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STATE OF UTAH
BEFORE THE DIVISION OF WATER RIGHTS—UTAH STATE ENGINEER

IN RE: CHANGE APPLICATION 85-39 (a45058)	**PROTEST OF BEST FRIENDS ANIMAL SOCIETY** **(HEARING REQUESTED)**

Best Friends Animal Society ("BFAS"), by and through its counsel of record, hereby protests change application a45058 submitted by Kanab City Corporation on August 22, 2019.

I. Introduction

In accordance with Utah Code Ann. §73-3-7, BFAS is an interested party and hereby protests the application for permanent change of water filed on behalf of Southern Red Sands ("SRS") by Kanab City Corporation ("the City") to add one or two additional underground well points of diversion to water right 85-39 and change the nature and the place of use of 600 acre feet of municipal water to industrial use ("hereinafter the "Application") in an area located near and impacting the BFAS Animal Sanctuary in Kane County, Utah. The City and SRS are hereby collectively referred to as the "Applicants". BFAS believes this is one of two change applications that will be filed on behalf of SRS to withdraw 600 acre feet of water from the

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proposed wells listed in the change application, resulting in a total diversion of 1200 acre feet of groundwater in the area.

BFAS owns the following water rights that will suffer impairment if this change application is approved: 85-142, 85-143, 85-144, 85-145, 85-146, 85-147, 85-148, 85-149, 85-150, 85-151, 85-298, 85-299, 85-398, 85-419, 85-420, 85-421, 85-422, 85-423, 85-424(a40330), 85-425, 85-426, 85-427, 85-428 (a14690)(a40330), 85-429(a40330), 85-430, 85-431, 85-452, 85-453, 85-633, 85-714, 85-715, 85-640, 85-1015(a25626, a40330), 85-1016(a37407), and 85-1031(a25626, a40330).

II. The Change Application May Not Be Approved Under Utah Law.

Utah law requires the Applicants produce sufficient evidence to support a reasonable belief that the Application can be approved in compliance with Utah Code Ann. §73-3-3 and §73-3-8. *See* Utah Code Ann. §73-3-3(5). Under Utah Code Ann. §73-3-8(1)(a), BFAS does not believe the Applicants have met their burden of proof showing (i) there is unappropriated water in the source; (ii) the proposed use will not impair existing rights or interfere with the more beneficial use of water; (iii) the proposed plan is (A) physically and economically feasible; and (B) would not prove detrimental to the public welfare; (iv) the applicant has the financial ability to complete the proposed works. In addition to the requirements of Utah Code Ann. §73-3-8, the City's Water Service Agreement violates the Utah Constitution, specifically, Article XI, Sec. 6 prohibiting municipal corporations from leasing, selling, or disposing of its water rights or sources of water supply. Each of these issues is addressed in turn below.

A. The Proposed Use Will Impair BFAS Senior Water Rights

The Applicants are entitled to approval of the Application if it complies with the requirements of Utah Code Ann. §73-3-3, does not impair an existing right without just compensation or adequate mitigation, and the State Engineer approves the change application consistent with the requirements of Utah Code §73-3-8. *See* Utah Code §73-3-3(3)(i)-(iii). The Applicants carry the burden to supply evidence to support a reasonable belief that the changes outlined in the Application can be perfected without impairing vested rights. *Searle v. Milburn Irrigation Co.*, 133 P.3d 382, 391 (Utah 2006). The Utah Supreme Court explained that the "owner of a water right has a vested right to the quality as well as the quantity which he has beneficially used." *Crafts v. Hansen*, 667 P.2d 1068, 1070 (Utah 1983), *citing Salt Lake City v. Boundary Springs Water Users Ass'n*, 270 P.2d 453, 455 (1954) (citation omitted). Accordingly, the State Engineer must first determine that the proposed changes will not impair any vested right to the beneficial use of a certain quality and quantity of water. *See HEAL Utah v. Kane Cty. Water Conservancy Dist.*, 378 P.3d 1246, 1250 (Utah Ct. App. 2016). And "[i]f the evidence produced by a protestant is compelling enough to undermine the reasonableness of the assertion that the proposed change will not impair vested rights, the state engineer should reject the application seeking to effect that change." *Id.* at 1253-1254, *quoting Searle*, 133 P.3d, 382, 391.

