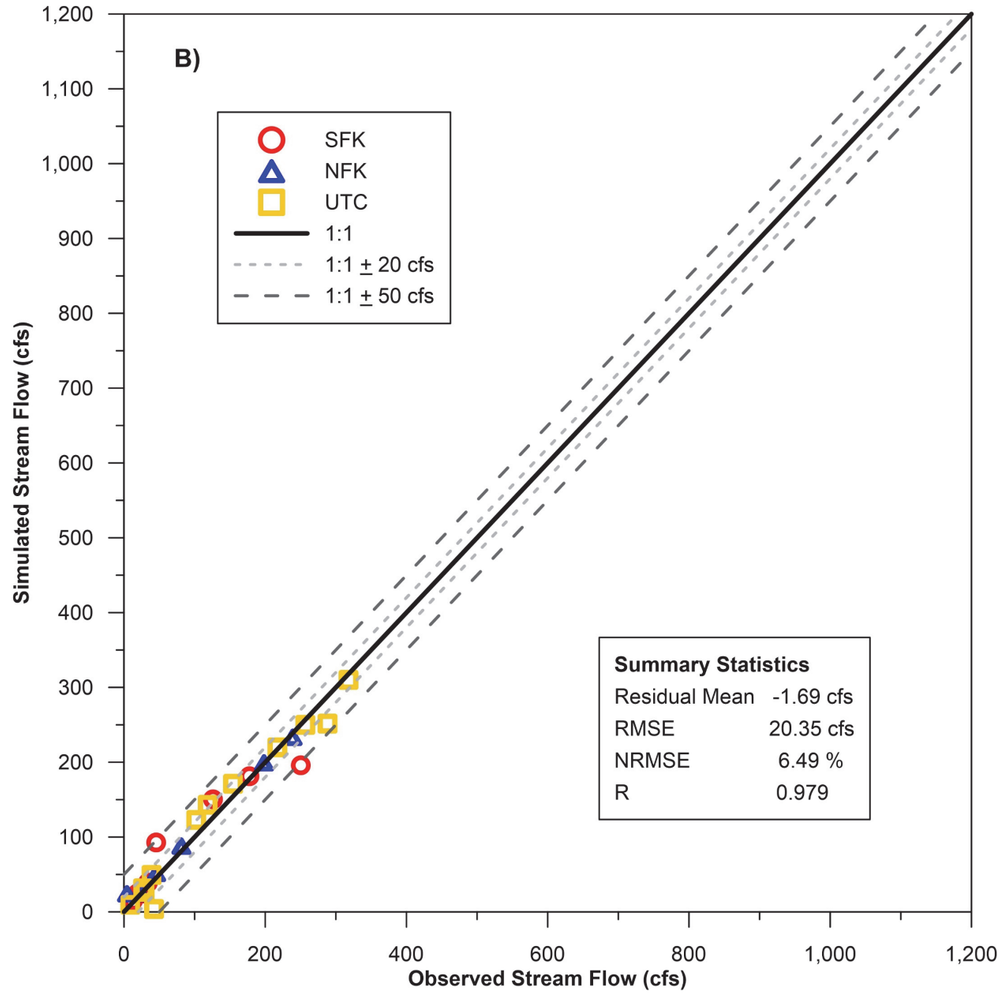

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S10
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-10

THE pebble PARTNERSHIP

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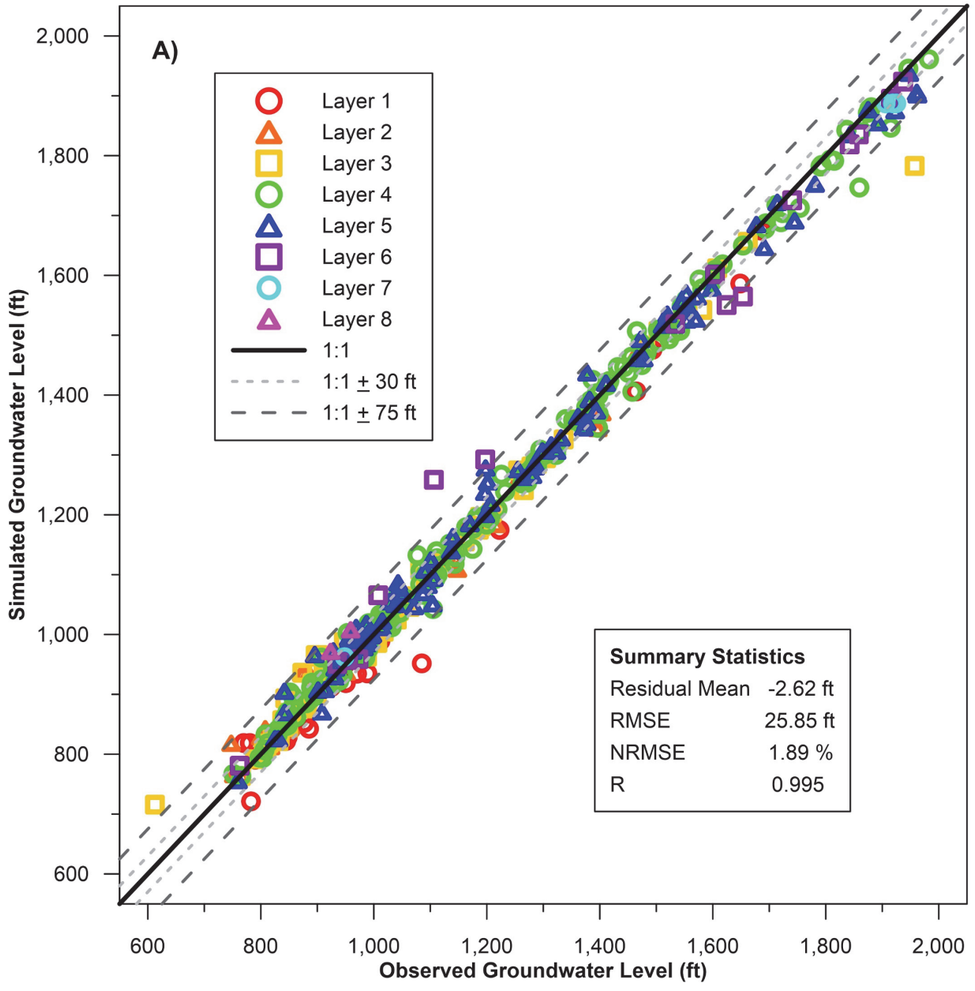

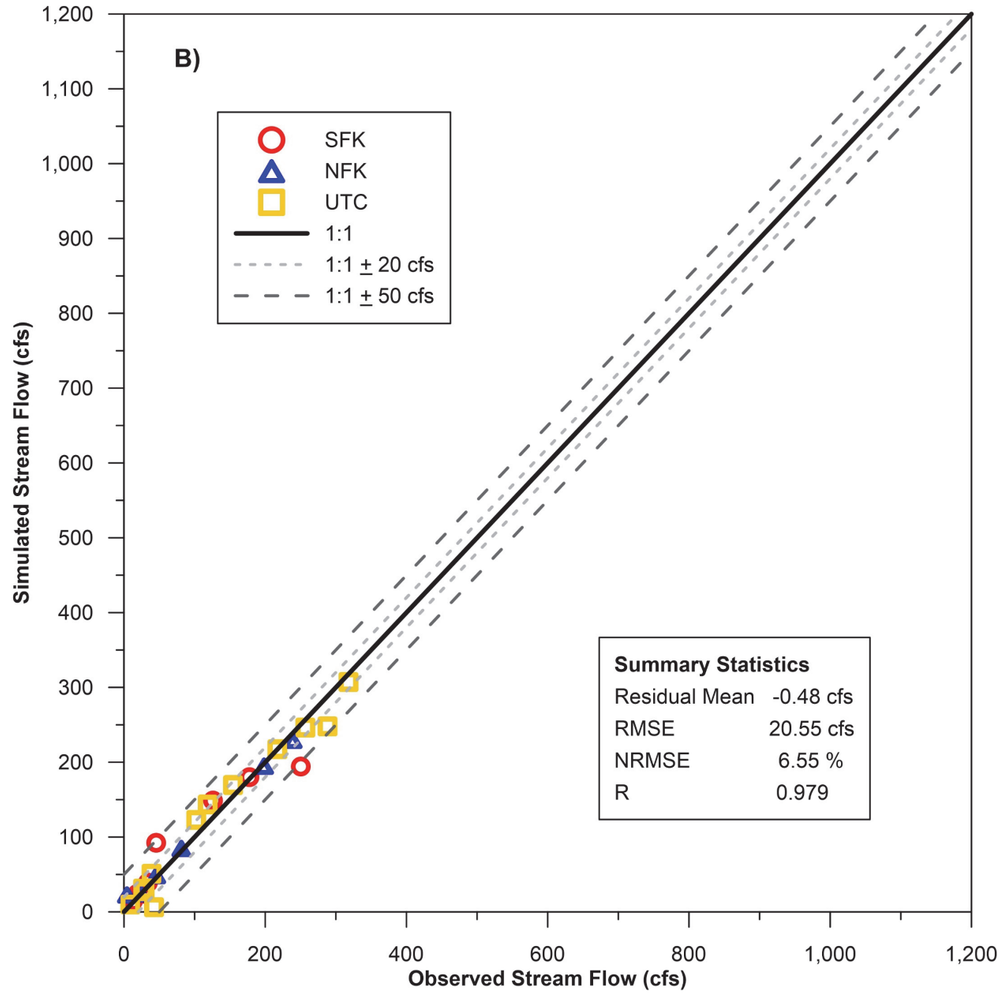

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S11
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-11

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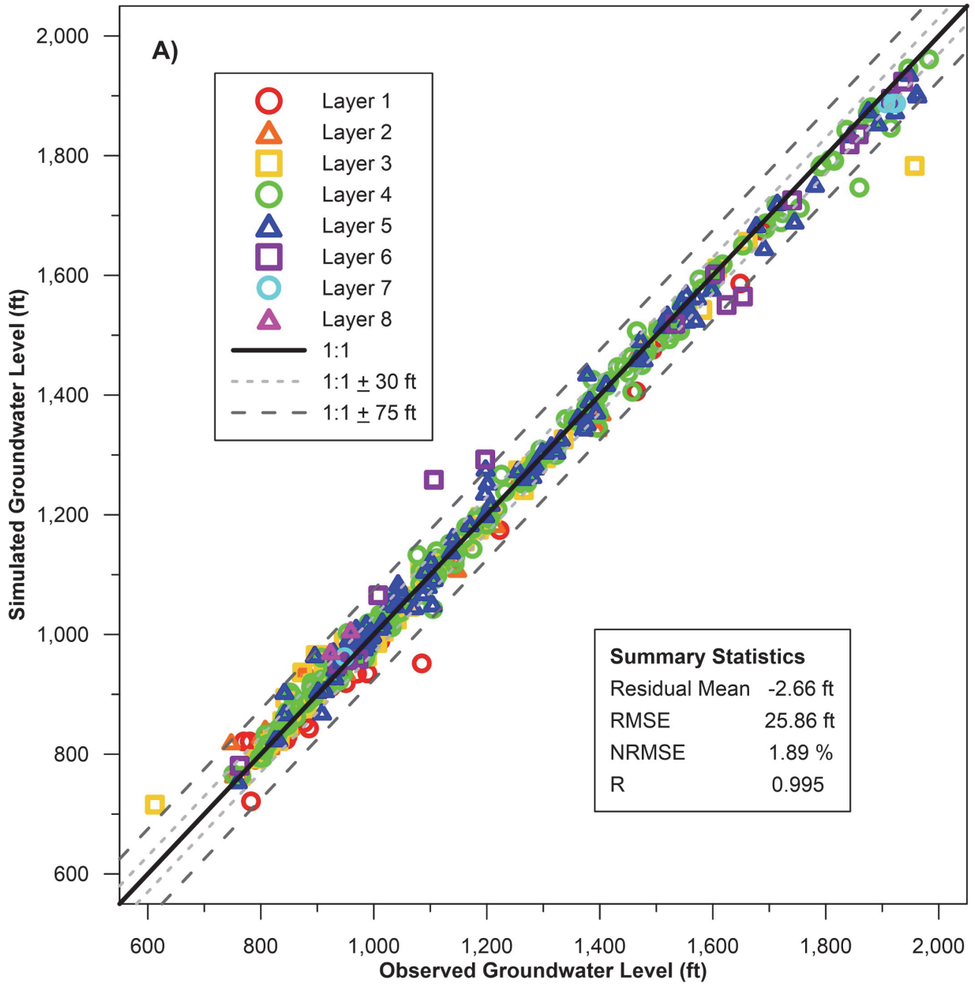

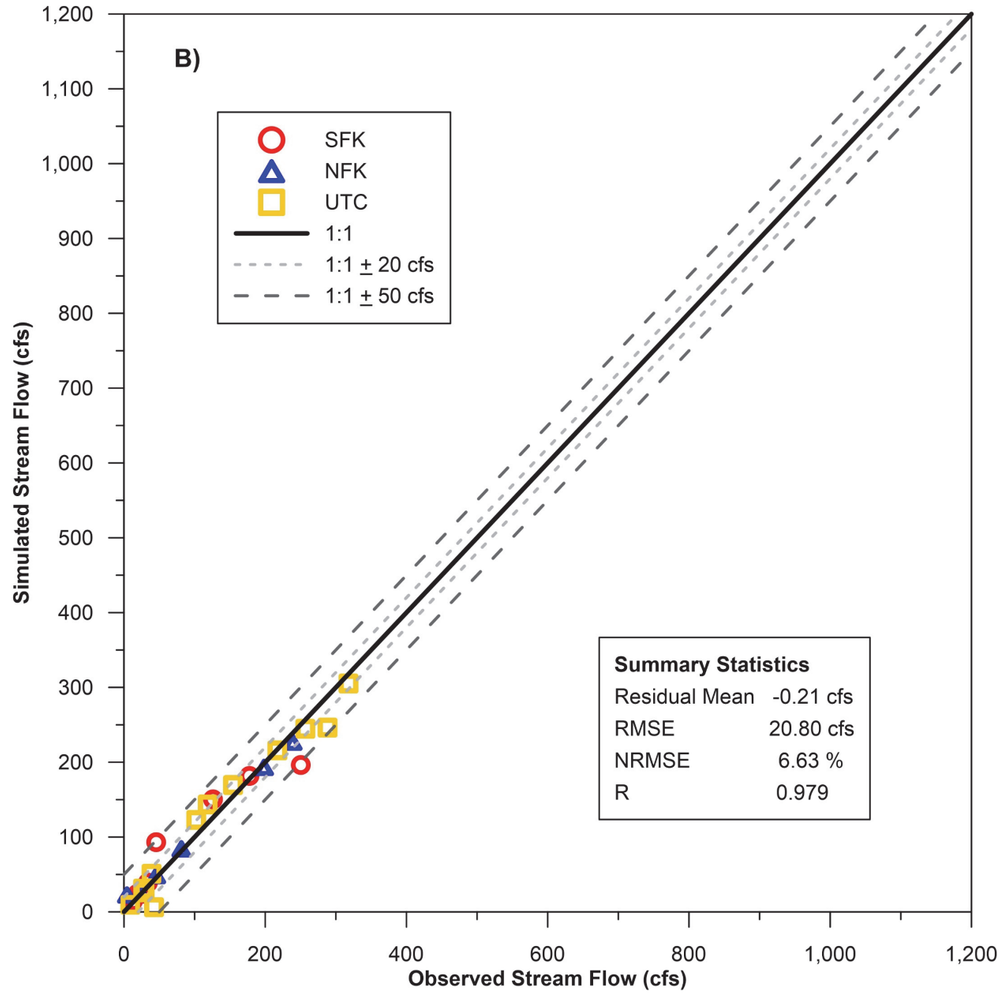

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S12
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-12

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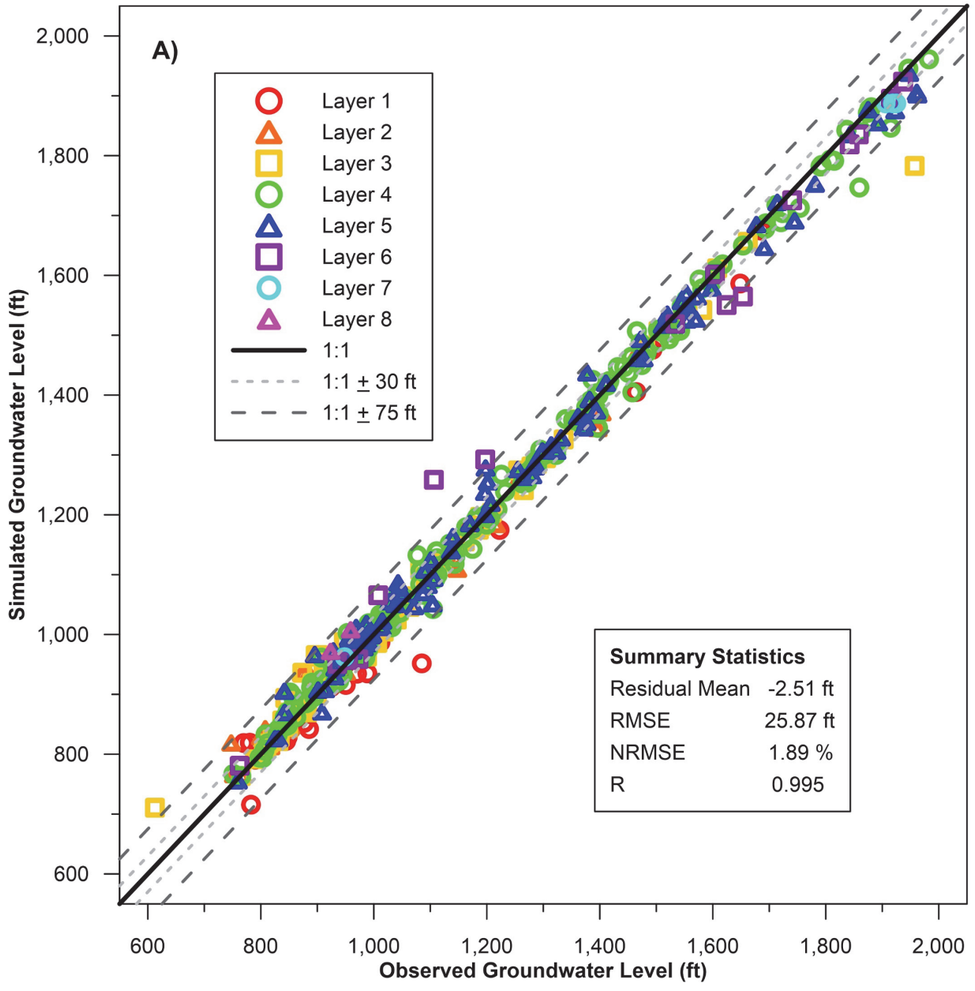

