

Hydrogeologic Assessment Approach

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OCT 29 2021

Crook County
Community Development

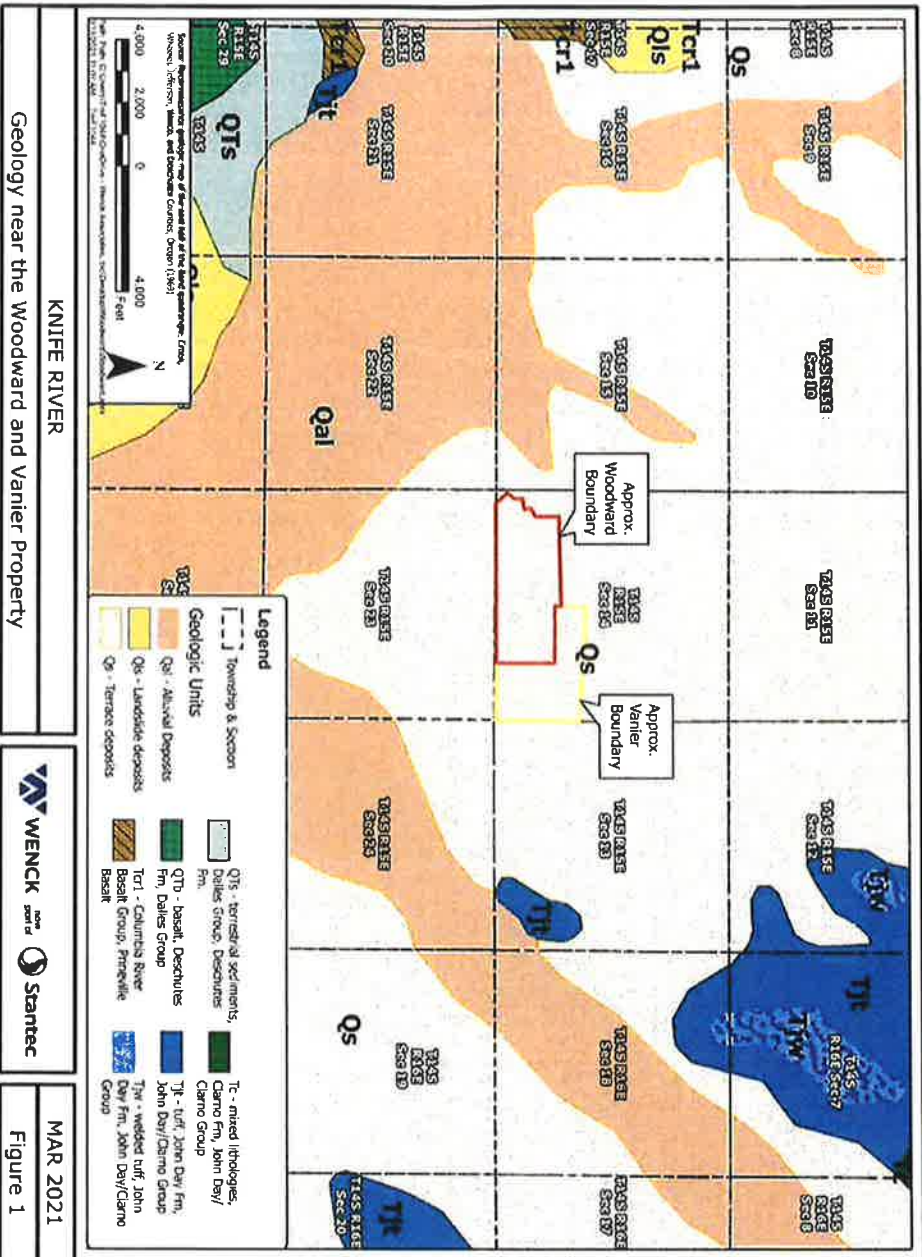
Identified water rights on file with the Oregon Water Resources Department