As stated above, BFAS owns multiple water rights that will be impaired by what is essentially a new groundwater diversion of 1200 acre feet of water under the present Application and anticipated change application. To determine actual impairment to the BFAS water rights, a study was commissioned to provide a detailed hydrologic baseline of the water availability in the area surrounding the proposed points of diversion and BFAS' Animal Sanctuary. Specifically, a detailed GIS based Hydrologic Assessment of the Watershed, Geohydrologic Framework, and Groundwater Resources of Best Friends Animal Society- Canyon Operations, Kane County, Utah: Phase 1 and Phase 2; HESA-Based Conceptual Site Model, Preliminary Water Budget, and Aquifer Storage Evaluation was prepared by Dr. Kenneth E. Kolm and Paul K.M. van der Heijde (hereinafter the "HESA Report"). The HESA Report predicts, in great detail, that the impacts of the SRS mining operation on BFAS and other nearby water rights will function as a new diversion of groundwater in an area that is fully appropriated. *See* HESA Report attached hereto as Exhibit "1"; *See* Area 85 Groundwater Policy attached as Exhibit "2". The HESA Report outlines the path of groundwater recharge and flow in the surrounding aquifers and studies the amount of water available in the source. Importantly, the proposed SRS well sites sit in a vital groundwater recharge area that supplies groundwater to the rest of the drainage. *See* HESA Report, Fig. 6, p. 12. As a result, the HESA Report concludes that the nearby City wells will suffer drawdown, requiring additional pumping, in turn, other wells and springs in the area will suffer drawdown and the West Fork Three Lakes perennial stream and springs will eventually dry up due to increased pumping of wells in the upgradient area. *See Id.* pp. 43-46. This pumping will generally negatively affect all of the water associated with BFAS's water rights, including all of its water rights associated with the Kanab Creek and springs.

Similarly, drawdown of the Kanab City wells due to a new diversion at the proposed well sites was also confirmed by the Utah Geological Survey and results of that study were sent to the City of Kanab. *See* Exhibit "3" attached. In addition, there are uses associated with water right 85-39 and listed on the water certificate. *See* Exhibit "4". No information has been provided indicating these uses will cease or that the water right will not be enlarged to add this additional 600 acre foot withdrawal. It is clear, however, based on the HESA Report and UGS information, the approval of this Application will cause a decline in activity of the City's well and the BFAS wells. The HESA Report also demonstrates that a decline in the groundwater flow paths down gradient of the mine and well site(s) will also cause a decline in the springs at Big Lake and Three Lakes Canyon, a decline in lake levels and lake habitat in those areas, a decline in the

BFAS springs in Kanab Canyon, and ultimately a reduction of surface water flows in Kanab Creek. *See* HESA Report, pp. 43-46.

Although the Applicants may argue they can provide replacement water, given the number of water rights that will be impaired (including the City's) and the lack of any feasible infrastructure to pipe water to the BFAS Sanctuary, let alone ownership of replacement water rights, easements, permits, and environmental approvals that will be required to provide replacement water, the evidence of certain impairment of the BFAS water rights alone, which are senior water rights to water right 85-39, provides the State Engineer with the compelling evidence required to reject this change application.

B. The Proposed Sand Mine is Economically Infeasible

In a January 14, 2019 letter from SRS to the State Institutional Trust Lands Administration ("SITLA"), Chad Staheli, a representative of SRS, remarks that the proposed mining operation requires a reduction of the royalty rate in its SITLA contracts due to economic factors such as transportation costs in bringing sand to market, lack of nearby rail line, the geology of the silica deposit, the costs associated with improving the Red Knoll Road and connection of utilities, the capital expenditures required to construct a plant on the Permits, and the number of other competing silica sand operations coming on board in the next 6-18 months. *See* Exhibit "5" attached. SITLA responded to the letter reducing the royalty rates and requesting a $100,000 advance royalty payment. *See* Exhibit "6" attached. SRS responded on February 12, 2019 that it cannot pay the $100,000 advanced royalty payment and requested a $50,000 payment. *See* Exhibit "7" attached. This documentation of financial trouble from SRS is disturbing and may indicate SRS's own instability and further demonstrates the Project is not economically feasible in the current market.