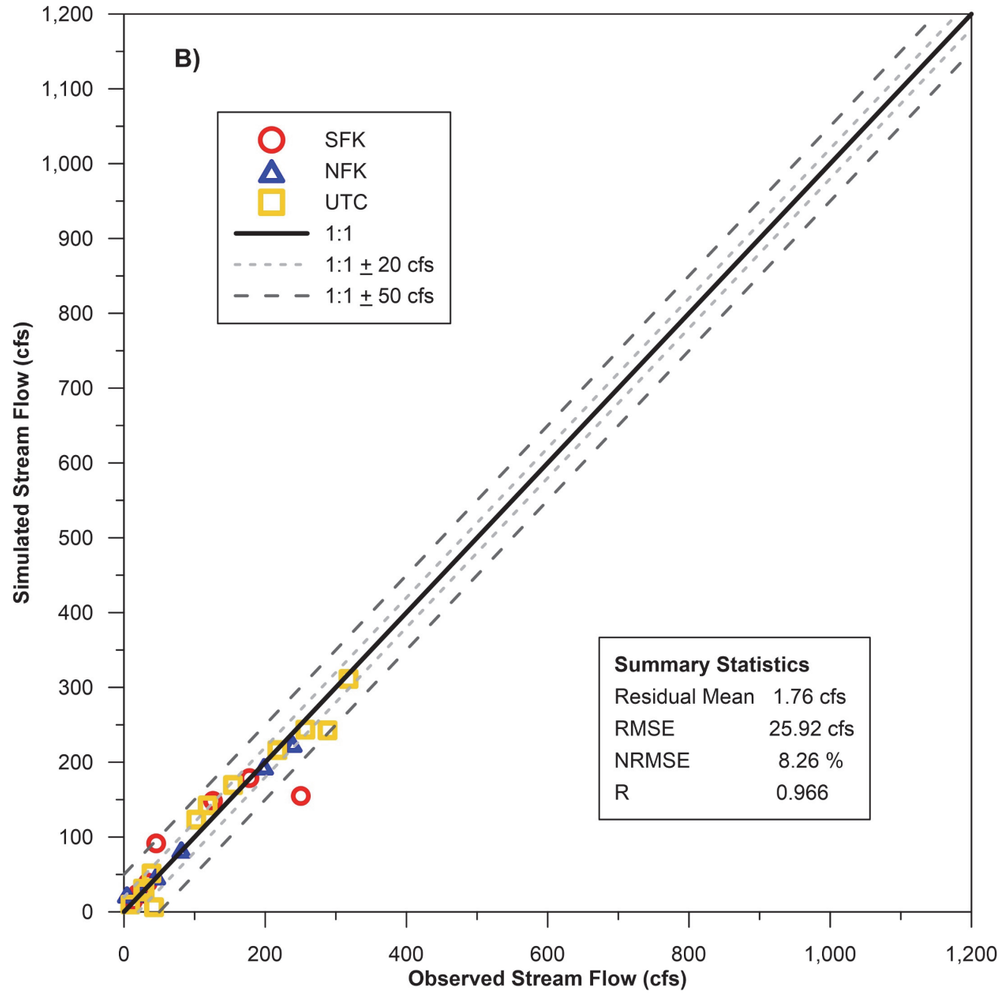

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
2. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC	FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S13	
APPROVED BY: RT		PROJECT NO: 1872-002	FIGURE NO: G-13

THE pebble PARTNERSHIP

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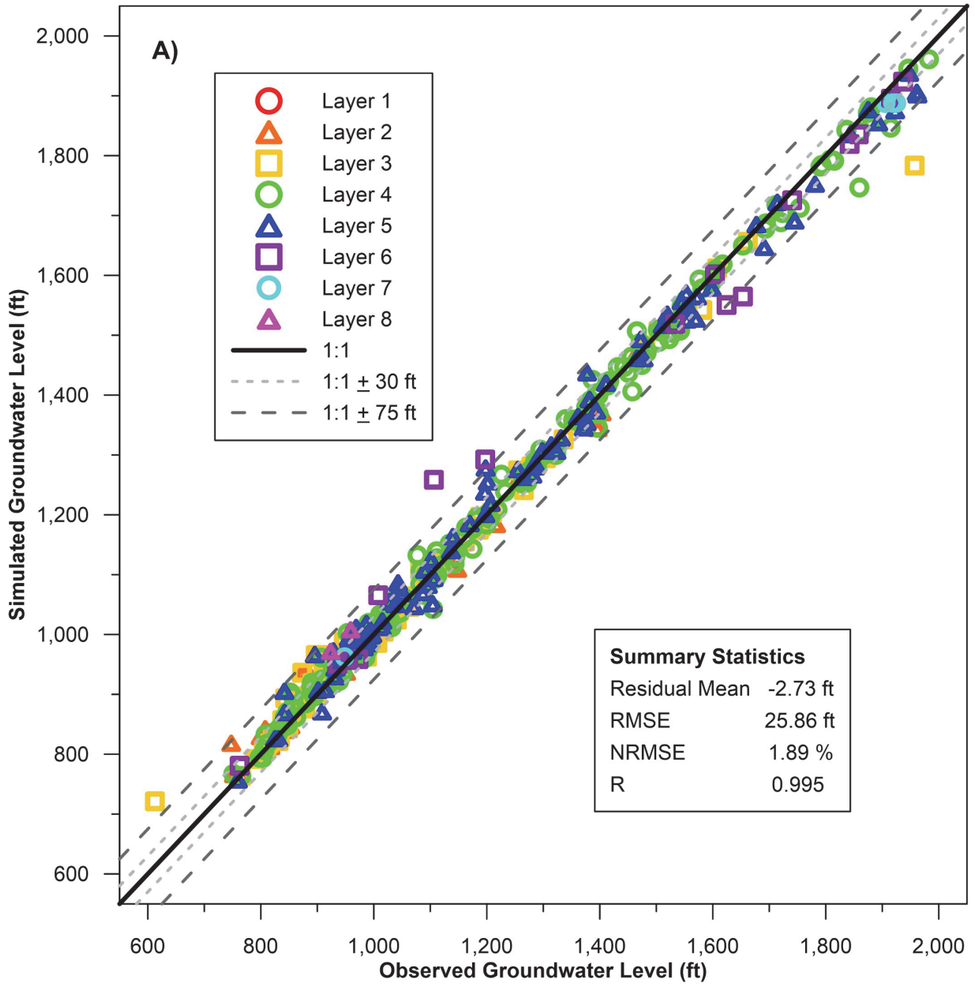

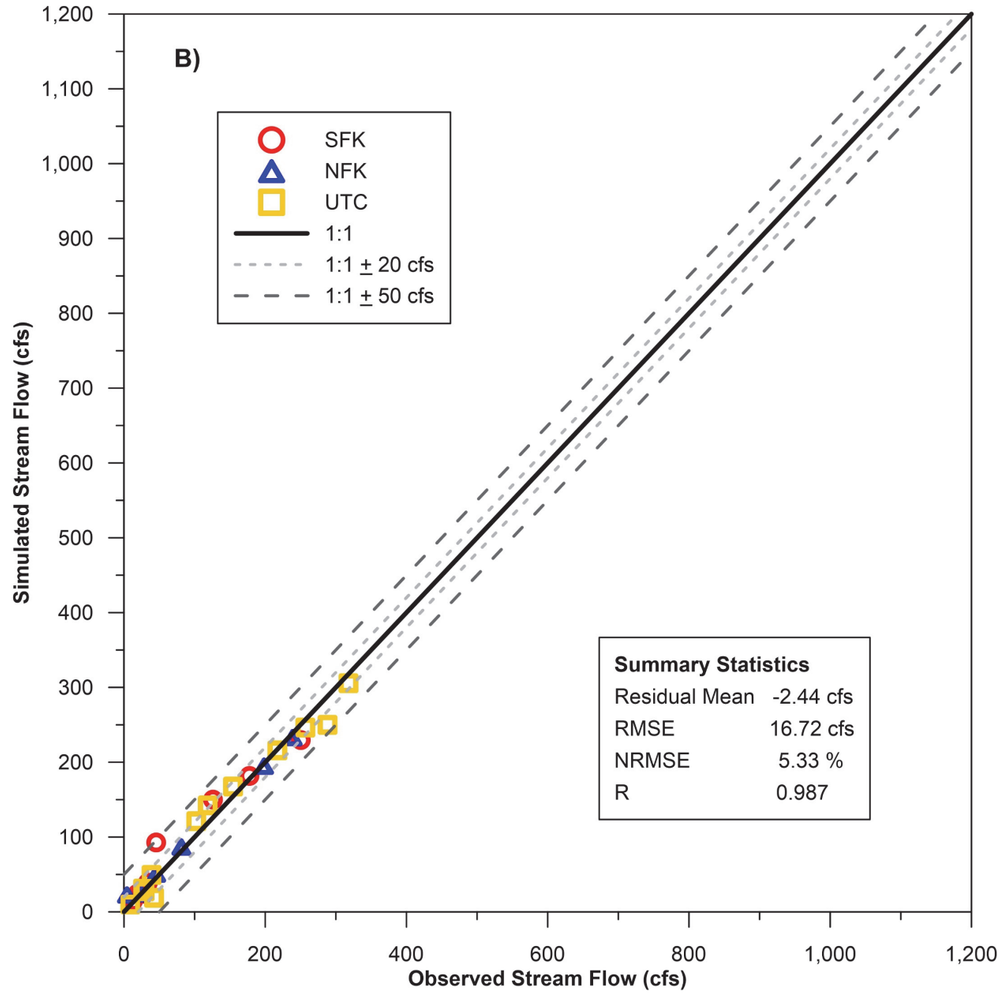

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S14
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-14

THE pebble PARTNERSHIP

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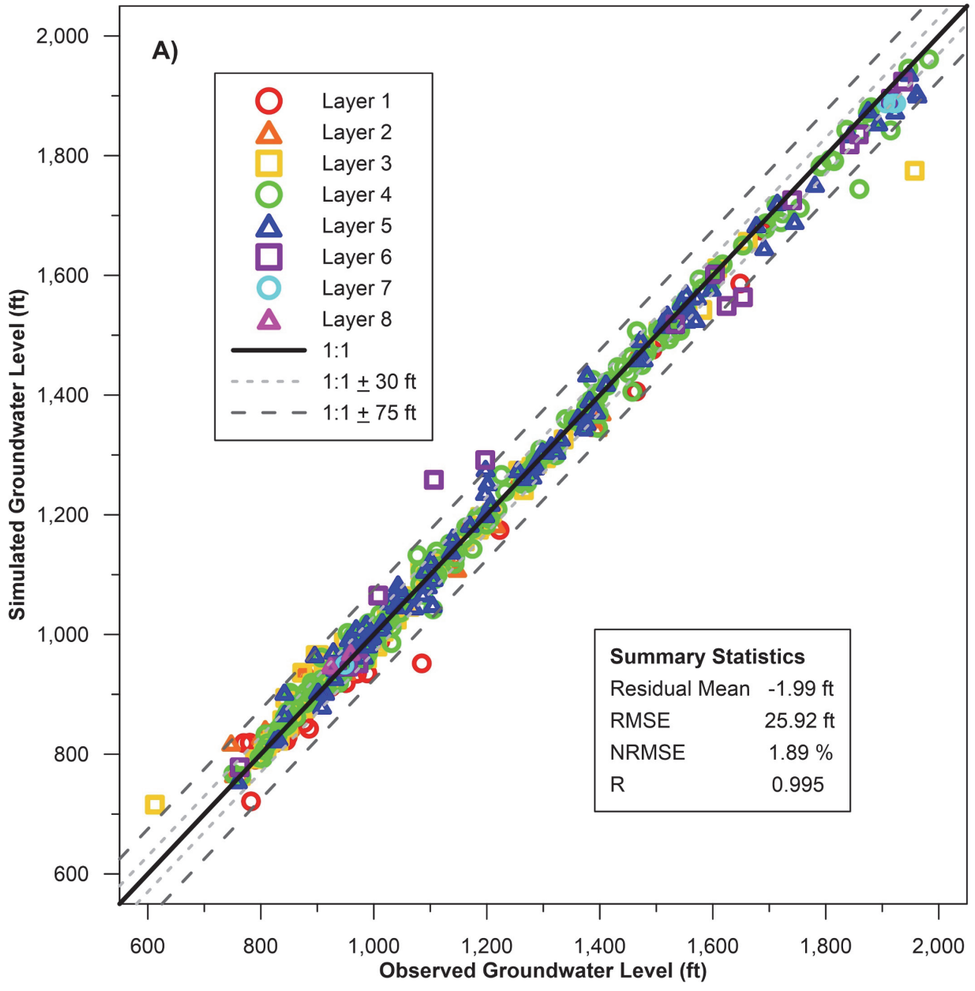

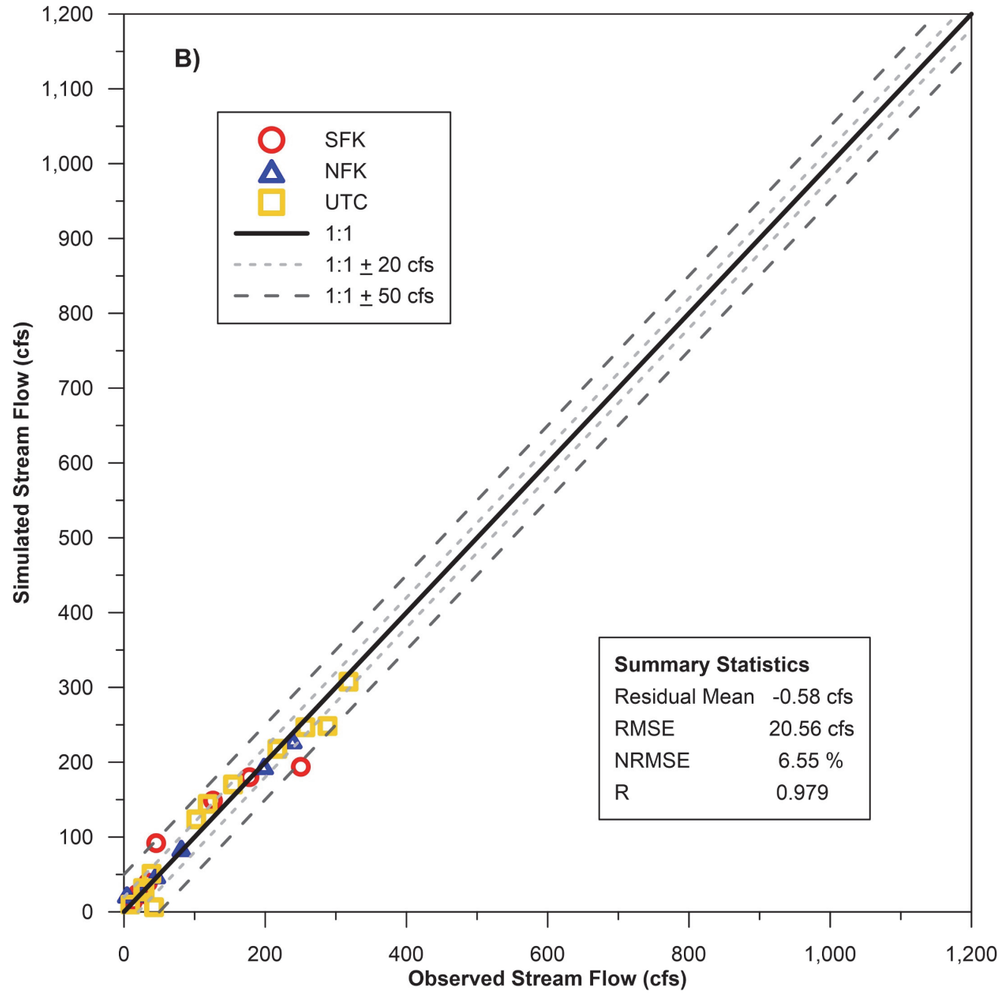

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S15
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-15

THE pebble PARTNERSHIP

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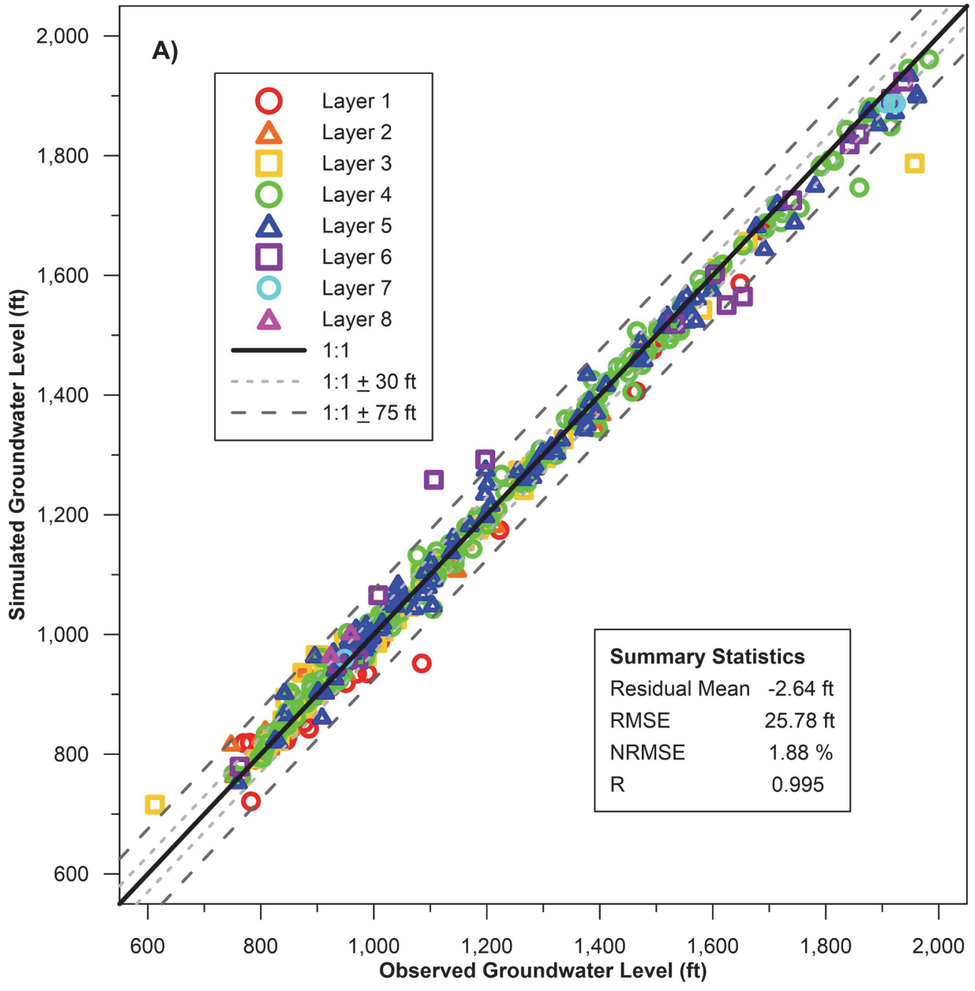