Reviewed geologic and hydrogeologic data

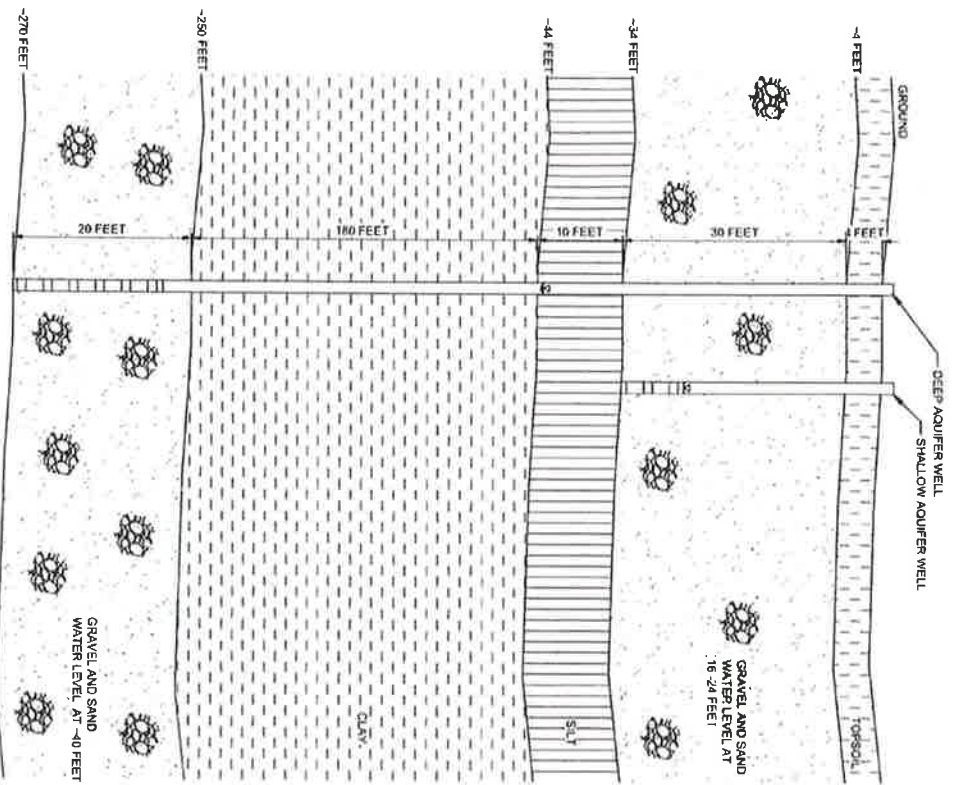
- Drilled and geologically logged three test wells to define site hydrogeologic conditions
- Completed aquifer tests on these wells to assess aquifer characteristics
- Cored and tested soils, overburden and gravels to address reclamation concerns
- Estimated potential groundwater inflows and identified potential recharge trench and monitoring well locations
- Evaluated reclamation plans and options



Geologic Setting



Terrace Deposits - Aquifer Configuration



Completed **A1400c** *Yrmael Mact Alan*

CROO 54339 **3/12/2016**

STATE OF OREGON
 WATER SUPPLY BUREAU REPORT
 (1) LAND USE (SEE SECTION 2) (SEE SECTION 410)

DATE OF REPORT: 3/12/2016
 WELL ID: A1400c
 STATE CARD #
 ORIGINAL LOG #

(2) TYPE OF WELL: DEEP WELL
 SHALLOW WELL
 OTHER

(3) WELL IDENTIFICATION: DEEP WELL
 SHALLOW WELL
 OTHER

(4) WELL METHOD: DRILL
 OTHER

(5) BORE HOLE CONSTRUCTION: SLAM
 OTHER

(6) CASING LINE: YES
 NO

(7) REPERFORATIONS: YES
 NO

(8) WELL TESTS: YES
 NO

(9) LOCATION OF WELL (Legal description):
 SECTION 20, T4N, R12E, S35
 DISTRICT 10, CLATSOP COUNTY, OREGON

(10) STATIC WATER LEVEL:
 DATE: 3/12/2016
 TIME: 10:00 AM
 LOCATION: 10 FEET FROM WELL HEAD

WELL LOG:
 DATE: 3/12/2016
 TIME: 10:00 AM
 LOCATION: 10 FEET FROM WELL HEAD

RECEIVED BY: LARRY
 DATE: 3/12/2016
 SIGNATURE: LARRY

This report was originally e-filed to the Department; the original e-filed document is attached.