Furthermore, the Applicant has provided no information with regard to its ability to obtain all required state and federal permits required for construction and operation of the mine in this location. SRS's conditional use permit for the mine is currently being litigated and the conclusion of the litigation may take many months or years to complete. For example, there is an Environmental Assessment required to be completed that may also alter or impact the timing of construction of the new mine. Given these uncertainties, a determination that this Application is feasible is premature due to permitting approvals by other Federal, state and local agencies that will be required before the mine may operate.

Finally, because the mining operation depends on water, and the water under this Application is provided by the City under a "surplus" water agreement," SRS cannot definitively say that it has acquired a permanent source of water to operate the mine for the next 50 years. *See* Section II.E below. The City's water projections do not appear to be able to sustain this diversion in addition to the growing needs of the City over the entire 50 year contract term. *Id.* It should not be the policy of the State Engineer, to allow permanent development, such as wells and mining amenities, to be based upon a water supply that is constitutionally required to be terminable and a temporary source of water until the City determines the water is needed for its inhabitants.

C. The Proposed Sand Mine is Detrimental to the Public Welfare

As stated above, the anticipated result of a 1200 acre foot groundwater withdrawal at the proposed well sites will result in drying up of surface spring sources and will also eventually impair the flows in Kanab Creek. Of importance, Three Lakes Canyon is the home to the largest living population of the Kanab Ambersnail, a federally listed Endangered Species. *See* Exhibit "8" attached. The population inhabits the wet meadow and marsh habitat of the "Three Lakes" ponds. *Id.* at p. 3. Another population is in a vegetated seep at the base of a sandstone cliff near the main stem of Kanab Creek in Kanab Creek Canyon. *Id.* Proposed critical habitat for the Ambersnail includes Three Lakes Canyon, the "Three Lakes" ponds and adjacent wetlands and seeps. *Id.* at p. 2. The Three Lakes Ambersnail population resides nearly entirely on BFAS Animal Sanctuary property and is currently managed to prevent habitat destruction or impairment of the species. *See* Exhibit "9" attached.

As stated in the HESA Report, the anticipated result of a 1200 acre foot withdrawal of groundwater at the proposed well sites will result in the Three Lakes area drying up. *See* Exhibit "1", pp. 43-46. This result will devastate the largest population of the Kanab Ambersnail at Three Lakes and destroy the species critical habitat at the BFAS Animal Sanctuary. As a result, the Application should be rejected as detrimental to public welfare and the natural stream environment under Utah Code Ann. §73-3-8(1)(b) because of its effect on a federally listed endangered species as well as destruction of its critical habitat. At the least, the State Engineer has a duty to withhold approval of the application until this matter has been fully investigated and studied by the United States Fish and Wildlife Service under Utah Code Ann. §73-3-8(1)(b).

D. No Information Was Provided Concerning the Applicant's Financial Strength

Under Utah Code Ann. §73-3-11 provides:

> Before either approving or rejecting an application the state engineer may require such additional information as will enable him properly to guard the public interests, and may require a statement of the following facts: In case of an incorporated company, he may require the submission of the articles of incorporation, the names and places of residence of its directors and officers, and the amount of its authorized and its paid-up capital. If the applicant is not a corporation, he may require a showing as to the names of the persons proposing to make the appropriation and a showing of facts necessary to enable him to determine whether or not they are qualified appropriators and have the financial ability to carry out the proposed work, and whether or not the application has been made in good faith.

Here, there is concern, given the Applicant's disclosures to SITLA, that SRS does not actually have the funding available to begin construction of the mine, to pay SITLA the royalties that are due, or to pay for the required road improvements and transportation costs necessary to transport the silica sand deposits to market. More importantly, if the Application is approved, impairment of nearby water rights is a foregone conclusion. BFAS is concerned about the Applicants' legal and financial ability to provide replacement water if required to do so by the State Engineer. In addition, many of the areas irrigated with spring water at the BFAS Sanctuary are remote and not easily accessible by piping should the springs run dry as a result of this Application. BFAS therefore requests that the State Engineer require the Applicants provide adequate financial documentation demonstrating they have the financial ability to carry out the proposed mining operation and, if necessary, a mechanism to legally provide a permanent source of replacement water in the same quantity and quality that is currently used at the Animal Sanctuary.