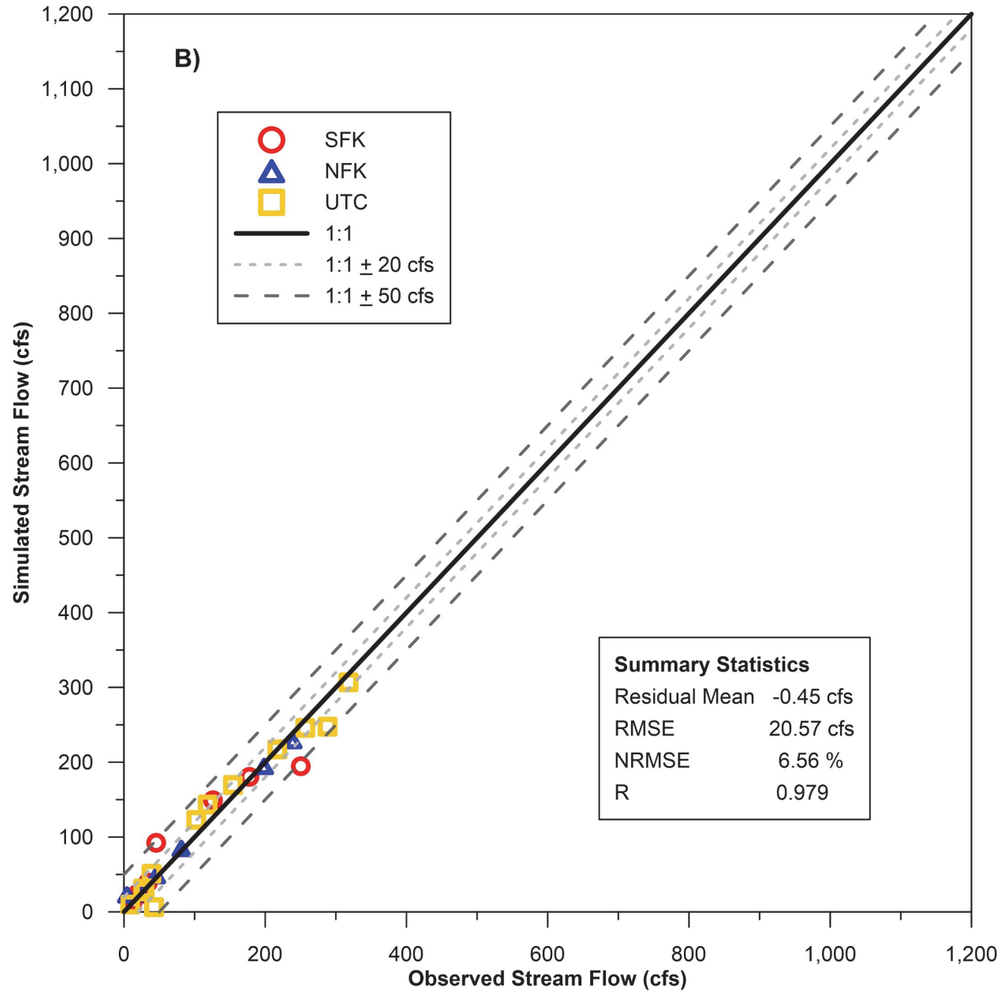

NOTES:
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
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SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: STEADY-STATE GROUNDWATER LEVELS (A) AND STREAM FLOWS (B) ALONG WITH SUMMARY STATISTICS FOR SENSITIVITY SCENARIO S16
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-16

THE pebble PARTNERSHIP

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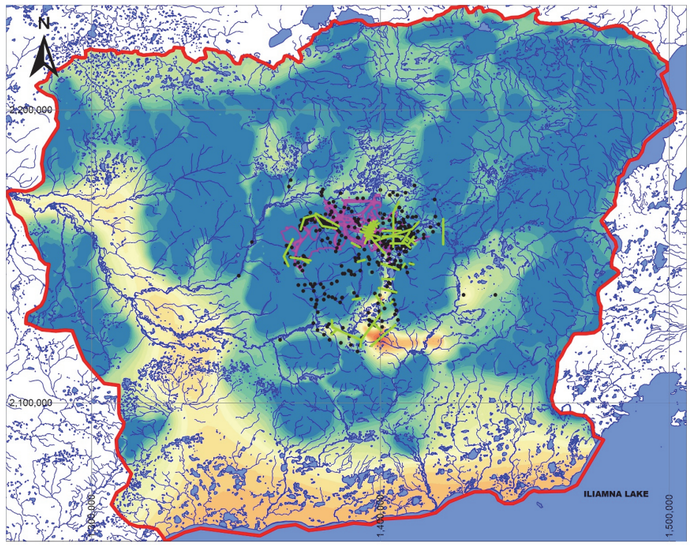
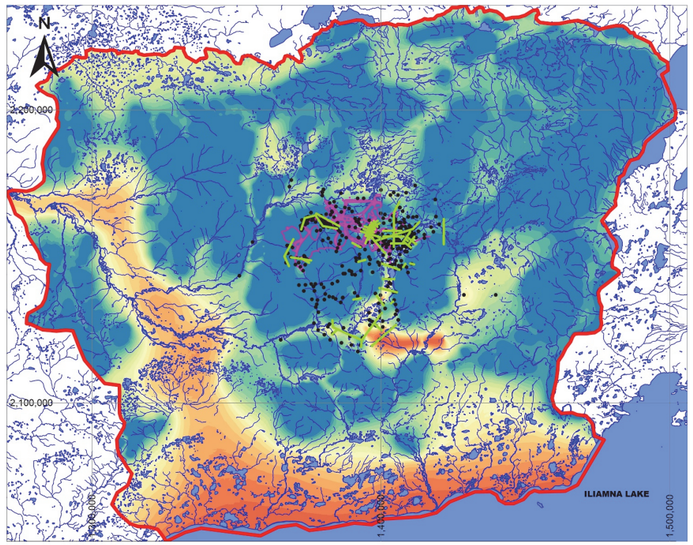
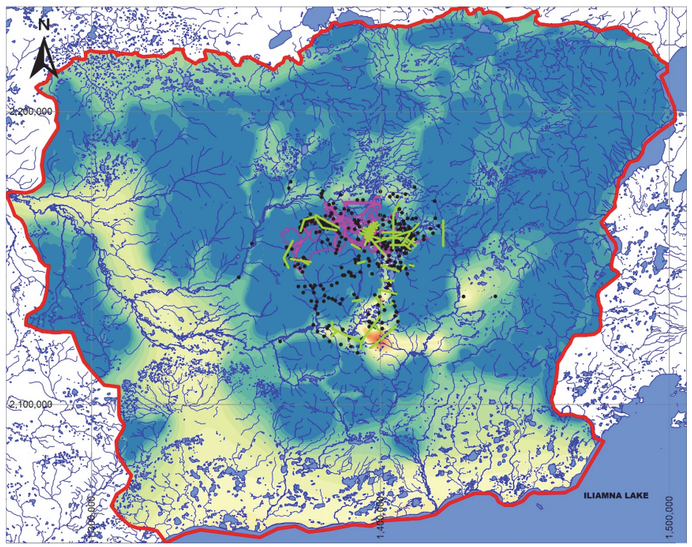


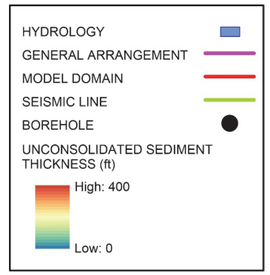
BASE CASE



S13: THICKER UNCONSOLIDATED SEDIMENTS



S14: THINNER UNCONSOLIDATED SEDIMENTS



NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP OCTOBER 4, 2018.
3. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
4. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL	
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: OVERBURDEN THICKNESS FOR THE BASE CASE AND SENSITIVITY SCENARIOS S13 AND S14	
APPROVED BY: RT				PROJECT NO: 1872-002	FIGURE NO: G-17

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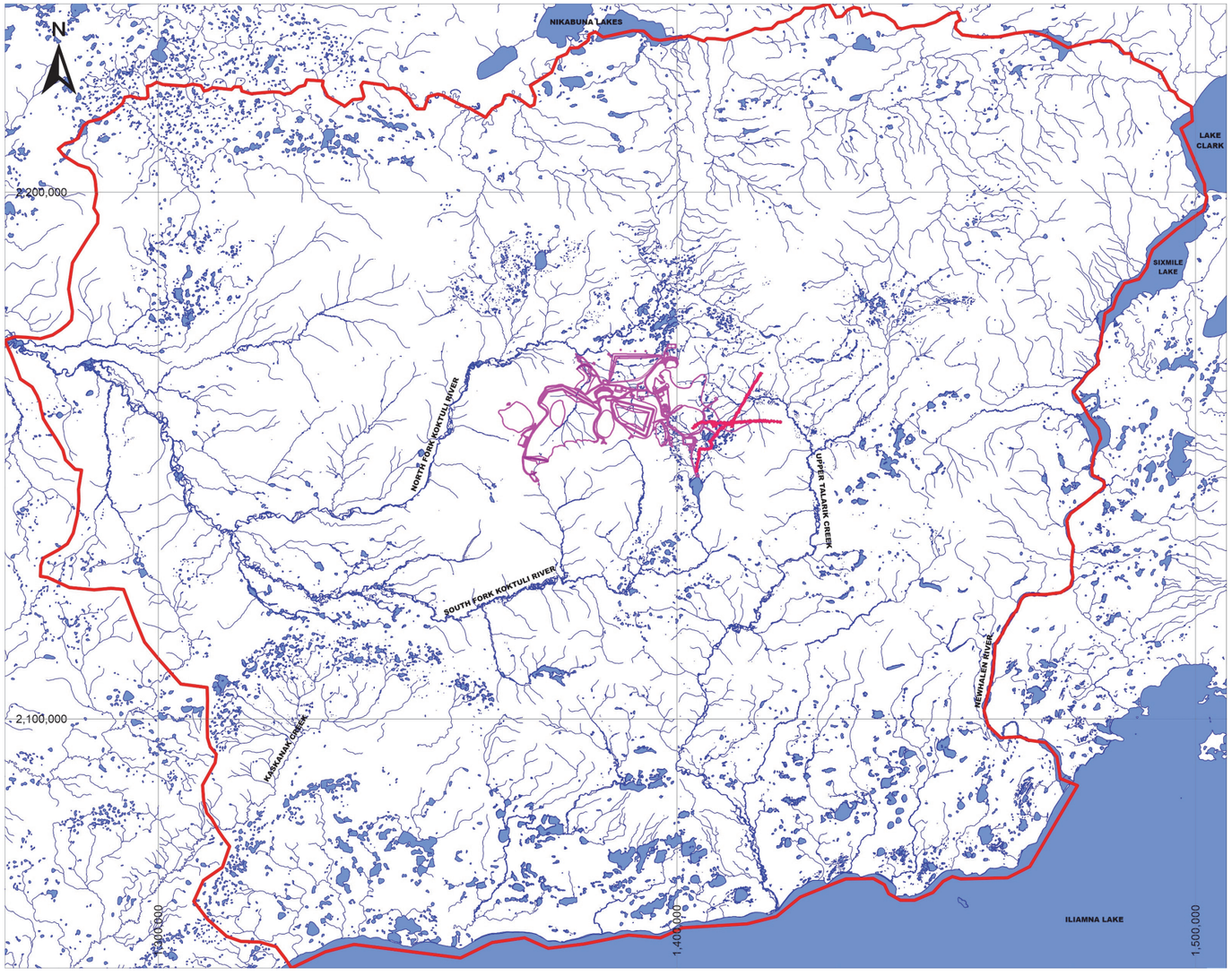

HYDROLOGY
GENERAL ARRANGEMENT
MODEL DOMAIN
SIMULATED FAULTS

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP OCTOBER 4, 2018.
3. INTERPRETED FAULT DISTRIBUTION SHOWN IN DRAWING 08.
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT ENTITLED “PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL” AND DATED 05-24-2019.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019	THE pebble PARTNERSHIP	BGC	REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC			FIGURE TITLE: SIMULATED FAULTS FOR SENSITIVITY SCENARIOS S15 AND S16
APPROVED BY: RT				PROJECT NO: 1872-002 / FIGURE NO: G-18

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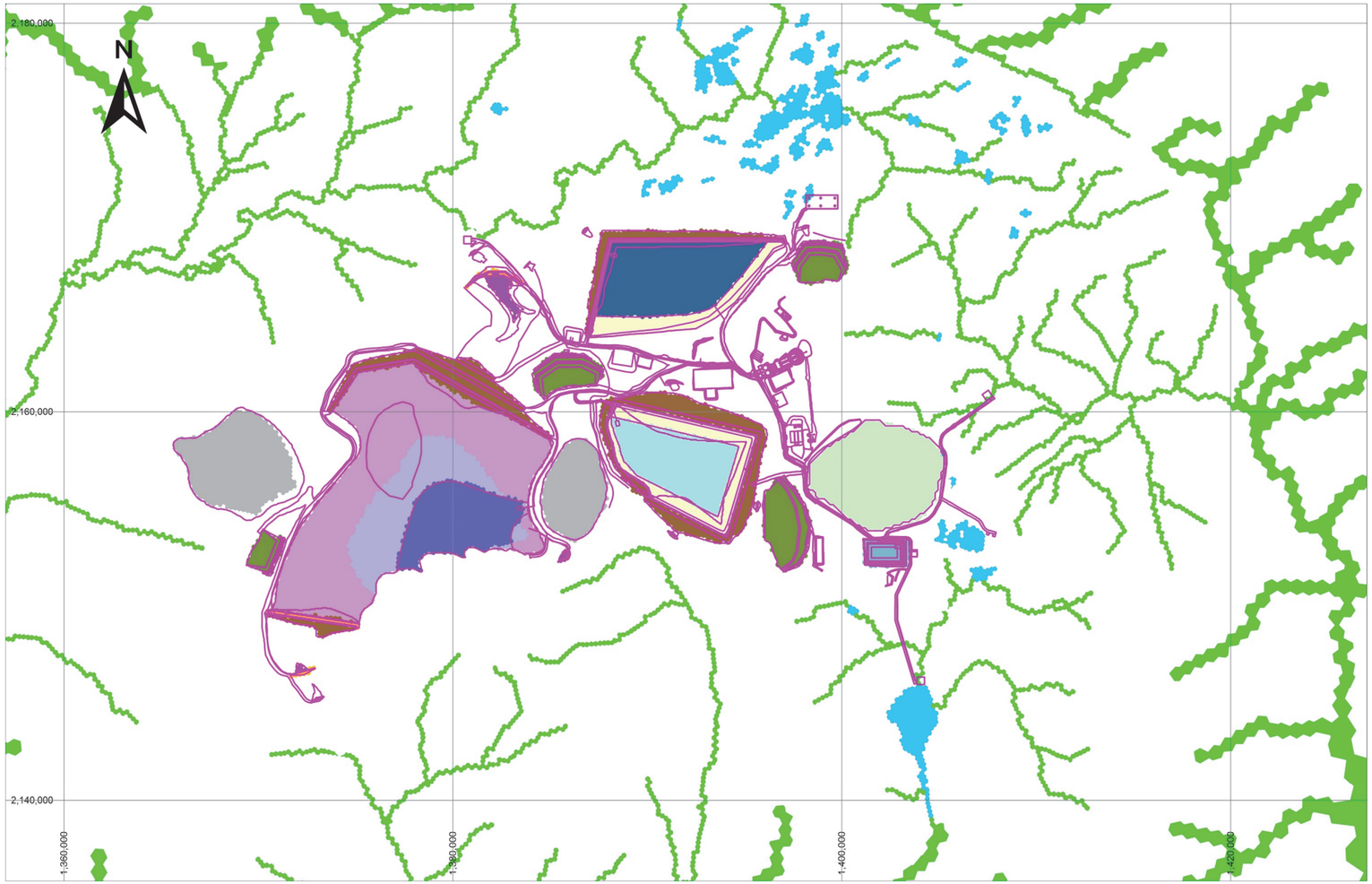

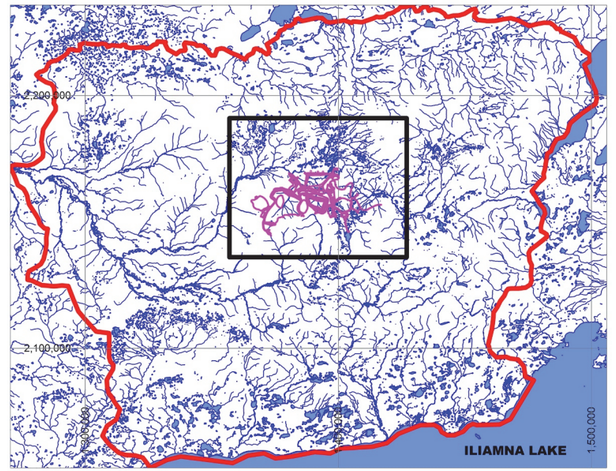

HYDROLOGY		LINER	
GENERAL ARRANGEMENT		EMBANKMENTS	
BGC MODEL DOMAIN		SEEPAGE CONTROL	
INSET MAP BOUNDARY		SEEPAGE RECOVERY PONDS	
BOUNDARY CONDITIONS		QUARRIES	
LAKES		STOCKPILES	
STREAMS		BULK TSF POND AND SATURATED TAILINGS	
OPEN PIT			
OPEN PIT WMP		SCENARIO S0	
MAIN WMP		SCENARIO S19	
PYRITIC TSF		SCENARIO S20	