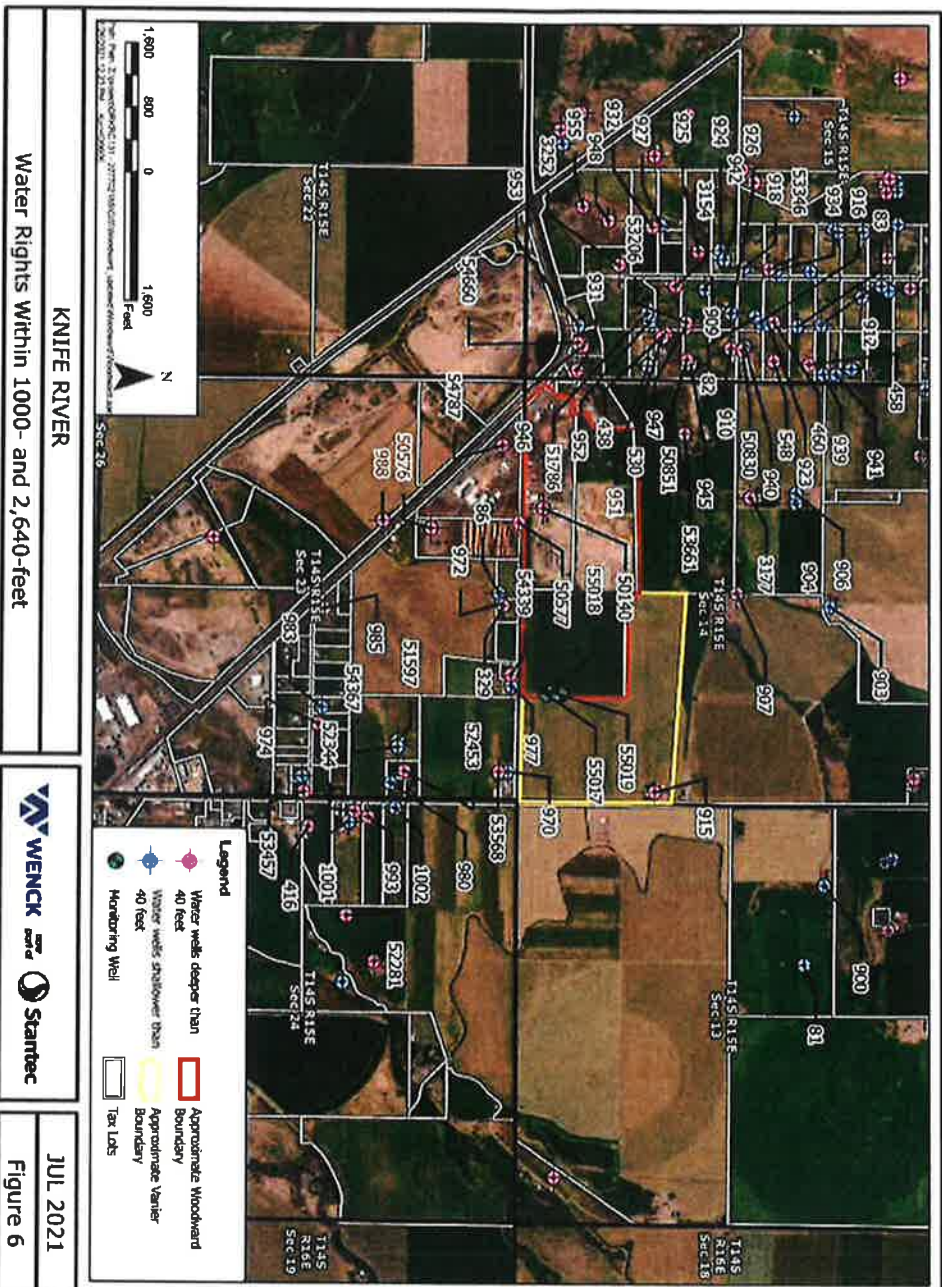
DATE SHIPPED: 3/12/2016
 DELIVERED TO: 3/12/2016
 DELIVERED BY: 3/12/2016

SPONSOR: **DEPARTMENT OF WATER RESOURCES**
 PROJECT: **WATER RESOURCES**
 CONTRACT NUMBER: **2016-001**
 DATE: **3/12/2016**