E. The Water Service Agreement is Unconstitutional

The Water Service Agreement between SRS and the City indicates it is for surplus water, stating the "City has determined that it has surplus water that it can provide SRS for use at the Project in an amount up to 600 acre feet of water per year during the term of this Agreement." *See* ¶1(b) of the Water Service Agreement attached hereto as Exhibit "10". The Water Service Agreement requires a $10,000 "application fee" for the water. The term of the Agreement is defined as an "initial term...[of] twenty (20) years from Effective Date. This Agreement shall automatically renew for up to three (3) additional ten (10) year terms unless SRS provides City written notice of its intent to terminate this Agreement at least 90 days before the end of the existing term." *Id.* at ¶3.

The Water Service Agreement, does not, however, contain a provision for the City to terminate the Water Service Agreement for lack of surplus water availability. The only party that may terminate the automatically renewing terms is SRS. Should Kanab need this water for City inhabitants in the future, there is no remedy available under the Agreement. This violated both the Utah Constitution and the City's ordinance 14-113.4 requiring an agreement or application for service in "substantially the same form" as provided in the ordinance. See Exhibit "11" attached. The provided form of agreement provides that the City Council may terminate the agreement if the surplus water is needed within the corporate limits of the City. *See Id.*

Astonishingly, the Water Service Agreement was approved by the City Council despite the fact that the City of Kanab's 40 Year Projected Water Usage Report, dated July 2014, states that at a growth rate of 3.25% the City will need to use *ALL* of its existing water rights, including all of the water associated with water right 85-39, to provide peak day demand of 6,367 gpm within the next 35 years. *See* Exhibit "12" attached. The Report concludes that "Kanab City will need to continue actively acquiring water rights to serve the future needs of its citizens."

Because the Agreement is not terminable by Kanab and contains long term, automatically renewing terms, the parties have effectively created an unconstitutional agreement, violating Article XI, Sec. 6 of the Utah Constitution (and the City's own ordinance), which prohibits municipal corporations from leasing, selling, or disposing of its water rights or sources of water supply. Though Kanab may sell its surplus water to nonresidents, the City does not appear to have any surplus water and an agreement to deliver a definite amount of water for automatically renewing terms is in effect a parting with water rights, forbidden by the Utah State Constitution.

See Genola Town v. Santaquin City, 1938, 96 Utah 88, 80 P.2d 930, *rehearing denied* 96 Utah 104, 85 P.2d 790.

III. Conclusion

Based on the information provided herein, BFAS requests the State Engineer reject the Application due to certain impairment of senior BFAS water rights, impossibility of the Applicants providing replacement water, impacts to the natural stream environment and public welfare, infeasibility of the proposed mining operation, financial health of the Applicant SRS, and the blatant unconstitutionality of the sale of water right 85-39 by the City to SRS. As stated above, BFAS requests a hearing be scheduled on this Application and hereby reserves the right to provide additional information supporting the arguments made herein during the hearing.

Dated this 2nd day of October, 2019.

Jones Waldo Holbrook & McDonough

/s/ *Janelle Eurick Bauer*

Janelle Eurick Bauer
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EXHIBIT 1

GIS-Based Hydrologic Assessment (HESA) of the Watershed, Geohydrologic Framework, and Groundwater Resources of Best Friends Animal Society-Canyon Operations (BFAS), Kane County, Utah: Phase 1 and Phase 2: HESA-Based Conceptual Site Model, Preliminary Water Budget, and Aquifer Storage Evaluation

Authors:
Dr. Kenneth E. Kolm, Hydrologic Systems Analysis, LLC., Golden, Colorado
and
Paul K.M. van der Heijde, Heath Hydrology, Inc., Boulder, Colorado

FINAL REPORT

Prepared For:

Best Friends Animal Society-Canyon Operations, Kane County, Utah

September 30, 2019

Front Page: View of Best Friends Animal Sanctuary-Canyon Operations Entrance, central Kanab Creek in the Navajo/Kanab Creek hydrologic system near Kanab, Utah. In this area Kanab Creek is a perennial stream, downcut into the Navajo Aquifer (Hydrogeologic Unit). (Photo by BFAS, July 2019).