NOTES:
1. PROJECTION: NAD83 STATEPLANE ALASKA (FEET).
2. GENERAL ARRANGEMENT PROVIDED BY PLP OCTOBER 4, 2018.
3. OPEN PIT SIMULATED USING YEAR 20 WHITTLE PIT PROVIDED BY PLP IN EMAIL DATED FEBRUARY 19, 2019 (FILE: FINAL_PIT_APRIL_11_2017.DXF).
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE REPORT "ENTITLED 'PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL" AND DATED 05-24-2019.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS FIGURE SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE: AS SHOWN	DATE: 05-24-2019		REPORT TITLE: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL
PREPARED BY: CT	CHECKED BY: TWC		FIGURE TITLE: END OF MINING BOUNDARY CONDITIONS FOR SENSITIVITY SCENARIOS S19
APPROVED BY: RT			PROJECT NO: 1872-002 / FIGURE NO: G-19

THE pebble PARTNERSHIP

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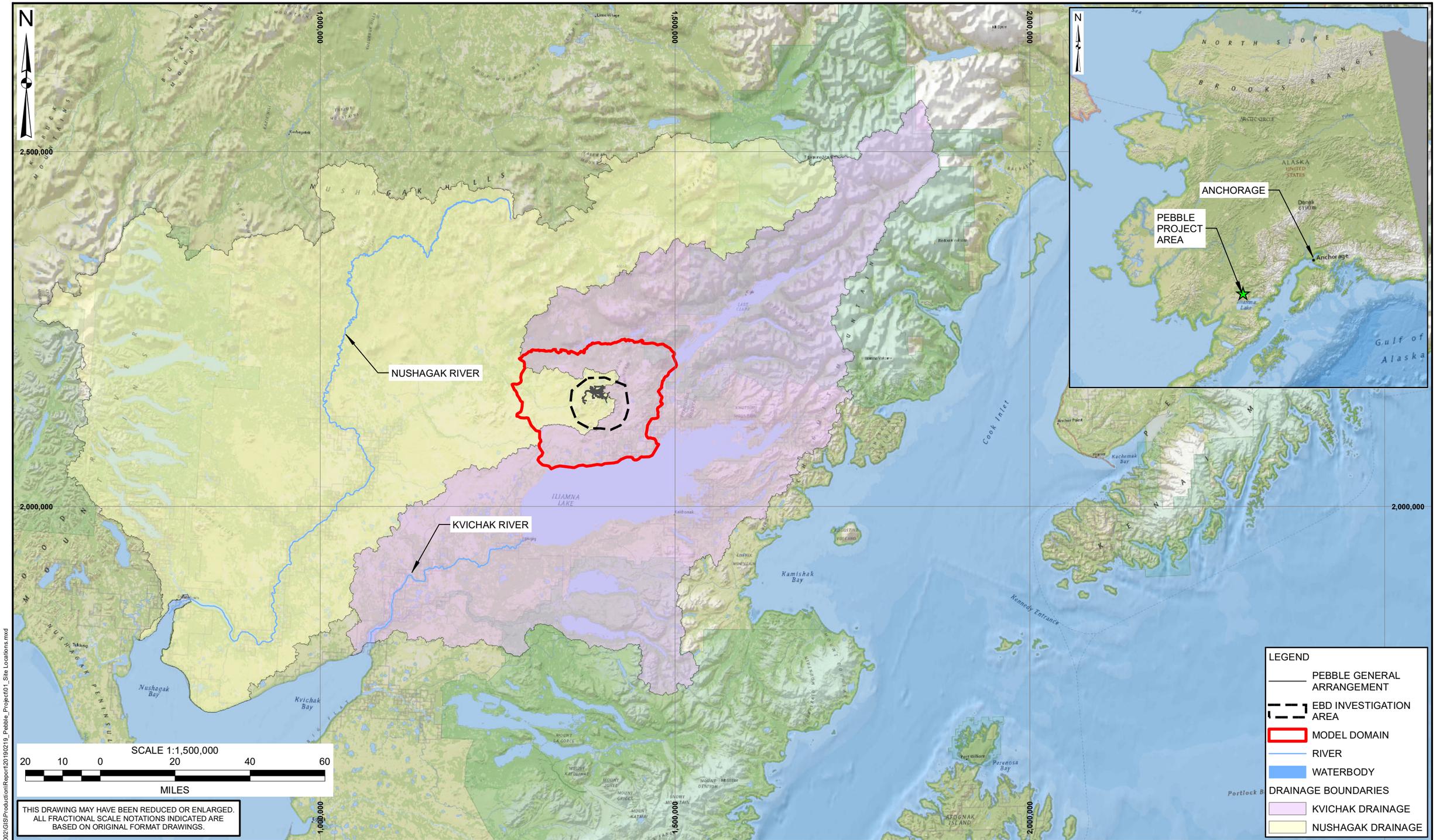
DRAWINGS



NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. RIVER DATA PROVIDED BY THE ALASKA DEPARTMENT OF NATURAL RESOURCES.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. PROJECTION IS NAD 1983 STATE PLAN ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
6. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1:1,500,000
DATE:	MAY 2019
DRAWN:	JVC, JVT
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: SITE LOCATION

PROJECT No.:	DWG No:
1872-002	01

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N

1,375,000

1,400,000

2,167,500

BULK TSF MAIN SEEPAGE COLLECTION POND

MAIN WATER MANAGEMENT POND

SEEPAGE COLLECTION POND

OVERBURDEN STOCKPILE

BULK TAILINGS STORAGE FACILITY

QUARRY A

QUARRY B

QUARRY C

PYRITIC TAILINGS AND PAG WASTE ROCK STORAGE FACILITY

OPEN PIT

BULK TAILINGS POND

SEEPAGE COLLECTION POND

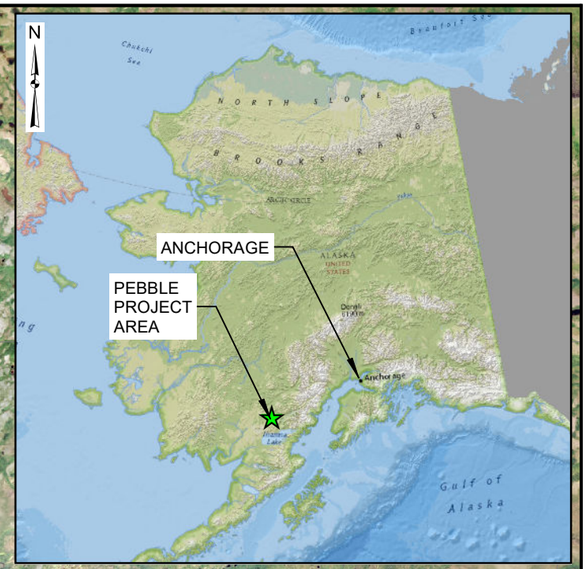
SEEPAGE COLLECTION POND

OVERBURDEN STOCKPILE

OPEN PIT WATER MANAGEMENT POND

2,142,500

2,142,500



SCALE 1:50,000

½ ¼ 0 ½ 1 1½

MILES

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LEGEND

PEBBLE GENERAL ARRANGEMENT

NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
4. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

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DATE:	MAY 2019
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CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: SITE LAYOUT

PROJECT No.:	DWG No:
1872-002	02

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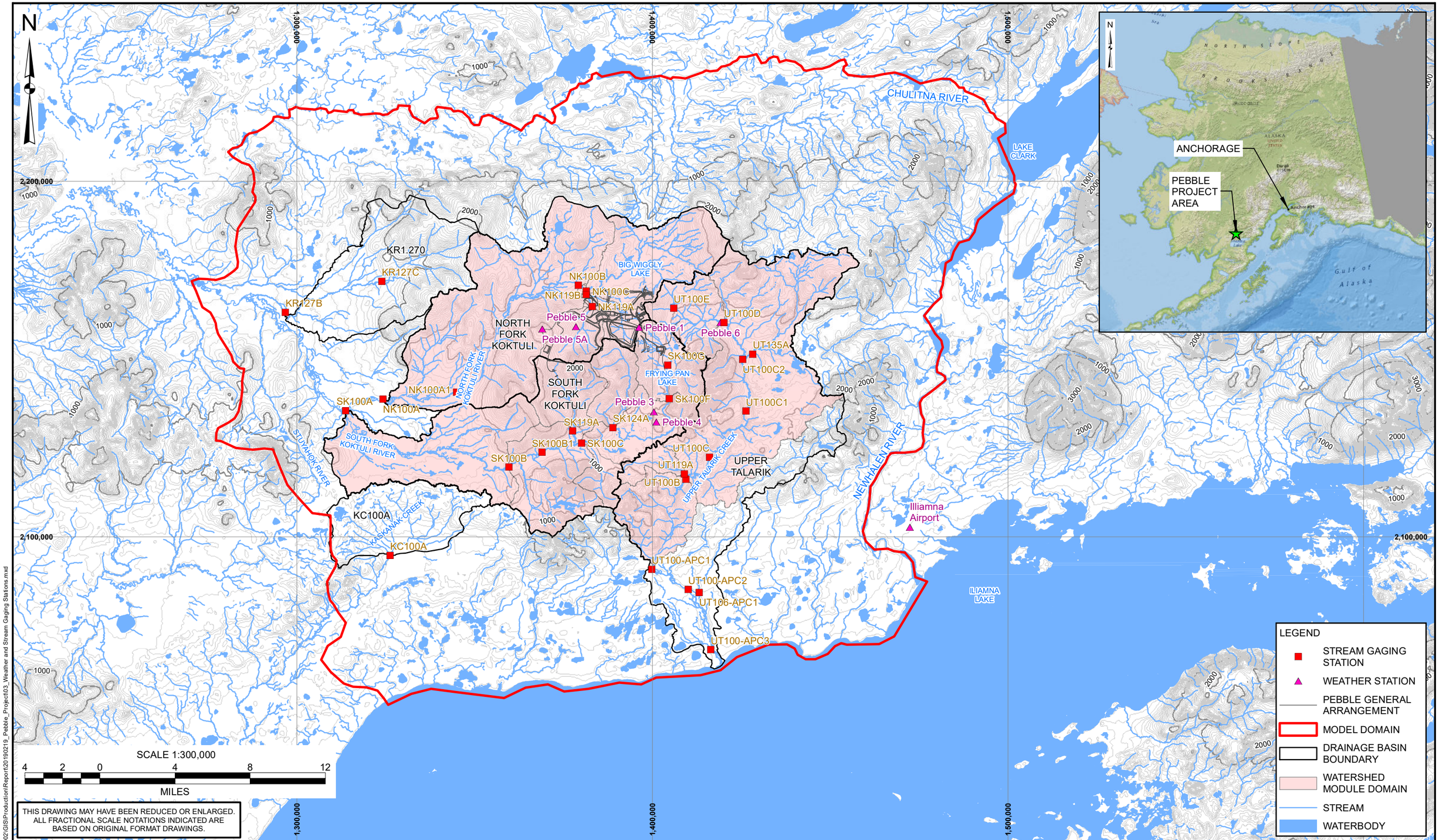

NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018 PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 50 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
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SCALE:	1:300,000
DATE:	MAY 2019
DRAWN:	JVC, JVT
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: WEATHER AND STREAM GAGING STATIONS

PROJECT No.: 1872-002

DWG No: 03

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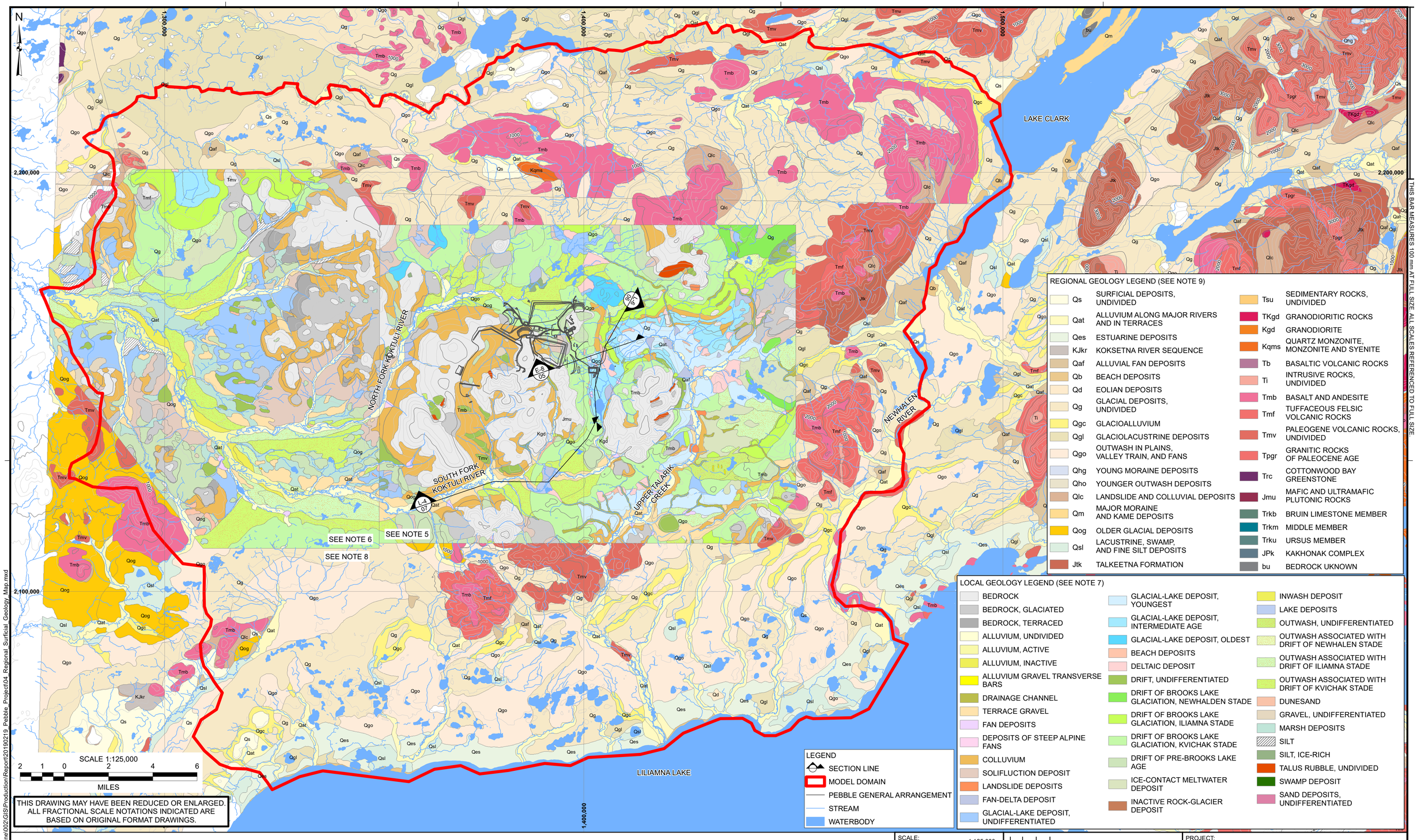

REGIONAL GEOLOGY LEGEND (SEE NOTE 9)

Qs	SURFICIAL DEPOSITS, UNDIVIDED	Tsu	SEDIMENTARY ROCKS, UNDIVIDED
Qat	ALLUVIUM ALONG MAJOR RIVERS AND IN TERRACES	TKgd	GRANODIORITIC ROCKS
Qes	ESTUARINE DEPOSITS	Kgd	GRANODIORITE
KJkr	KOKSETNA RIVER SEQUENCE	Kqms	QUARTZ MONZONITE, MONZONITE AND SYENITE
Qaf	ALLUVIAL FAN DEPOSITS	Tb	BASALTIC VOLCANIC ROCKS
Qb	BEACH DEPOSITS	Ti	INTRUSIVE ROCKS, UNDIVIDED
Qd	EOLIAN DEPOSITS	Tmb	BASALT AND ANDESITE
Qg	GLACIAL DEPOSITS, UNDIVIDED	Tmf	TUFFACEOUS FELSIC VOLCANIC ROCKS
Qgc	GLACIOALLUVIUM	Tmv	PALEOGENE VOLCANIC ROCKS, UNDIVIDED
Qgl	GLACIOLACUSTRINE DEPOSITS	Tpgr	GRANITIC ROCKS OF PALEOCENE AGE
Qgo	OUTWASH IN PLAINS, VALLEY TRAIN, AND FANS	Trc	COTTONWOOD BAY GREENSTONE
Qhg	YOUNG MORAINE DEPOSITS	Jmu	MAFIC AND ULTRAMAFIC PLUTONIC ROCKS
Qho	YOUNGER OUTWASH DEPOSITS	Trkb	BRUIN LIMESTONE MEMBER
Qlc	LANDSLIDE AND COLLUVIAL DEPOSITS	Trkm	MIDDLE MEMBER
Qm	MAJOR MORAINE AND KAME DEPOSITS	Trku	URSUS MEMBER
Qog	OLDER GLACIAL DEPOSITS	JPk	KAKHONAK COMPLEX
Qsl	LACUSTRINE, SWAMP, AND FINE SILT DEPOSITS	bu	BEDROCK UKNOWN
Jtk	TALKEETNA FORMATION		

LOCAL GEOLOGY LEGEND (SEE NOTE 7)

- BEDROCK
- BEDROCK, GLACIATED
- BEDROCK, TERRACED
- ALLUVIUM, UNDIVIDED
- ALLUVIUM, ACTIVE
- ALLUVIUM, INACTIVE
- ALLUVIUM GRAVEL TRANSVERSE BARS
- DRAINAGE CHANNEL
- TERRACE GRAVEL
- FAN DEPOSITS
- DEPOSITS OF STEEP ALPINE FANS
- COLLUVIUM
- SOLIFLUCTION DEPOSIT
- LANDSLIDE DEPOSITS
- FAN-DELTA DEPOSIT
- GLACIAL-LAKE DEPOSIT, UNDIFFERENTIATED
- GLACIAL-LAKE DEPOSIT, YOUNGEST
- GLACIAL-LAKE DEPOSIT, INTERMEDIATE AGE
- GLACIAL-LAKE DEPOSIT, OLDEST
- BEACH DEPOSITS
- DELTAIC DEPOSIT
- DRIFT, UNDIFFERENTIATED
- DRIFT OF BROOKS LAKE GLACIATION, NEWHALDEN STADE
- DRIFT OF BROOKS LAKE GLACIATION, ILIAMNA STADE
- DRIFT OF BROOKS LAKE GLACIATION, KVICHAK STADE
- DRIFT OF PRE-BROOKS LAKE AGE
- ICE-CONTACT MELTWATER DEPOSIT
- INACTIVE ROCK-GLACIER DEPOSIT
- INWASH DEPOSIT
- LAKE DEPOSITS
- OUTWASH, UNDIFFERENTIATED
- OUTWASH ASSOCIATED WITH DRIFT OF NEWHALEN STADE
- OUTWASH ASSOCIATED WITH DRIFT OF ILIAMNA STADE
- OUTWASH ASSOCIATED WITH DRIFT OF KVICHAK STADE
- DUNESAND
- GRAVEL, UNDIFFERENTIATED
- MARSH DEPOSITS
- SILT
- SILT, ICE-RICH
- TALUS RUBBLE, UNDIVIDED
- SWAMP DEPOSIT
- SAND DEPOSITS, UNDIFFERENTIATED