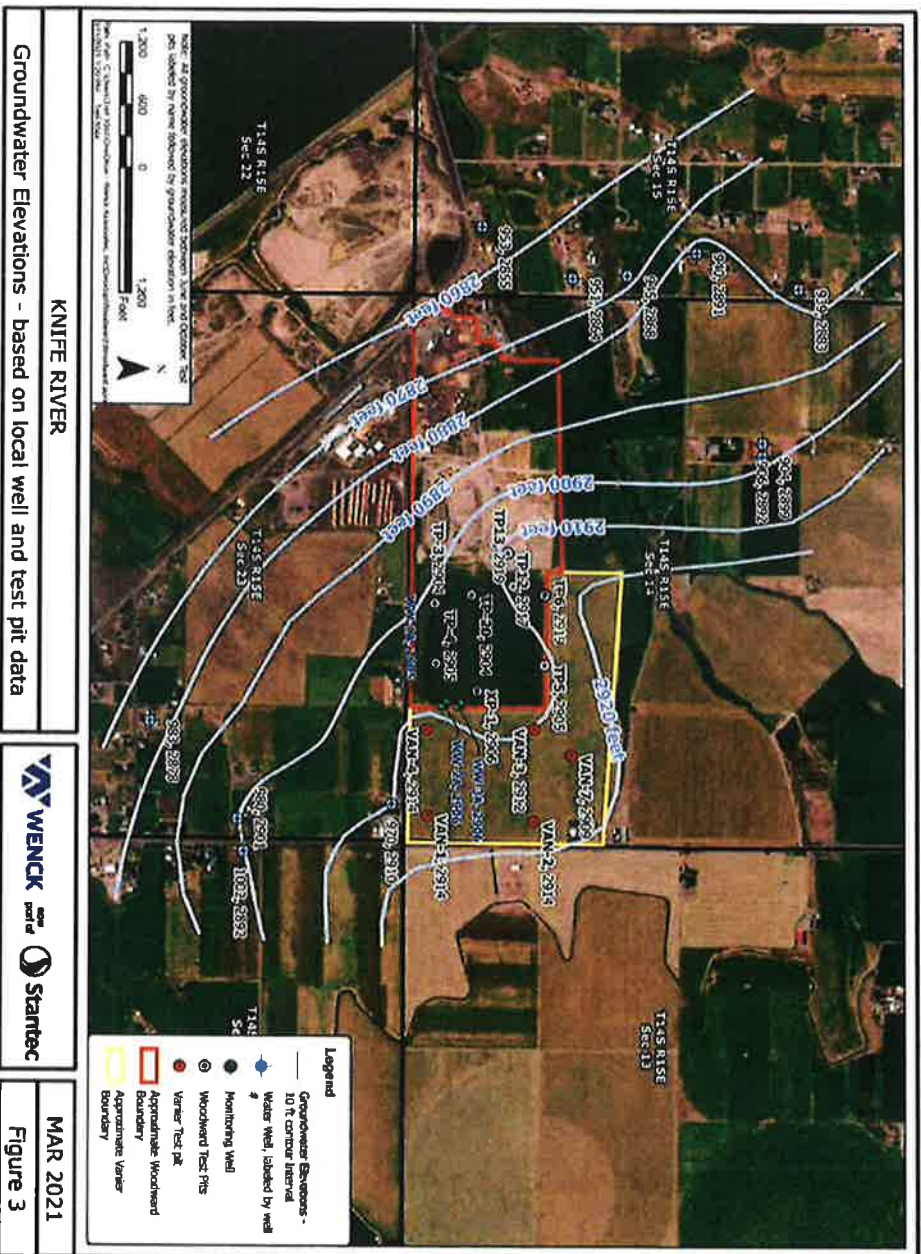
STATE OF OREGON
 WATER SUPPLY BUREAU
 1000 NE Oregon Street, Portland, Oregon 97232
 TEL: 503-231-7000 FAX: 503-231-7001
 WWW.OREGONWATERRESOURCES.ORG

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Local Water Wells



Groundwater Flow



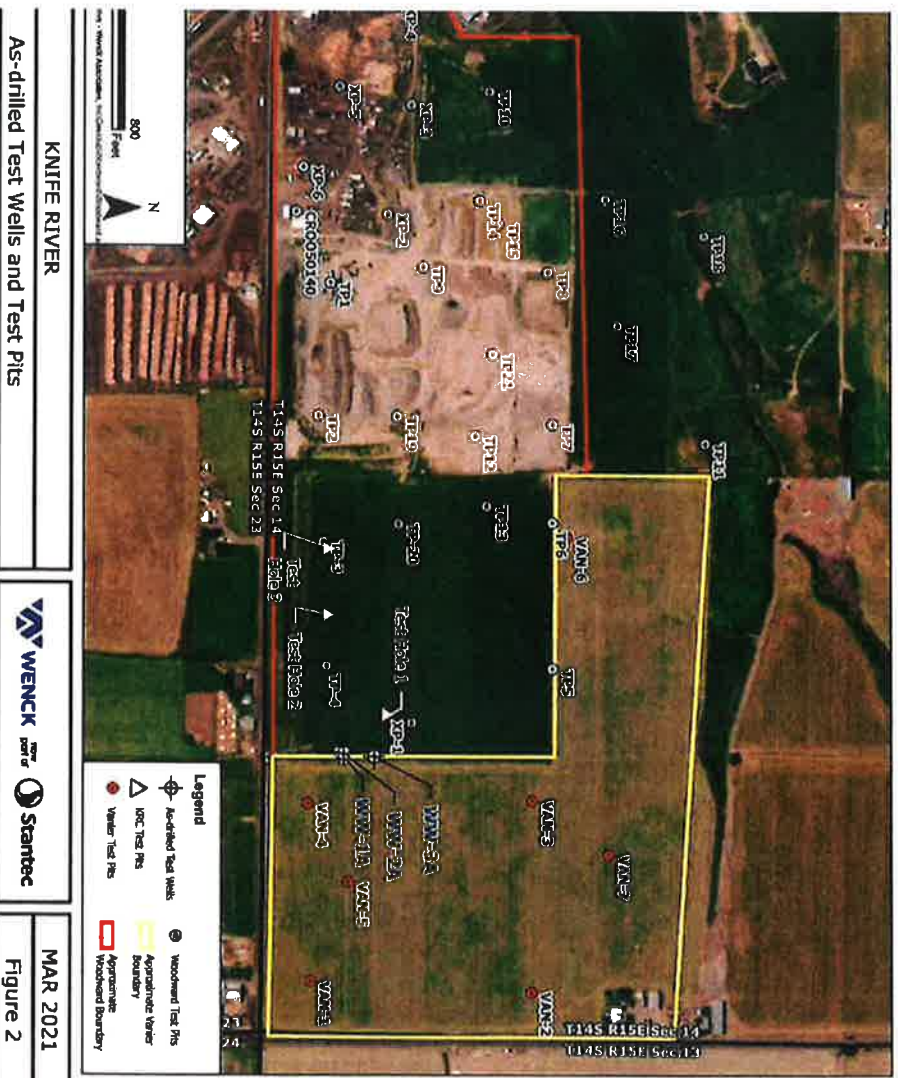
Groundwater Elevations - based on local well and test pit data