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EXECUTIVE SUMMARY

This report presents the findings of Phase 1 and Phase 2 of a 3-phase project focused on improving the understanding of the hydrogeological setting of the water supply sources for the Best Friends Animal Society – Canyon Operations (BFAS), the quantification of the water resources available to BFAS, and updating the BFAS springs and wells protection against mining activities with regards to water supply and contamination. In Phase 1, a Hydrologic and Environmental System Analysis (HESA) of the central Kanab Creek watersheds was completed to identify the hydrological systems of specific importance to the sustainability of the BFAS springs and wells as water supply for the Canyon Operations. It was concluded that the BFAS water supply was mainly dependent on the hydrologic system formed by the central Kanab Creek Watershed and the Upper Navajo aquifer underlying the surrounding region, including Red Knoll. This hydrologic system, referred to as the Jurassic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system, was chosen in Phase 2 of the project as the setting for the quantification of the water resources available to BFAS, resulting in a preliminary global water budget (PWB) of the area in the JNKC hydrologic system affecting the BFAS water supply. It is a preliminary water budget as there are many uncertainties with respect to the determination of the individual components given the sparseness of relevant published data.

The Jurassic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system is a complex mix of fractured and faulted Navajo Sandstone rock, Eolian (wind-deposited) and Pedogenic Sand, Alluvium, and hydro-structures (fault and fracture zones that are either conductive or a barrier to groundwater flow). The Upper Navajo Sandstone bedrock (Jn) has both matrix flow and fracture flow. As the hydraulic conductivity of the matrix (Kmh) is significant less than the hydraulic conductivity of the fracture zones (Kfh), fracture flow will dominate travel times and will be most important for contaminant studies and well/spring protections, as well as estimating groundwater storage and recharge rates.

Recharge to the Upper Navajo aquifer in the JNKC hydrologic system is by infiltration of precipitation (snow and rain) directly into bedrock, or through the eolian sand cover on the surface of the uplands and interfluve tops; by north-south and east-west trending fracture-controlled ephemeral stream channels, and by losing reaches of flowing streams. Groundwater flow in the Upper Navajo aquifer is strongly fracture controlled, and moves from the drainage divides in the same direction as the stream with various stream reaches being gaining or losing depending on topography, bedrock hydrogeology, hydrostructures, and saturated thickness of the bedrock. Most of the streams are French drains where groundwater flows parallel to the surface feature, and discharges into the gaining streams. The sub-regional groundwater flow direction is from west to east around and near Red Knoll, and east to west from the Johnson Wash groundwater divide. The High K Zone flow systems of Kanab Creek, West Fork Three Lakes drainage, and Cave Creek drainage collect most of the groundwater flow system which ultimately ends in the Kanab Creek main channel system. Groundwater then discharges out of the JNKC hydrologic system in three notable places due to the hydrogeology and the complex hydrostructures: 1) The Kanab Creek fracture zone/French drain that receives groundwater to various springs and seeps along its path including the Red Canyon upper Kanab Creek springs where the perennial Kanab Creek begins, and at the BFAS springs along the central parts of the canyon including Big Lake near the BFAS Headquarters; 2) The Three Lakes discharge zone in

Three Lakes Canyon; and 3) The West Fork Three Lakes discharge zone that delivers groundwater to the City of Kanab.

Detailed cross-sections are provided to illustrate potential groundwater pathways and potential changes in aquifer function due to the proposed Red Sands mining and groundwater extraction sites. Regardless of whether the Red Sands wells are located in the Upper Navajo aquifer, or the Lamb Point Tongue aquifer, or a combination of both aquifers, the impacts to the Town of Kanab wells, and BFAS wells and springs are significant. The West Fork Three Lakes perennial stream and spring dries up. There is a potential decline in the productivity of the Town of Kanab and BFAS wells. There is a reduction in the phreatophytes (habitat destruction). There is a water level decline notable along the groundwater flow paths down gradient of the mine and well site causing a decline in the springs at Big Lake and Three Lakes Canyons, a decline in lake levels and lake habitat, a decline in the BFAS springs in Kanab Canyon, and ultimately a reduction of surface water flow in Kanab Creek. The removal of eolian sand at the mine site will reduce the groundwater infiltration and increase the evapotranspiration significantly resulting in further declines in water tables downgradient.