THIS BAR MEASURES 100 mm AT FULL SIZE ALL SCALES REFERENCED TO FULL SIZE

NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 50 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. LOCAL GEOLOGY SIMPLIFIED AFTER "SURFICIAL GEOLOGIC MAP OF THE PEBBLE LIMITED PARTNERSHIPS PEBBLE PROJECT," HAMILTON, T.D., 2007.
6. AREA R GEOLOGY SIMPLIFIED AFTER "PROVISIONAL SURFICIAL GEOLOGIC MAP OF PEBBLE LIMITED PARTNERSHIP'S AREA R, HAMILTON, T.D., 2011.
7. SIMPLIFIED LEGEND AFTER HAMILTON, T.D., 2007 AND HAMILTON, T.D., 2011.
8. DIGITAL DATA FOR THE REGIONAL GEOLOGY FROM THE PRELIMINARY GEOLOGIC MAP OF THE COOK INLET REGION, ALASKA, U.S. GEOLOGICAL SURVEY.
9. SIMPLIFIED LEGEND BASED ON SCIENTIFIC INVESTIGATIONS MAP 3153, U.S. GEOLOGICAL SURVEY, HTTPS://PUBS.USGS.GOV/SIM/3153/SIM3153_PAMPHLET.PDF.
10. SURFICIAL GEOLOGY CROSS-SECTION LABELS REPRODUCED FROM PLP EBD CH 8, DATED JUNE 1, 2011.
11. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
12. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

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DATE:	MAY 2019
DRAWN:	JVC, JVT
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL

TITLE: REGIONAL SURFICIAL GEOLOGY MAP

PROJECT No.:	DWG No.:
1872-002	04

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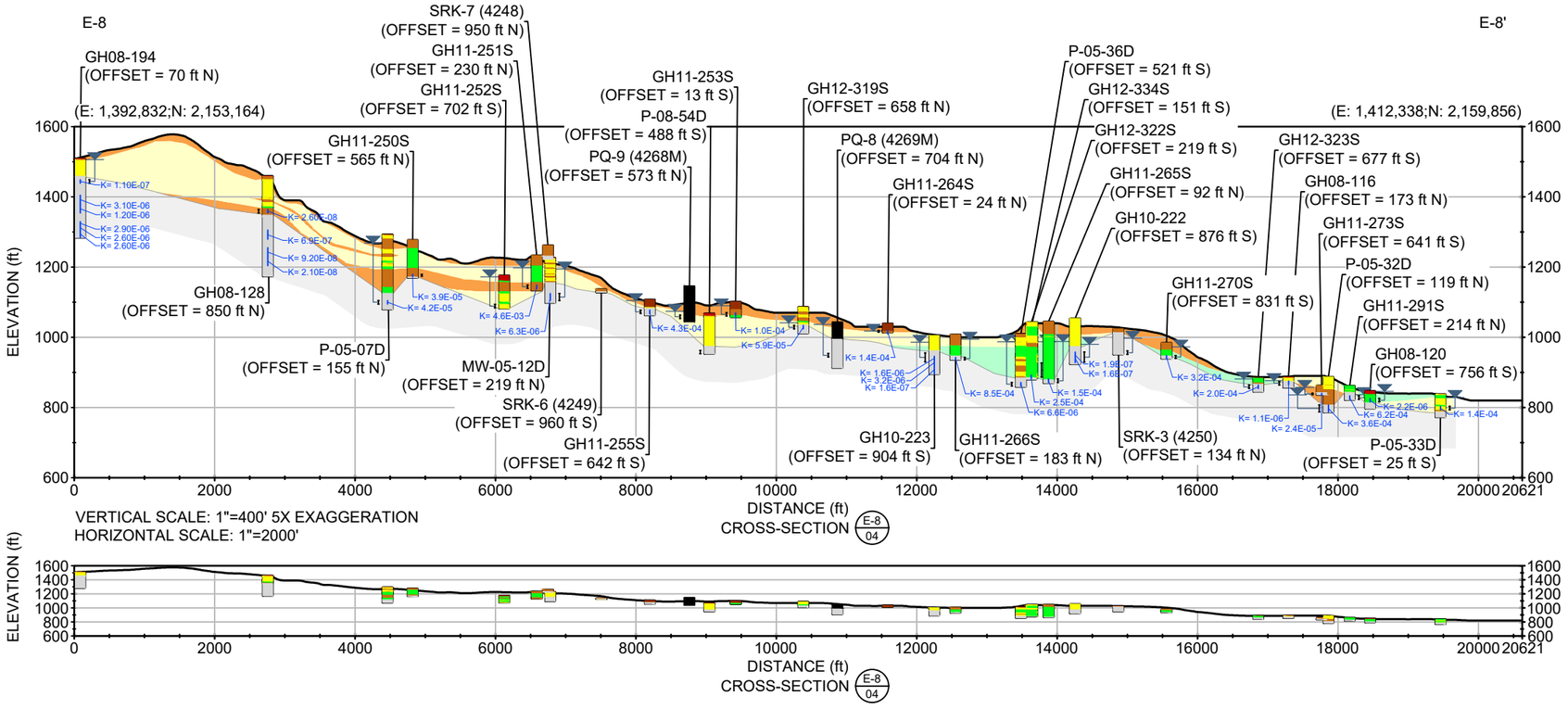
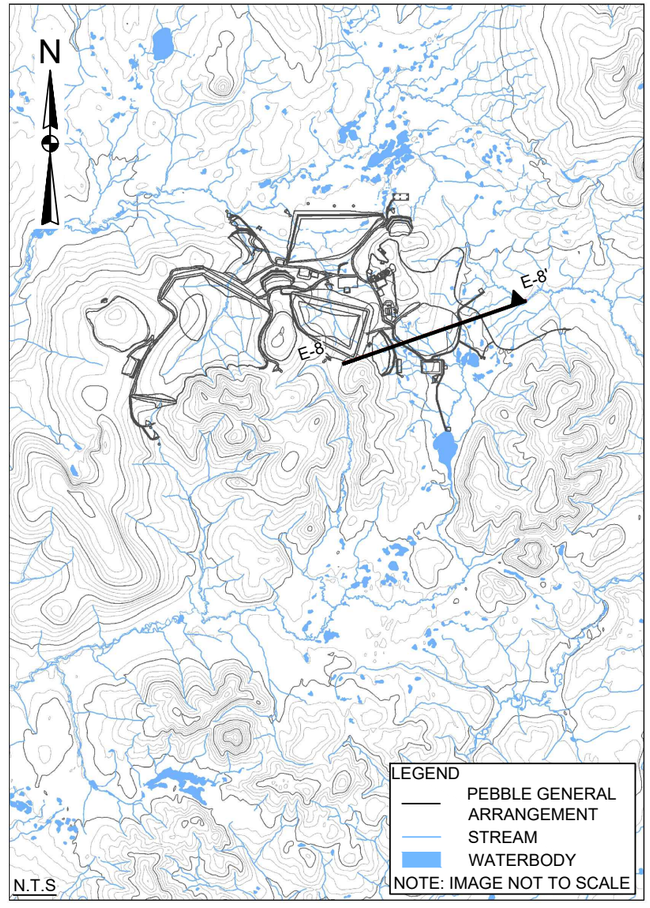


VERTICAL SCALE: 1"=400' 5X EXAGGERATION
HORIZONTAL SCALE: 1"=2000'



LEGEND

- SCREENED INTERVAL
- HYDRAULIC CONDUCTIVITY TEST INTERVAL (SEE NOTE 4)

BOREHOLE UNITS

- NO RECOVERY
- OVERBURDEN
- PEAT
- CLAY / SILTY CLAY
- SAND / SILTY SAND
- GRAVEL / GRAVELLY SAND
- BEDROCK

SCALE 1" = 2,000'

1,000 0 1,000 2,000 3,000

FEET

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

NOTES:

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON CONTOURS PROVIDED BY PEBBLE, DATED SEPTEMBER 28, 2018.
4. HYDRAULIC CONDUCTIVITY DATA PRESENTED IN UNITS OF FT/S.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

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DATE:	MAY 2019
DRAWN:	WKL
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: The Pebble Partnership

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: SURFICIAL GEOLOGY CROSS-SECTION E-8

PROJECT No.: 1872-002

DWG No.: 05

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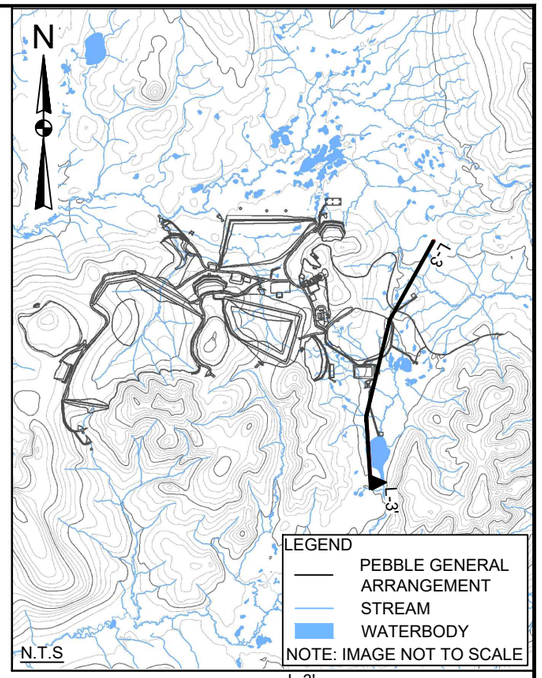

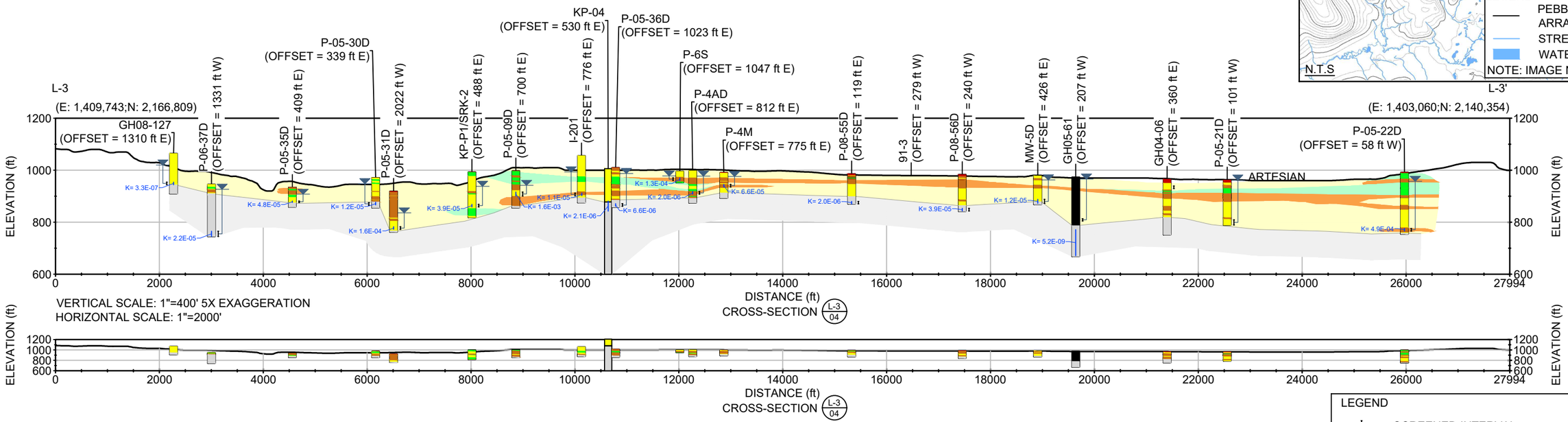

VERTICAL SCALE: 1"=400' 5X EXAGGERATION
HORIZONTAL SCALE: 1"=2000'

LEGEND

- SCREENED INTERVAL
- HYDRAULIC CONDUCTIVITY TEST INTERVAL (SEE NOTE 4)

BOREHOLE UNITS

- NO RECOVERY
- OVERBURDEN
- PEAT
- CLAY / SILTY CLAY
- SAND / SILTY SAND
- GRAVEL / GRAVELLY SAND
- BEDROCK

SCALE 1" = 2,000'

1,000 0 1,000 2,000 3,000

FEET

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NOTES:

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3. BASE TOPOGRAPHIC DATA BASED ON CONTOURS PROVIDED BY PEBBLE, DATED SEPTEMBER 28, 2018.
4. HYDRAULIC CONDUCTIVITY DATA PRESENTED IN UNITS OF FT/S.
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DATE:	MAY 2019
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CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

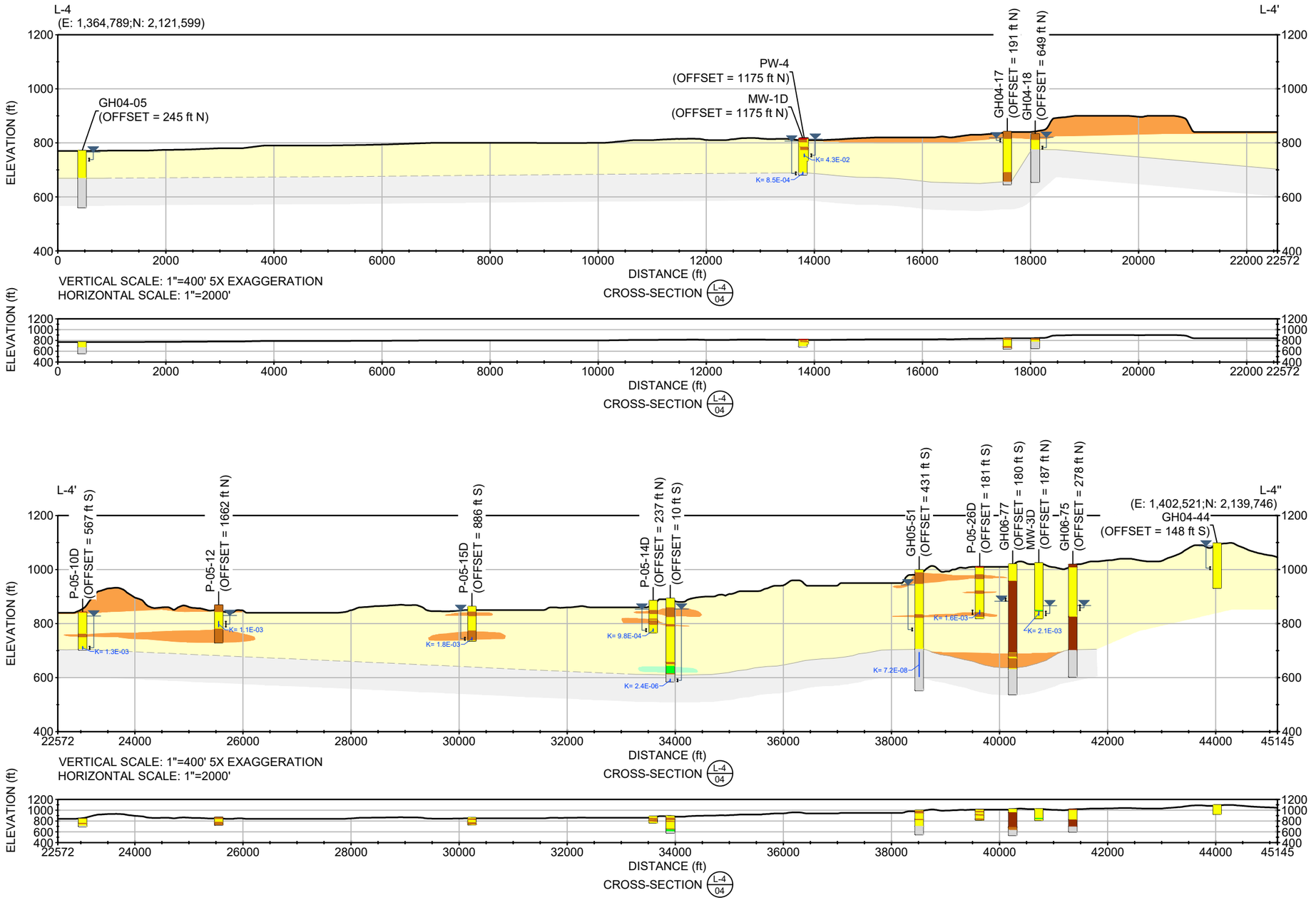
PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: SURFICIAL GEOLOGY CROSS-SECTION L-3

PROJECT No.: 1872-002

DWG No.: 06

X:\Projects\1872_Pebble_Mine\CAD\Production\Report-Memo\20190221_PEBBLE_PROJECT-NUMERICAL_GROUNDWATER_MODEL\05-07.dwg Layout: 06 Plot Date: May 23 19 Time: 5:49 PM



LEGEND

- SCREENED INTERVAL
- HYDRAULIC CONDUCTIVITY TEST INTERVAL (SEE NOTE 4)

BOREHOLE UNITS

- NO RECOVERY
- OVERBURDEN
- PEAT
- CLAY / SILTY CLAY
- SAND / SILTY SAND
- GRAVEL / GRAVELLY SAND
- BEDROCK

SCALE 1" = 2,000'

1,000 0 1,000 2,000 3,000

FEET

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NOTES:

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3. BASE TOPOGRAPHIC DATA BASED ON CONTOURS PROVIDED BY PEBBLE, DATED SEPTEMBER 28, 2018.
4. HYDRAULIC CONDUCTIVITY DATA PRESENTED IN UNITS OF FT/S.
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DATE:	MAY 2019
DRAWN:	WKL
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: SURFICIAL GEOLOGY CROSS-SECTION L-4