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Figure 3

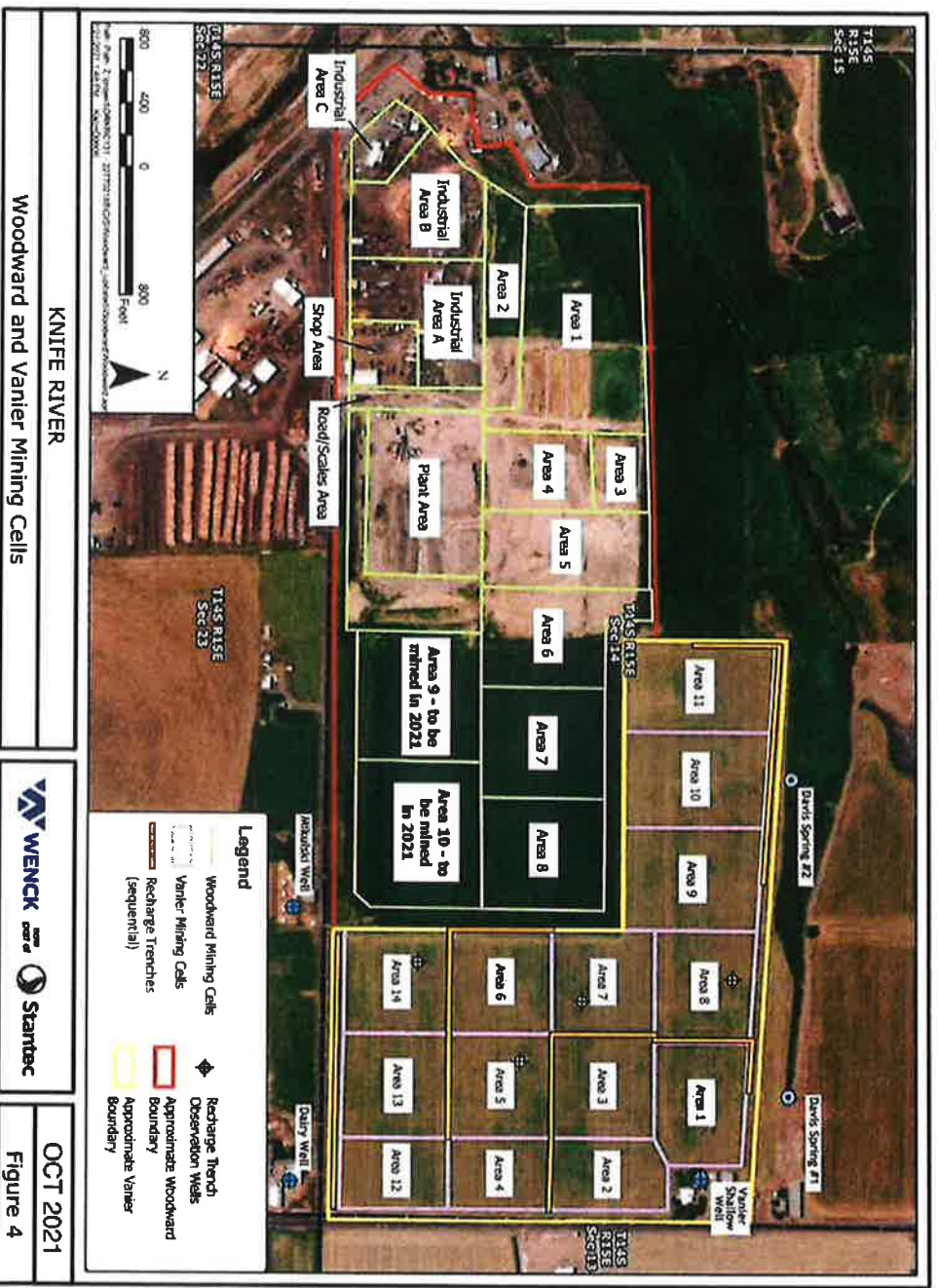
Well Drilling and Aquifer Testing – WW1A