The HESA completed in phase 1 showed that the JNKC hydrologic system is a well-defined system for which the boundary conditions and internal surface water–groundwater interactions are relatively well-understood and quantifiable to various degrees of accuracy. In order to estimate the upper bounds of the water resources present in the JNKC hydrologic system, a preliminary (global) water budget (PWB) has been developed for the JNKC hydrologic system, focused on the external inputs (inflows) and outputs (outflows). In addition, an analysis was made of the storage capacity of the Jurassic Navajo aquifer in the PWB area. The delineation of the PWB area is based on the location of BFAS springs and wells including Big Lake and Three Lakes, the location of the stream gage in Kanab Creek, and the natural boundaries of the JNKC hydrologic system, and covers almost the entire JNKC hydrologic system as determined in the HESA of Phase 1. The PWB area is bounded by the low permeability Sevier Fault to the west, the groundwater divides to the southwest, north, east, and southeast, and the Jn bedrock exposures to the south, and includes additional outcrop exposures of Jurassic Lambs Point Tongue of the Navajo Formation and Kanab Creek alluvium to the south so that the Kanab Creek gage could be used in the water budget.

There is one distinct time period evaluated in the JNKC hydrologic system water budget: pre-mine development which is present-day. Phase 3 will evaluate the projected water use post-development, which are future projections to determine the impacts of sand mining on water supply, groundwater recharge changes, and potential groundwater/surface water contamination. Pre-mine development or current use has limited municipal, domestic and irrigation demand and kept most of the JNKC hydrologic system of the Red Knoll recharge region in its natural state, a period that in this report is referred to as the pre-mine development present day phase. Starting as early as 2020, the start of the mining of frack sands in the Red Knoll area, together with the initiation of a steady increase in mining water use at some specified rate, well location, and well depth, and the removal of the sands and vegetation, which are part of the JNKC recharge units and function, will represent a significant increase in the anthropogenic withdrawals from the JNKC hydrologic system that could continue up to 50 years. This latter period will be evaluated as Phase 3, and will be referred to as the projected-development phase. A preliminary water budget (PWB) has been developed for the pre-development time period.

The significant inputs of the PWB are: 1) groundwater inflow (i.e., underflow) at western boundary from recharge in area between the PWB boundary and the first closed hydrostructure of the Sevier Fault zone; 2) recharge by infiltration of precipitation (rain and snow) across the entire PWB area using the concept of hydro zones explained later in this report; 3) direct surface runoff from precipitation to streams; 4) Kanab Creek inflow at Northern PWB boundary from nearby springs; and 5) groundwater leakage from Jnl through Kanab Creek French drain towards Kanab Creek. The outputs of the PWB are: 1) consumptive use by riparian vegetation; 2) evaporation from open water (Big Lake and Three Lakes); 3) consumptive use BFAS wells and springs (production minus return flow); 4) municipal use (Kanab City wells and springs); 5) domestic consumptive use (non-BFAS private wells); 6) Kanab Creek outflow at Southern boundary (at USGS gage near highway bridge); and 7) groundwater underflow at Southern boundary (in Qal in Kanab Creek canyon).The post-development JNKC water budget of Phase 3 will have the same type of inputs as the pre-development water budget, but has an additional outflow term, the mining operation water use (developed wells for mining water supply).

The closing term or balancing term in the pre-mine development PWB is formed by direct runoff to streams from precipitation. That term, adjusted for changes in average precipitation, will then used as an input for the Phase 3 preliminary post-development water budget, in which the closing term is a deficit inflow assigned to water released from aquifer storage.