PROJECT No.: 1872-002

DWG No.: 07

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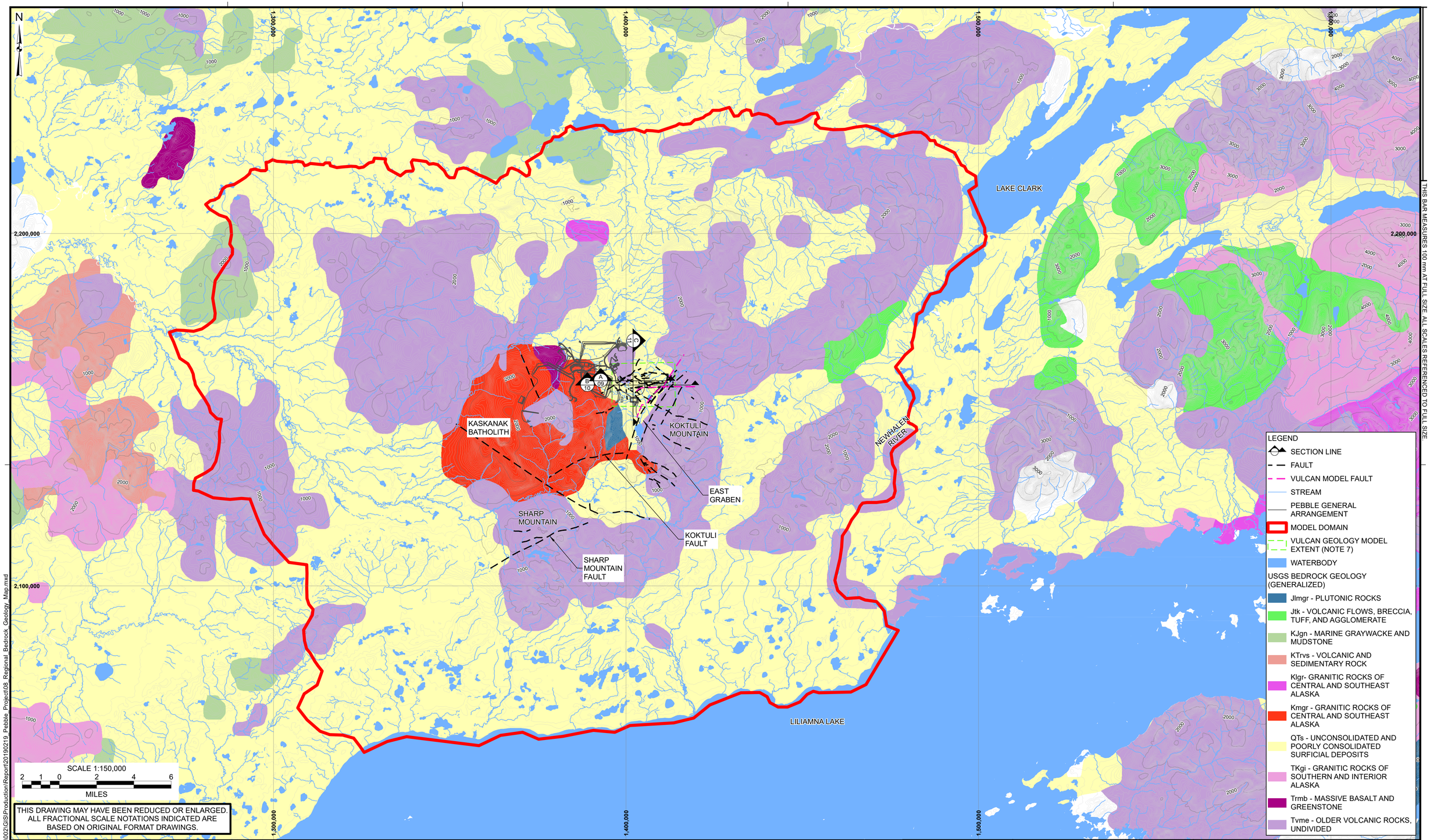

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NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 50 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. DIGITAL DATA FOR THE BEDROCK GEOLOGY FROM THE GEOLOGIC MAP OF ALASKA, U.S. GEOLOGICAL SURVEY.
6. REGIONAL FAULT DATA PROVIDED BY PEBBLE, DATED SEPTEMBER 12, 2018.
7. LOCAL GEOLOGY AND FAULT DATA PROVIDED AS VULCAN MODEL FILES BY PEBBLE, DATED SEPTEMBER 12, 2018.
8. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
9. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

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DATE:	MAY 2019
DRAWN:	JVC, JVT
CHECKED:	RT
APPROVED:	TC

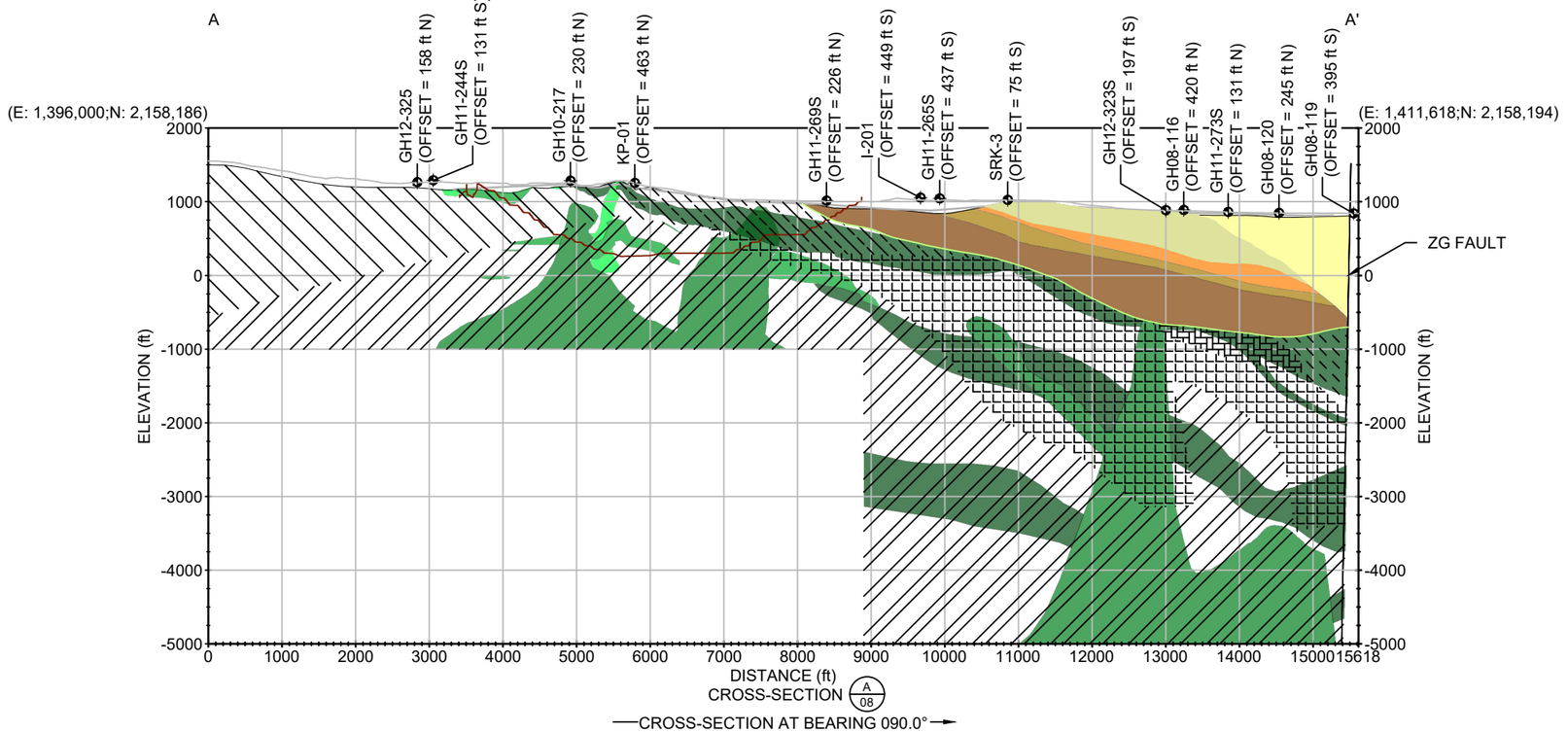
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

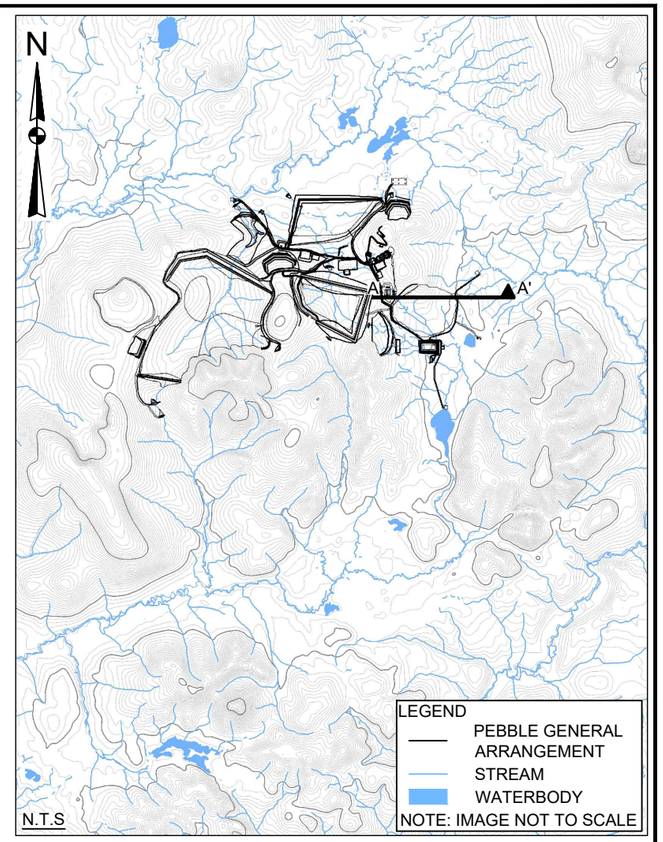
CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: REGIONAL BEDROCK GEOLOGY MAP

PROJECT No.:	DWG No.:
1872-002	08





LEGEND

PROPOSED OPEN PIT

TERTIARY / CRETACEOUS CONTACT

INTERPRETED GEOLOGY (NOTE 4)

TERTIARY

- BASALT
- COBBLE CONGLOMERATE
- WACKE
- MUDSTONE-SILTSTONE
- PEBBLE CONGLOMERATE

CRETACEOUS

- GRANODIORITE SILL
- GRANODIORITE PLUTON
- DIORITE SILL
- MEGA BRECCIA
- UNDIFFERENTIATED SEDIMENTS

ALTERATION TYPE

- SODIC-POTASSTIC
- ILLITE-PYRITE
- POTASSTIC-SILICATE
- SODIC-CALCIC-POTASSTIC
- QUARTZ-SERICITE-PYRITE
- SERICITIC

SCALE 1" = 2,000'

1,000 0 1,000 2,000 3,000

FEET

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

NOT FOR CONSTRUCTION. FOR PRELIMINARY CONCEPTUAL PURPOSES ONLY.

NOTES:

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2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON EAGM_ELEVATION_ONTOURS_2400_5FT PROVIDED BY PEBBLE, DATED SEPTEMBER 11, 2018.
4. INTERPRETED GEOLOGY AND ALTERATION IS FROM GEOLOGICAL MODEL FILES RECEIVED FROM PEBBLE SEPTEMBER 12, 2018.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1":2,000'
DATE:	MAY 2019
DRAWN:	RH
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: BEDROCK GEOLOGY CROSS SECTION A

PROJECT No.: 1872-002

DWG No.: 09

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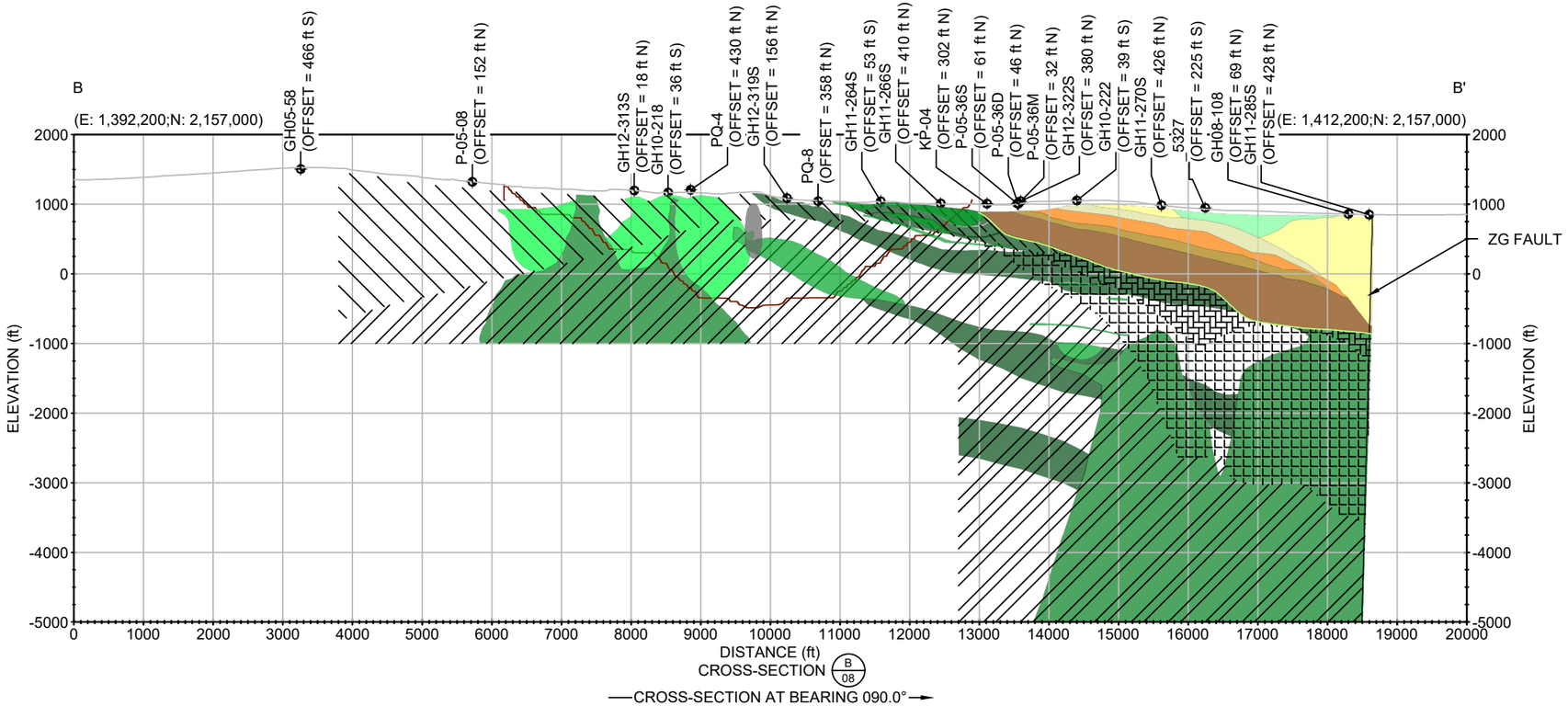

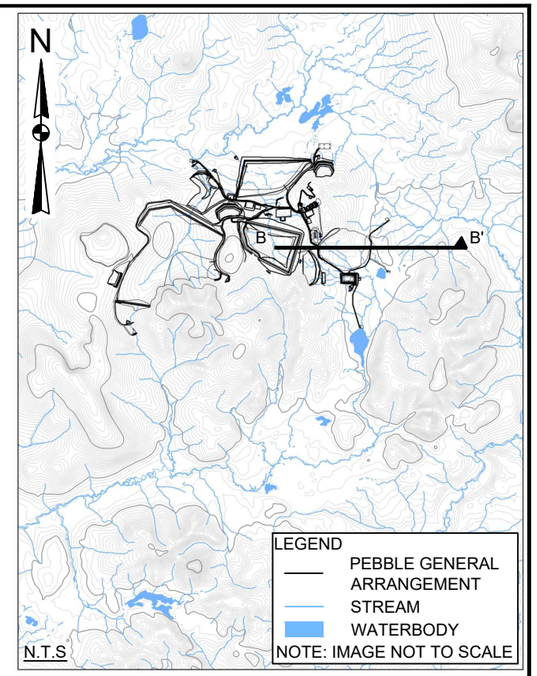

LEGEND

PROPOSED OPEN PIT

TERTIARY / CRETACEOUS CONTACT

INTERPRETED GEOLOGY (NOTE 4)

TERTIARY

- BASALT
- COBBLE CONGLOMERATE
- WACKE
- MUDSTONE-SILTSTONE
- PEBBLE CONGLOMERATE

CRETACEOUS

- GRANODIORITE SILL
- GRANODIORITE PLUTON
- DIORITE SILL
- MEGA BRECCIA
- FELSIC FRAGMENTED ROCK
- UNDIFFERENTIATED SEDIMENTS

ALTERATION TYPE

- SODIC-POTASSTIC
- ILLITE-PYRITE
- POTASSTIC-SILICATE
- SODIC-CALCIC-POTASSTIC
- QUARTZ-SERICITE-PYRITE
- SERICITIC
- DDH8431 ALTERATION

SCALE 1" = 2,000'

1,000 0 1,000 2,000 3,000

FEET

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

NOT FOR CONSTRUCTION. FOR PRELIMINARY CONCEPTUAL PURPOSES ONLY.