Well Construction	Logbook	Remarks
<p>22.24 ft. Sandstone 22.25 ft. Sandstone 22.26 ft. Sandstone 22.27 ft. Sandstone 22.28 ft. Sandstone 22.29 ft. Sandstone 22.30 ft. Sandstone 22.31 ft. Sandstone 22.32 ft. Sandstone 22.33 ft. Sandstone 22.34 ft. Sandstone 22.35 ft. Sandstone 22.36 ft. Sandstone 22.37 ft. Sandstone 22.38 ft. Sandstone 22.39 ft. Sandstone 22.40 ft. Sandstone 22.41 ft. Sandstone 22.42 ft. Sandstone 22.43 ft. Sandstone 22.44 ft. Sandstone 22.45 ft. Sandstone 22.46 ft. Sandstone 22.47 ft. Sandstone 22.48 ft. Sandstone 22.49 ft. Sandstone 22.50 ft. Sandstone 22.51 ft. Sandstone 22.52 ft. Sandstone 22.53 ft. Sandstone 22.54 ft. Sandstone 22.55 ft. Sandstone 22.56 ft. Sandstone 22.57 ft. Sandstone 22.58 ft. Sandstone 22.59 ft. Sandstone 22.60 ft. Sandstone 22.61 ft. Sandstone 22.62 ft. Sandstone 22.63 ft. Sandstone 22.64 ft. Sandstone 22.65 ft. Sandstone 22.66 ft. Sandstone 22.67 ft. Sandstone 22.68 ft. Sandstone 22.69 ft. Sandstone 22.70 ft. Sandstone 22.71 ft. Sandstone 22.72 ft. Sandstone 22.73 ft. Sandstone 22.74 ft. Sandstone 22.75 ft. Sandstone 22.76 ft. Sandstone 22.77 ft. Sandstone 22.78 ft. Sandstone 22.79 ft. Sandstone 22.80 ft. Sandstone 22.81 ft. Sandstone 22.82 ft. Sandstone 22.83 ft. Sandstone 22.84 ft. Sandstone 22.85 ft. Sandstone 22.86 ft. Sandstone 22.87 ft. Sandstone 22.88 ft. Sandstone 22.89 ft. Sandstone 22.90 ft. Sandstone 22.91 ft. Sandstone 22.92 ft. Sandstone 22.93 ft. Sandstone 22.94 ft. Sandstone 22.95 ft. Sandstone 22.96 ft. Sandstone 22.97 ft. Sandstone 22.98 ft. Sandstone 22.99 ft. Sandstone 23.00 ft. Sandstone</p>	<p>22.24 ft. Sandstone 22.25 ft. Sandstone 22.26 ft. Sandstone 22.27 ft. Sandstone 22.28 ft. Sandstone 22.29 ft. Sandstone 22.30 ft. Sandstone 22.31 ft. Sandstone 22.32 ft. Sandstone 22.33 ft. Sandstone 22.34 ft. Sandstone 22.35 ft. Sandstone 22.36 ft. Sandstone 22.37 ft. Sandstone 22.38 ft. Sandstone 22.39 ft. Sandstone 22.40 ft. Sandstone 22.41 ft. Sandstone 22.42 ft. Sandstone 22.43 ft. Sandstone 22.44 ft. Sandstone 22.45 ft. Sandstone 22.46 ft. Sandstone 22.47 ft. Sandstone 22.48 ft. Sandstone 22.49 ft. Sandstone 22.50 ft. Sandstone 22.51 ft. Sandstone 22.52 ft. Sandstone 22.53 ft. Sandstone 22.54 ft. Sandstone 22.55 ft. Sandstone 22.56 ft. Sandstone 22.57 ft. Sandstone 22.58 ft. Sandstone 22.59 ft. Sandstone 22.60 ft. Sandstone 22.61 ft. Sandstone 22.62 ft. Sandstone 22.63 ft. Sandstone 22.64 ft. Sandstone 22.65 ft. Sandstone 22.66 ft. Sandstone 22.67 ft. Sandstone 22.68 ft. Sandstone 22.69 ft. Sandstone 22.70 ft. Sandstone 22.71 ft. Sandstone 22.72 ft. Sandstone 22.73 ft. Sandstone 22.74 ft. Sandstone 22.75 ft. Sandstone 22.76 ft. Sandstone 22.77 ft. Sandstone 22.78 ft. Sandstone 22.79 ft. Sandstone 22.80 ft. Sandstone 22.81 ft. Sandstone 22.82 ft. Sandstone 22.83 ft. Sandstone 22.84 ft. Sandstone 22.85 ft. Sandstone 22.86 ft. Sandstone 22.87 ft. Sandstone 22.88 ft. Sandstone 22.89 ft. Sandstone 22.90 ft. Sandstone 22.91 ft. Sandstone 22.92 ft. Sandstone 22.93 ft. Sandstone 22.94 ft. Sandstone 22.95 ft. Sandstone 22.96 ft. Sandstone 22.97 ft. Sandstone 22.98 ft. Sandstone 22.99 ft. Sandstone 23.00 ft. Sandstone</p>	<p>Notes from logbook at 20' 72' feet [Detailed logbook text describing well construction and test results]</p>



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Figure 2

Recharge Trenches and Monitoring Wells

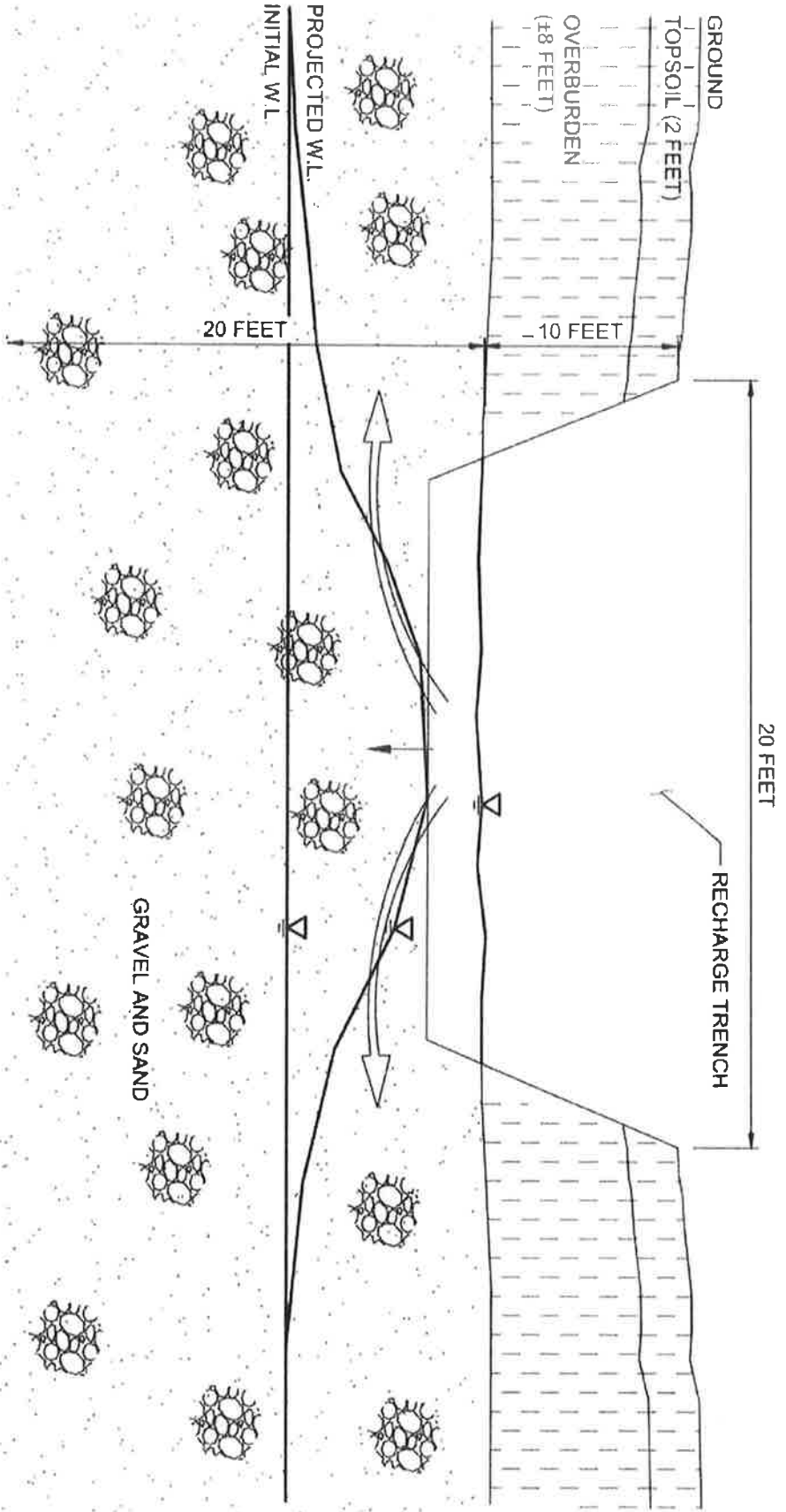


KNIFE RIVER
Woodward and Vanier Mining Cells

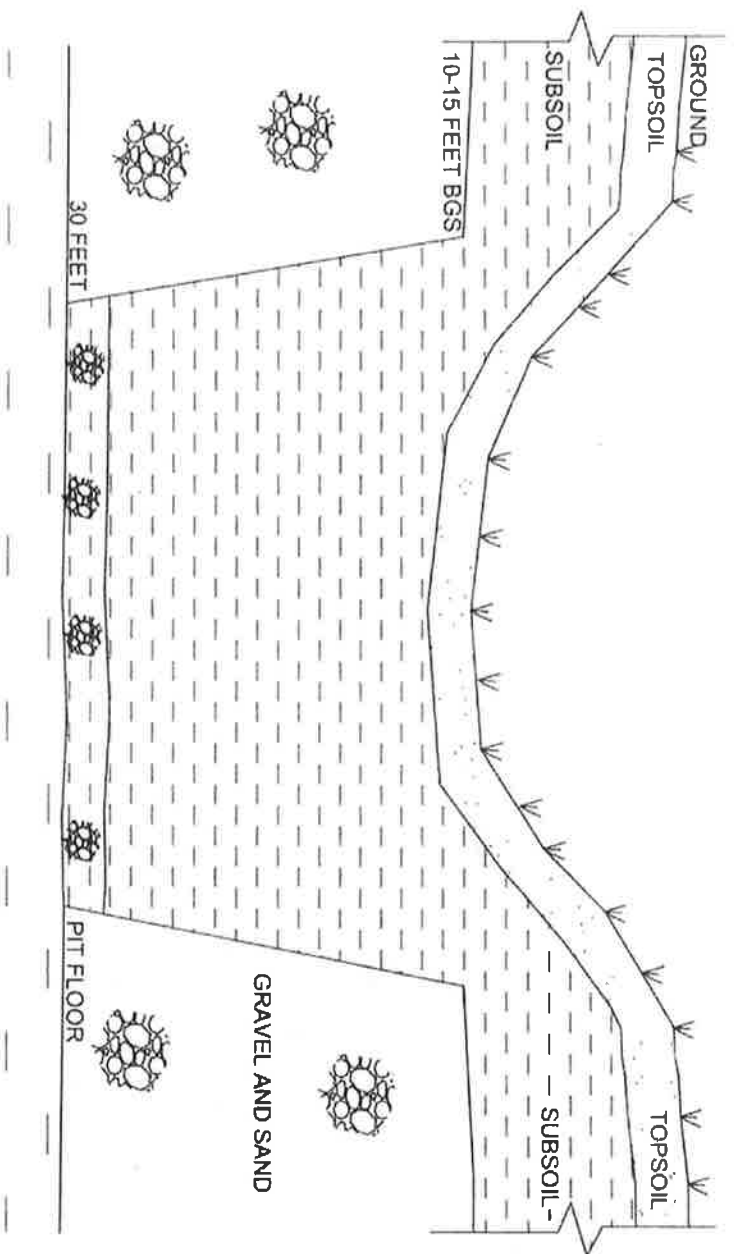


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Figure 4

Recharge Trench Approach



Reclaimed Mining Cell



Findings and Recommendations

- Mining will remove water only from the uppermost aquifer and given our proposed mine plan, including the construction of a recharge trench, Knife River's operation will mitigate any operational impacts to groundwater and will not impact neighboring water rights.
- Knife River has committed to collect baseline data on five nearby groundwater sources (three shallow wells and two springs) and will install and monitor wells adjacent to their mining operation and recharge trench.
- Knife River has proposed a groundwater guarantee
- Potential groundwater inflows to Vanier may range up to approximately 290 gpm on the eastern edge of the property and diminish to the west. Lesser flows may be encountered, and may range from 13 to 60 gpm. Mine plan design will ensure minimal open face and contemporaneous reclamation
- Knife River will backfill mine cells immediately following mining. A certain volume of clastics (sand and gravel) will always remain on the pit floor. Overburden will be backfilled under dewatered conditions which allows for a progressive backfill program. The upper overburden lift will be ripped to remove compaction before placement of topsoil. Topsoil will be disked and seeded during appropriate seeding window. Fertilizer (manure or organic matter) will be added as necessary.
- No new materials will be introduced. Existing topsoil will be salvaged separately and immediately replaced. Water quality will not be impacted. Water quantity will not be impacted. If anything irrigation demand will be reduced. Reclamation success has been established based on material handling program. Overburden quality is suitable as subsoil