NOTES:

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON EAGM_ELEVATION_ONTOURS_2400_5FT PROVIDED BY PEBBLE, DATED SEPTEMBER 11, 2018.
4. INTERPRETED GEOLOGY AND ALTERATION IS FROM GEOLOGICAL MODEL FILES RECEIVED FROM PEBBLE SEPTEMBER12, 2018.
5. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1":2,000'
DATE:	MAY 2019
DRAWN:	RH
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: BEDROCK GEOLOGY CROSS SECTION B

PROJECT No.: 1872-002

DWG No.: 10

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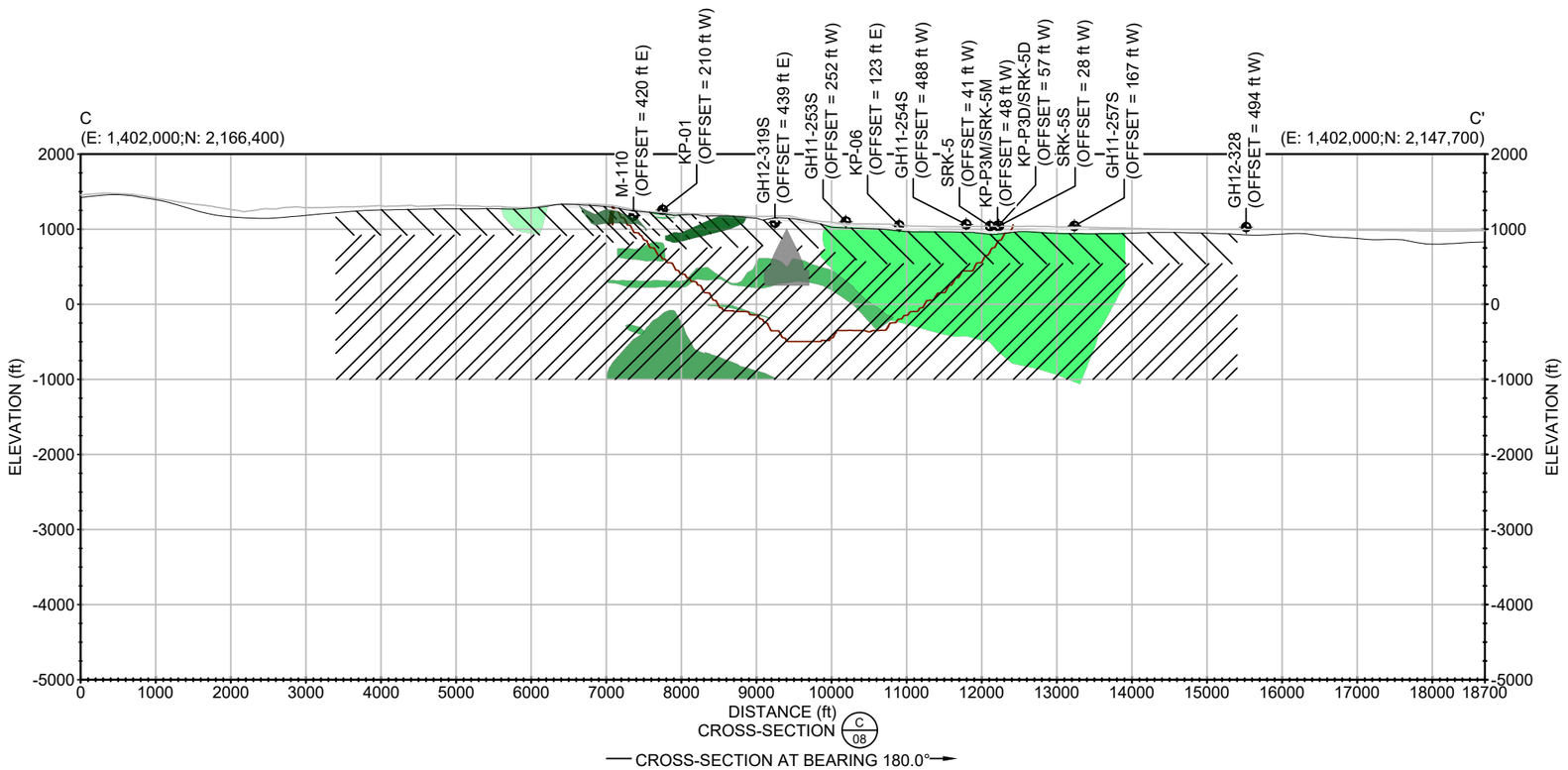

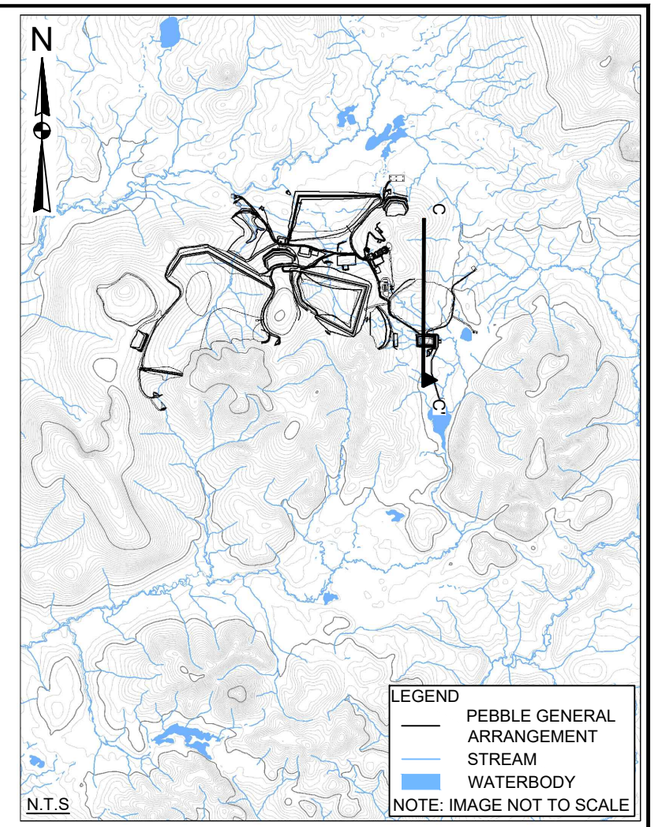

LEGEND

PROPOSED OPEN PIT

INTERPRETED GEOLOGY (NOTE 4)

TERTIARY

- BASALT
- COBBLE CONGLOMERATE
- WACKE
- MUDSTONE-SILTSTONE
- PEBBLE CONGLOMERATE

CRETACEOUS

- GRANODIORITE SILL
- GRANODIORITE PLUTON
- DIORITE SILL
- MEGA BRECCIA
- GABBRO
- UNDIFFERENTIATED SEDIMENTS

ALTERATION TYPE

- SODIC-POTASSTIC
- ILLITE-PYRITE
- POTASSTIC-SILICATE
- SODIC-CALCIC-POTASSTIC
- QUARTZ-SERICITE-PYRITE
- DDH8431 ALTERATION

SCALE 1" = 2,000'

1,000 0 1,000 2,000 3,000

FEET

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NOT FOR CONSTRUCTION. FOR PRELIMINARY CONCEPTUAL PURPOSES ONLY.

NOTES:

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2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT: NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON EAGM_ELEVATION_ONTOURS_2400_5FT PROVIDED BY PEBBLE, DATED SEPTEMBER 11, 2018.
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DATE:	MAY 2019
DRAWN:	RH
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: BEDROCK GEOLOGY CROSS SECTION C

PROJECT No.: 1872-002

DWG No.: 11

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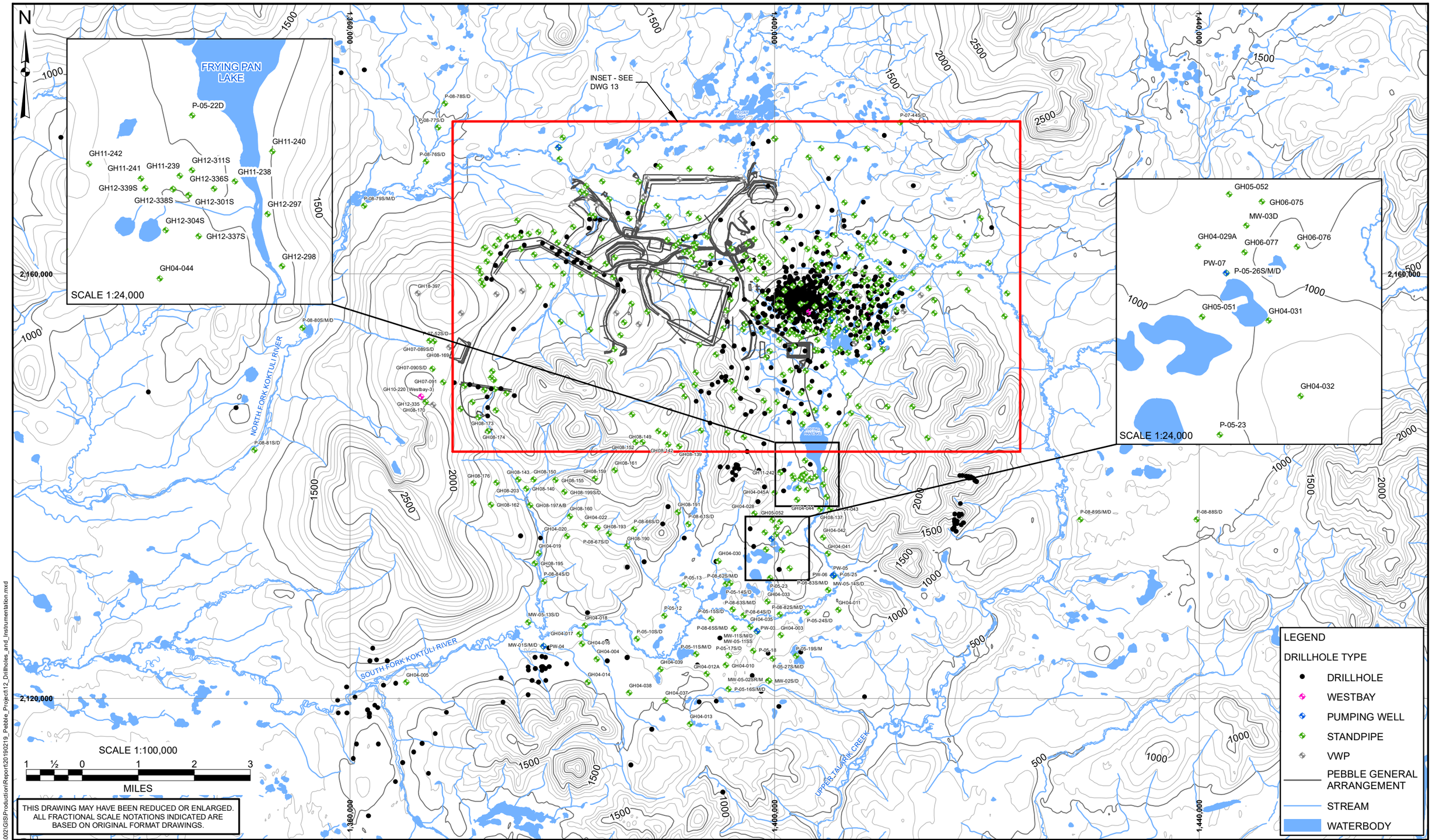

NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018 PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. DRILLHOLES NOT LABELLED UNLESS INSTRUMENTED.
6. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
7. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1:100,000
DATE:	MAY 2019
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CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: DRILLHOLES AND INSTRUMENTATION

PROJECT No.:	DWG No:
1872-002	12

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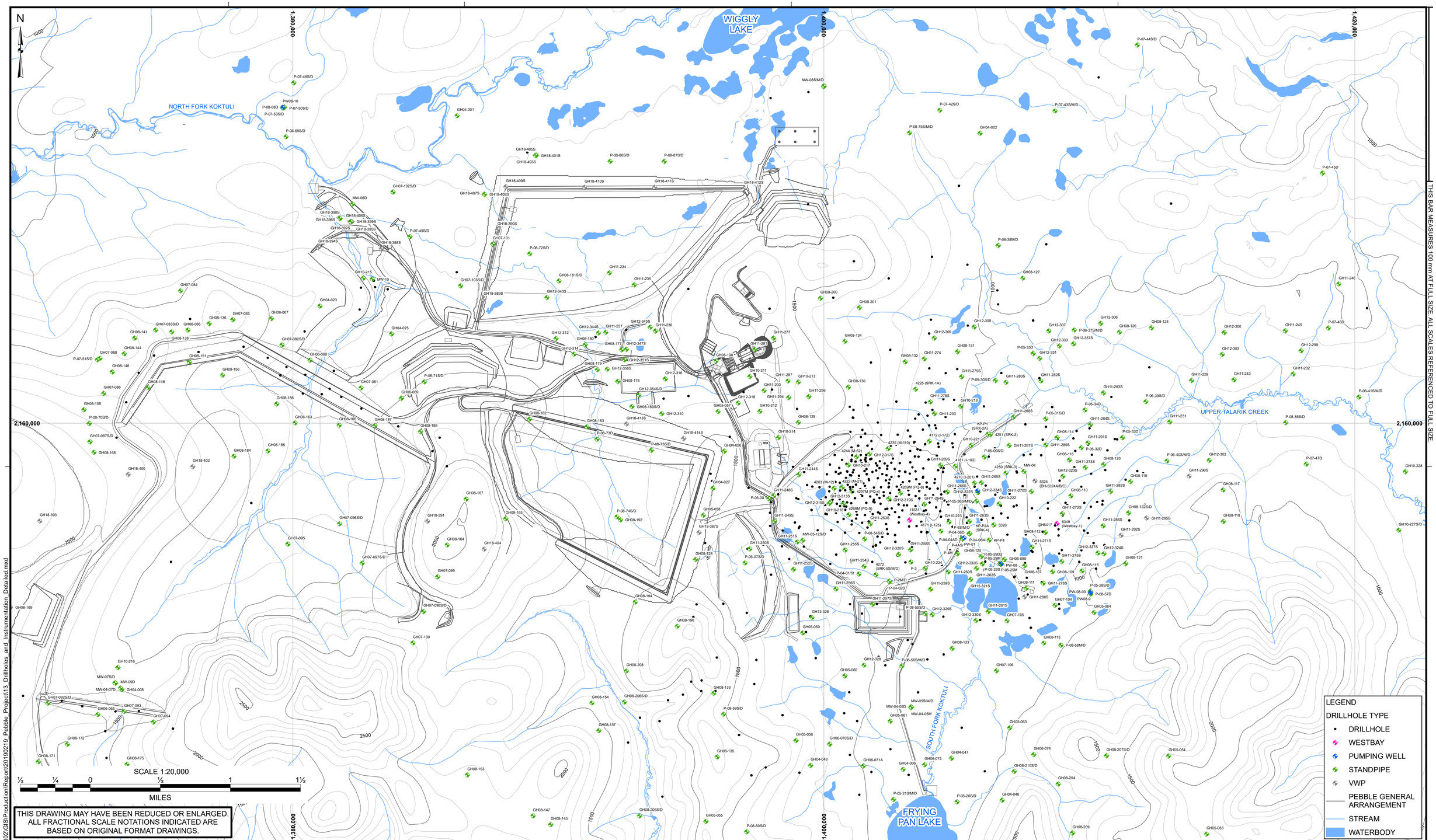

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NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018 PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. DRILLHOLES NOT LABELLED UNLESS INSTRUMENTED.
6. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
7. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

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CHECKED:	RT
APPROVED:	TC

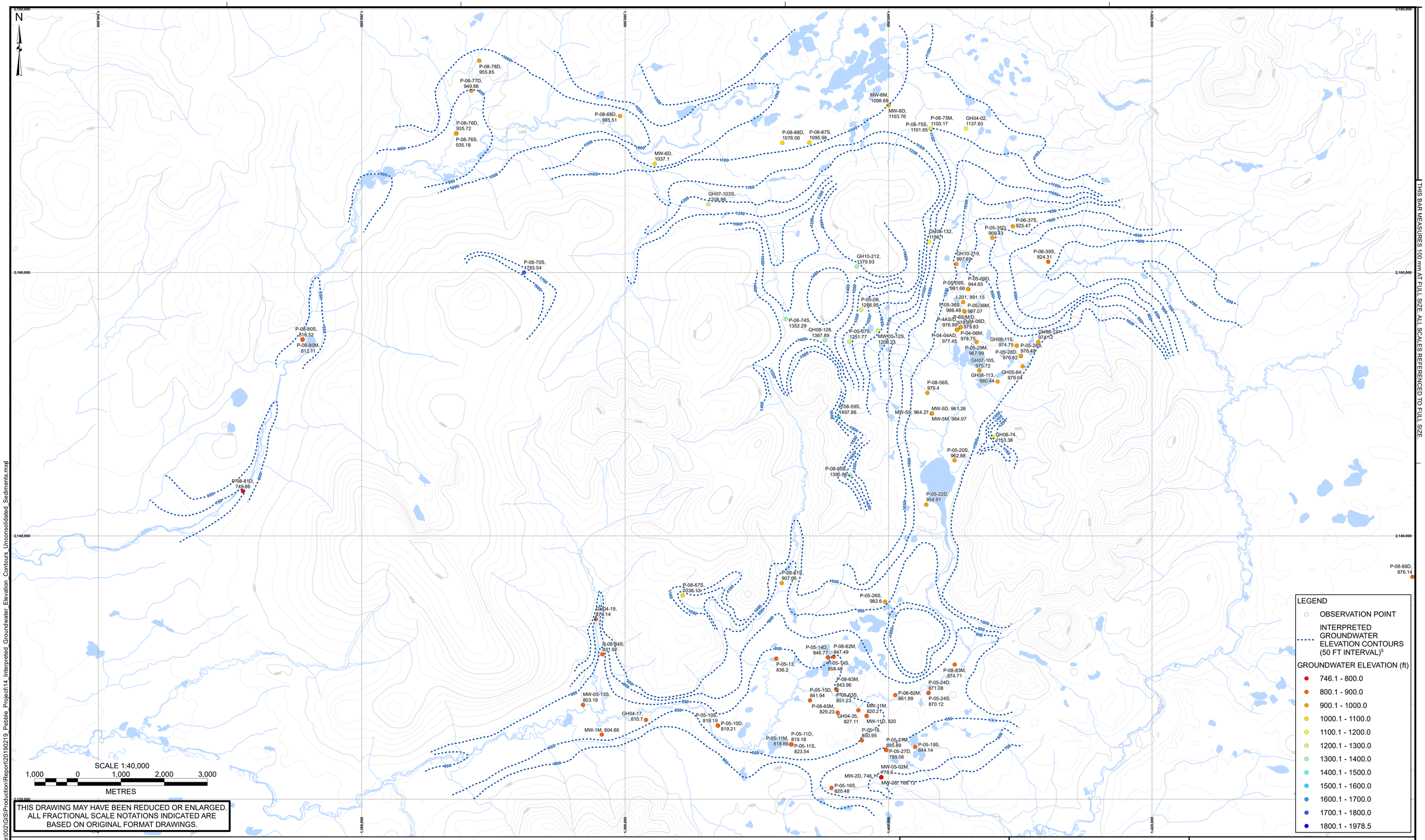
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: DRILLHOLES AND INSTRUMENTATION (DETAIL VIEW)

PROJECT No.:	DWG No.:
1872-002	13



NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018 PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. GROUNDWATER ELEVATION CONTOURS BASED ON GROUNDWATER LEVELS MEASURED IN WELLS COMPLETED IN UNCONSOLIDATED MATERIALS, APRIL 2011. DASHED LINES USED TO INDICATE INTERPRETED NATURE OF GROUNDWATER ELEVATION CONTOURS.
6. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
7. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1:40,000
DATE:	MAY 2019
DRAWN:	JVT
CHECKED:	RT
APPROVED:	TC

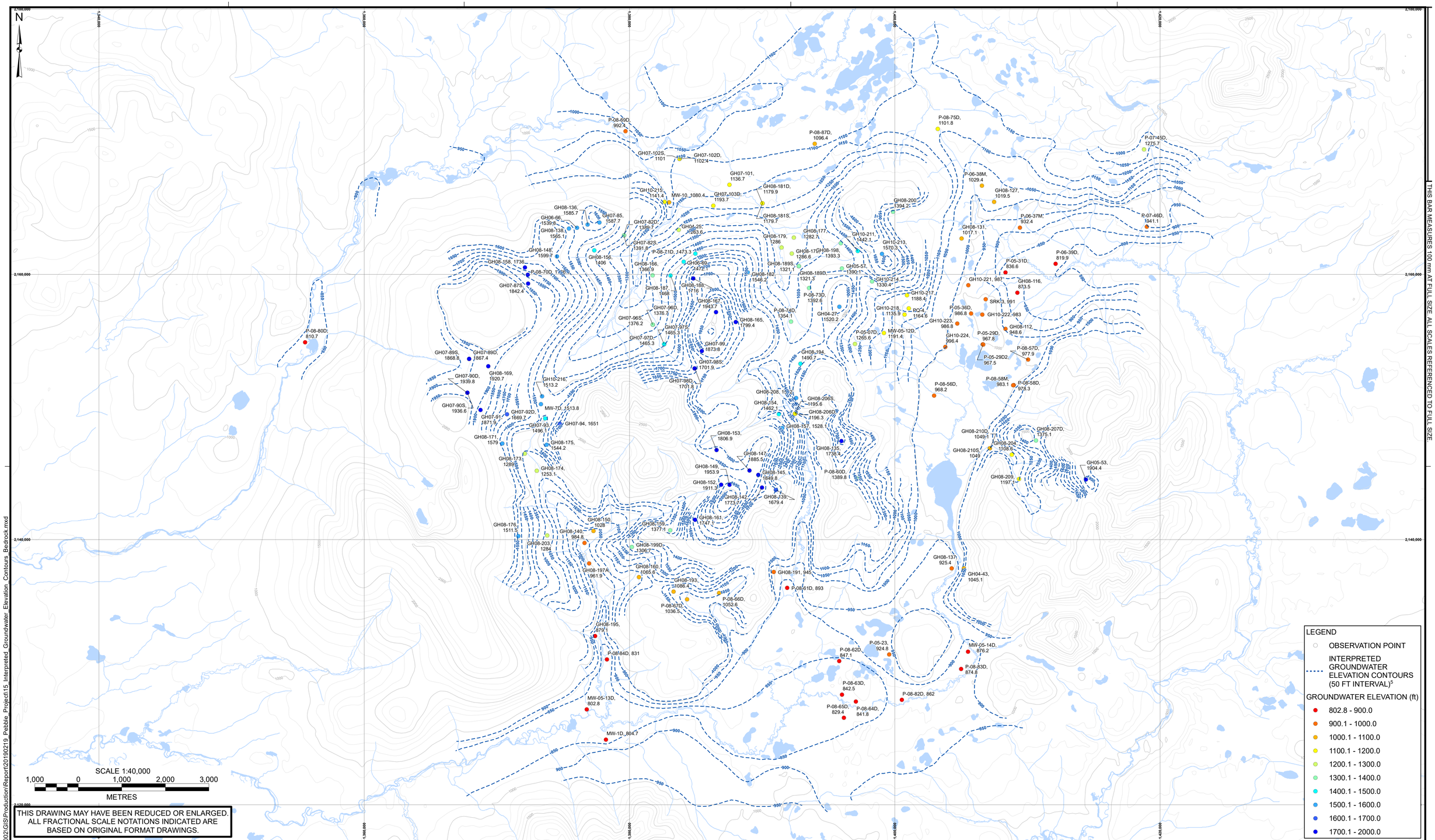
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: INTERPRETED GROUNDWATER ELEVATION CONTOURS (UNCONSOLIDATED SEDIMENTS)

PROJECT No.:	DWG No.:
1872-002	14



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NOTES:
1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "PEBBLE PROJECT NUMERICAL GROUNDWATER FLOW MODEL", AND DATED MAY 2019.
3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018 PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. GROUNDWATER ELEVATION CONTOURS BASED ON GROUNDWATER LEVELS MEASURED IN WELLS COMPLETED IN BEDROCK, APRIL 2011. DASHED LINES USED TO INDICATE INTERPRETED NATURE OF GROUNDWATER ELEVATION CONTOURS.
6. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
7. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

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DATE:	MAY 2019
DRAWN:	JVT
CHECKED:	RT
APPROVED:	TC

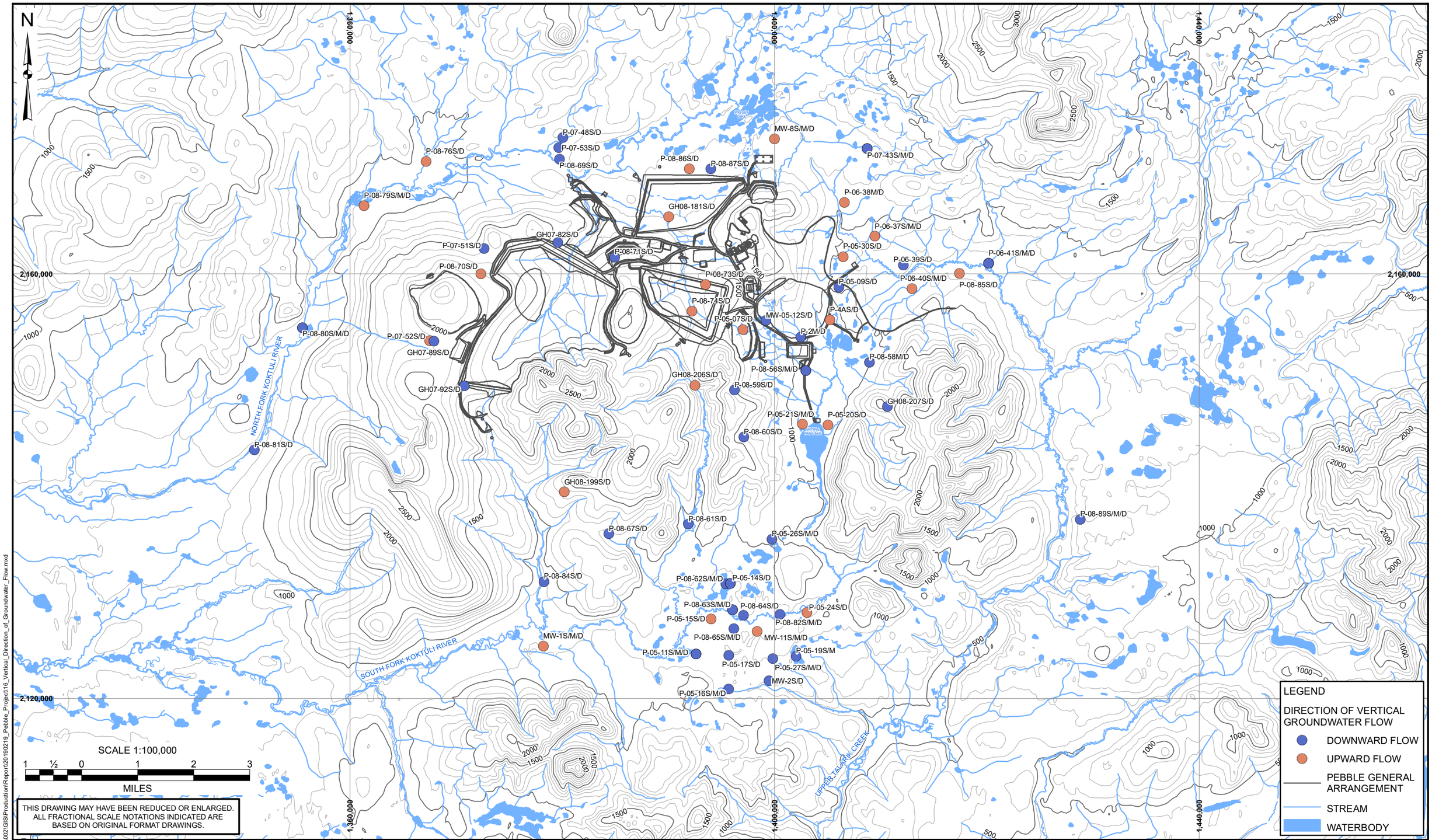
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: INTERPRETED GROUNDWATER ELEVATION CONTOURS (BEDROCK)

PROJECT No.:	DWG No.:
1872-002	15



NOTES:
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3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET 2018 PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
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DATE:	MAY 2019
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CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: VERTICAL DIRECTION OF GROUNDWATER FLOW

PROJECT No.:	DWG No:
1872-002	16

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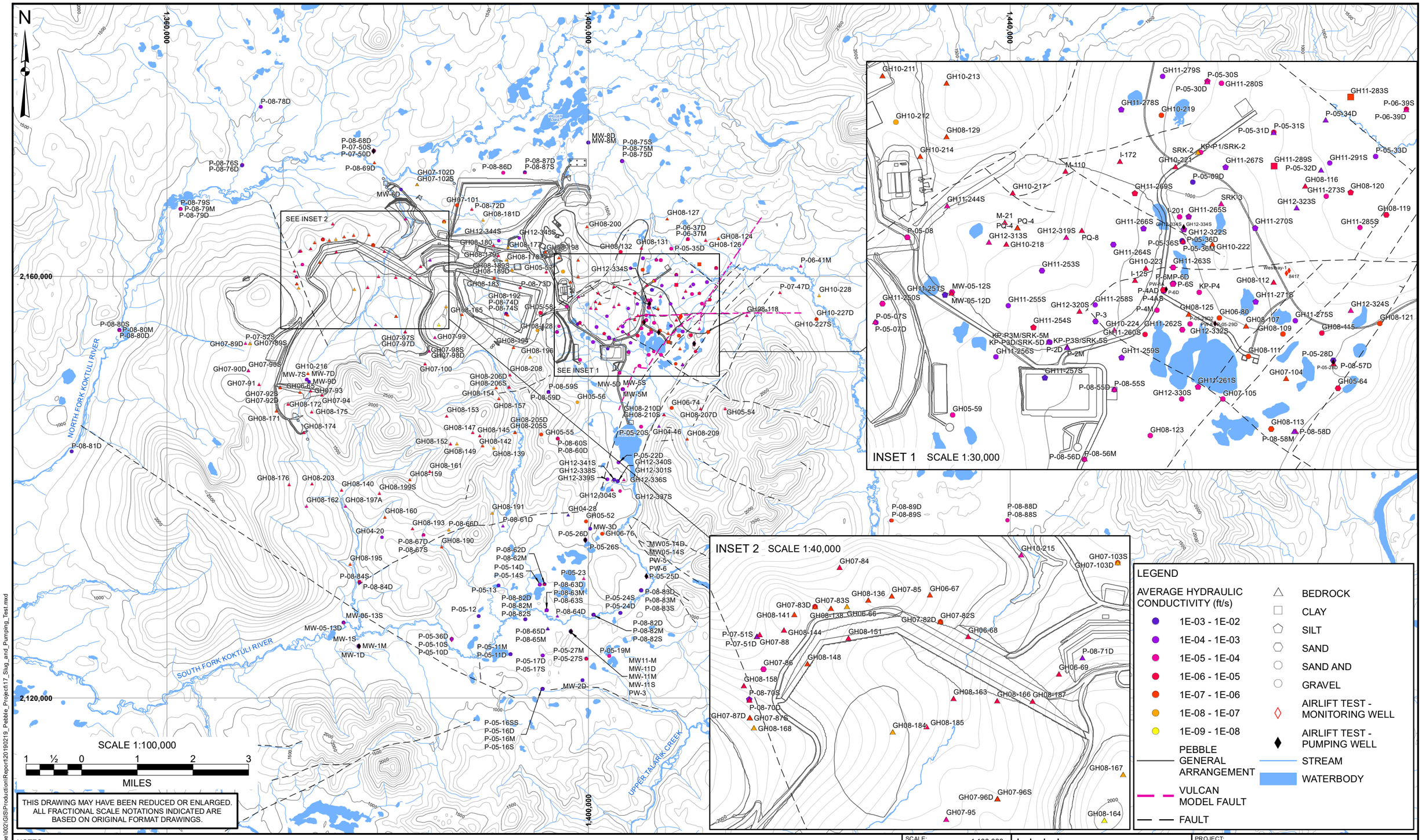

NOTES:
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3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. SLUG TESTING HYDRAULIC CONDUCTIVITY DATA BASED ON AVERAGE REPORTED VALUES.
6. REGIONAL FAULT DATA PROVIDED BY PEBBLE, DATED SEPTEMBER 12, 2018
7. LOCAL GEOLOGY AND FAULT DATA PROVIDED AS VULCAN MODEL FILES BY PEBBLE, DATED SEPTEMBER 12, 2018.
8. NO GEOLOGY DATA IS SHOWN IN RELATION TO AIRLIFT HYDRAULIC CONDUCTIVITY TEST DATA.
9. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
10. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1:100,000
DATE:	MAY 2019
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CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: SLUG AND PUMPING TEST DATA

PROJECT No.:	DWG No:
1872-002	17

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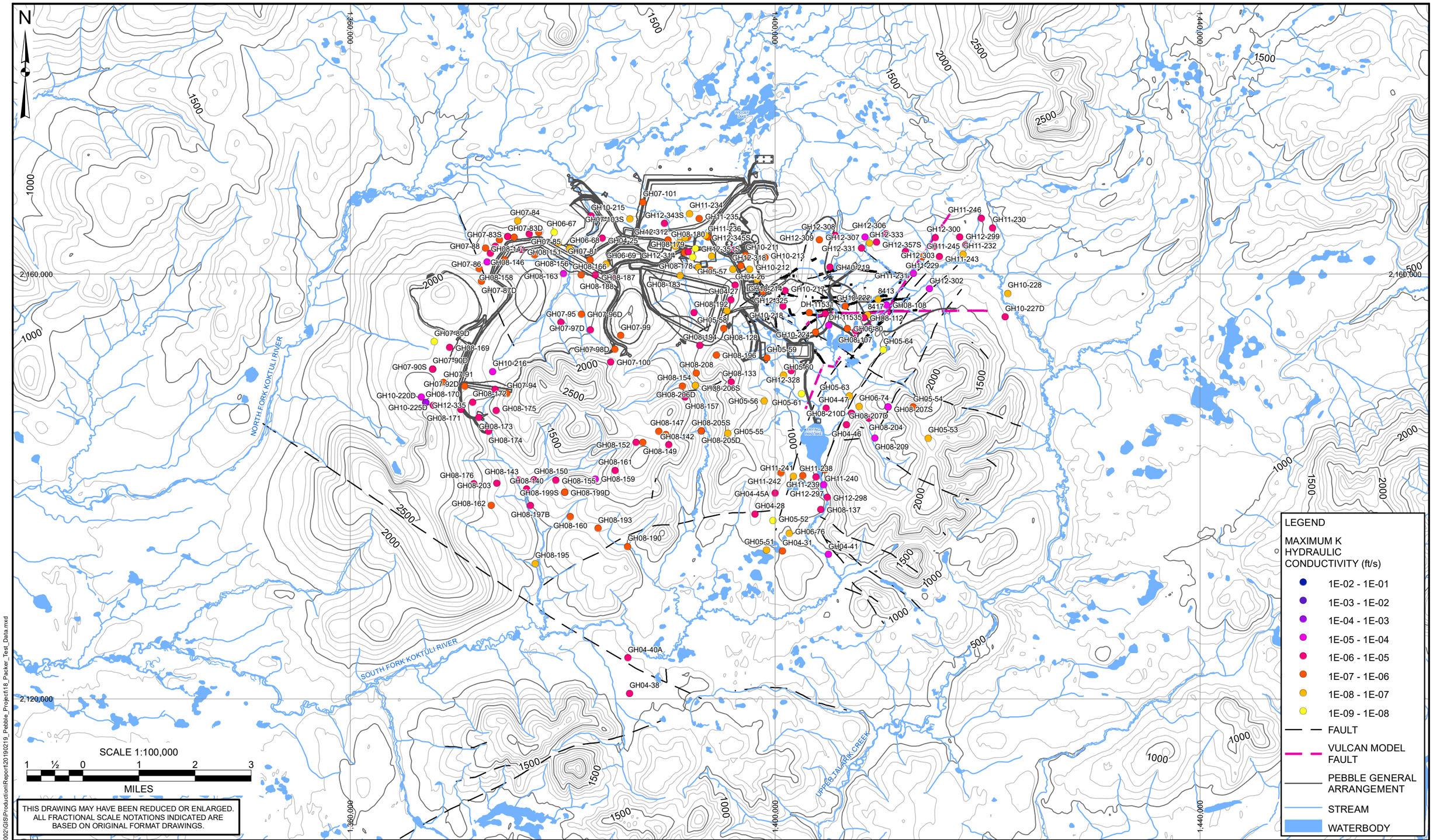

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3. BASE TOPOGRAPHIC DATA BASED ON USGS NATIONAL ELEVATION DATASET PROVIDED BY THE USGS, DATED JANUARY 08, 2018. CONTOUR INTERVAL IS 100 FEET.
4. GENERAL ARRANGEMENT PROVIDED BY PLP DECEMBER 19, 2018.
5. REGIONAL FAULT DATA PROVIDED BY PEBBLE, DATED SEPTEMBER 12, 2018.
6. LOCAL GEOLOGY AND FAULT DATA PROVIDED AS VULCAN MODEL FILES BY PEBBLE, DATED SEPTEMBER 12, 2018.
7. PACKER TESTING HYDRAULIC CONDUCTIVITY DATA PRESENTED IS THE MAXIMUM REPORTED TEST VALUE PER DRILLHOLE.
8. PROJECTION IS NAD 1983 STATEPLANE ALASKA 5 FIPS 5005 FEET. VERTICAL DATUM IS NAVD88.
9. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1:100,000
DATE:	MAY 2019
DRAWN:	JVC, JVT
CHECKED:	RT
APPROVED:	TC

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: THE pebble PARTNERSHIP

PROJECT: PEBBLE PROJECT
NUMERICAL GROUNDWATER FLOW MODEL

TITLE: PACKER TEST DATA

PROJECT No.: 1872-002

DWG No: 18

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