Using the precipitation data sets for 1981-2010 for the Kanab, Utah area, a series of potential recharge and consumptive use by riparian vegetation scenarios have been evaluated based on detailed knowledge of the hydrogeology and landscape characteristics. The calculation of the recharge term in the PWB for the Jn aquifer and the Jnl aquifer can be summarized as follows: 1)_the low estimate for recharge in the Jn aquifer is 4940 ac-ft/yr, the high estimate is 9881 ac-ft/yr, and the "best" estimate used in the PWB is 7587 ac-ft/yr; 2)_the low estimate for (direct) recharge in the Jnl aquifer (in the central-south part of the PWB area) is 125 ac-ft/yr, the high estimate is 250 ac-ft/yr, and the "best" estimate used in the PWB is 188 ac-ft/yr . The "best" estimate for recharge in both the Jn and Jnl aquifers amounts to about 15 % of overall precipitation in the PWB area or 2.3 inches/yr. a, The average consumptive use by riparian vegetation was estimated at 3817 ac-ft/yr. Direct runoff to streams was calculated at 3905 ac-ft/yr, and the Kanab Creek outflow determined by gage data was 6820 ac-ft/yr .

Many of the components of the PWB calculations include large uncertainties. The most reliable data are the USGS stream flow data at Kanab Creek at the Kanab Creek bridge below the BFAS operations, the springs and wells production data from the City of Kanab and BFAS, and the precipitation data from NOAA used to develop various recharge scenarios. All other data sets provide a "snap shot" of a particular variable in time as they were gathered at various, non-comparable moments in time and should be considered a first estimate, subject to refining by further field studies. Another area where significant cost-effective improvements to the PWB can be made is more detailed and frequent monitoring of the Kanab Creek and Three Lakes surface water system (both the lakes region, and the West Fork of Three Lakes Canyon tributary, specifically in the vicinity of the Town of Kanab and BFAS wells and springs and above and below the area where the Town of Kanab and BFAS source protection zone intercedes with projected mining areas and water supply reductions due to mine pumping. Finally, more detailed monitoring of selected, "representative" springs, in the BFAS area, should be initiated to obtain an indication of the relationships over time between spring discharge, climate variations, and Kanab Creek runoff, as well as an insight in the resilience of the JNKC hydrologic system to external stresses.

The Upper Navajo (Jn) groundwater system is mostly unconfined, i.e., having a readily fluctuating water table, and the aquifer storativity is characterized by so-called specific yield. The Upper Navajo aquifer has both matrix specific yield (small) and fracture specific yield (large). The matrix specific yield estimates range from 5 – 10 %; the fracture flow specific yield estimates range from 10 – 20% As there is a significant presence of fracture zones in the JNKC system, fractures are the dominant feature in determining available groundwater storage. The results of GIS-based calculations show that the JNKC groundwater system has a storage minimum of about 43,462 ac-ft, and a storage maximum of about 114,188ac-ft, indicating significant uncertainty in the actual storage available in the JNKC groundwater system. Areas along the groundwater flow paths that directly affect the yields and water quality of the BFAS wells and springs, and the City of Kanab wells at the West Fork Three Lakes Canyon, Main Fork Three Lakes Canyon, Cave Creek Canyon, and Kanab Creek, have the largest amount of storage. The current BFAS source protection plans identify these hydro zones as critical, and the effects of the proposed mining and related well extraction on these protection zones will be evaluated in Phase 3 of this project.

1 INTRODUCTION

Under an agreement with Best Friends Animal Society-Canyon Operations, Kane County, Utah (BFAS) of March 25, 2019 for evaluation of the potential effects of nearby siting of a planned surface sand mine and accompanying industrial well on BFAS's water supply both in terms of quantity and quality, and on the water rights of BFAS (see Figure 1), Hydrologic Systems Analysis LLC (HSA) of Golden, Colorado, in conjunction with Heath Hydrology, Inc. (HHI) of Boulder, Colorado, was tasked to: 1) perform a Hydrologic and Environmental System Analysis (HESA) of the area detailing the characteristics of the surface water and groundwater systems and their interactions; 2) collect climate, hydrological, hydrogeological and other data necessary to construct a water budget for the BFAS site, delineate the area for which the water budget will be developed, and prepare an as-accurate-as-possible water budget for the Site; and 3) evaluate the nearby siting of planned surface sand mine and accompanying industrial well that potentially affect the BFAS site using the HESA and water budget results. The approximate study area is shown in Figure 1 and is based, in part, on the extent of the hydrogeological systems present. Each of these tasks constitutes a phase of the project. This report contains the results of Phase 1, Hydrologic and Environmental System Analysis (HESA), and Phase 2, developing a preliminary water budget (PWB) for the part of the hydrologic system affecting the BFAS site, in this report referred to as the BFAS study area.

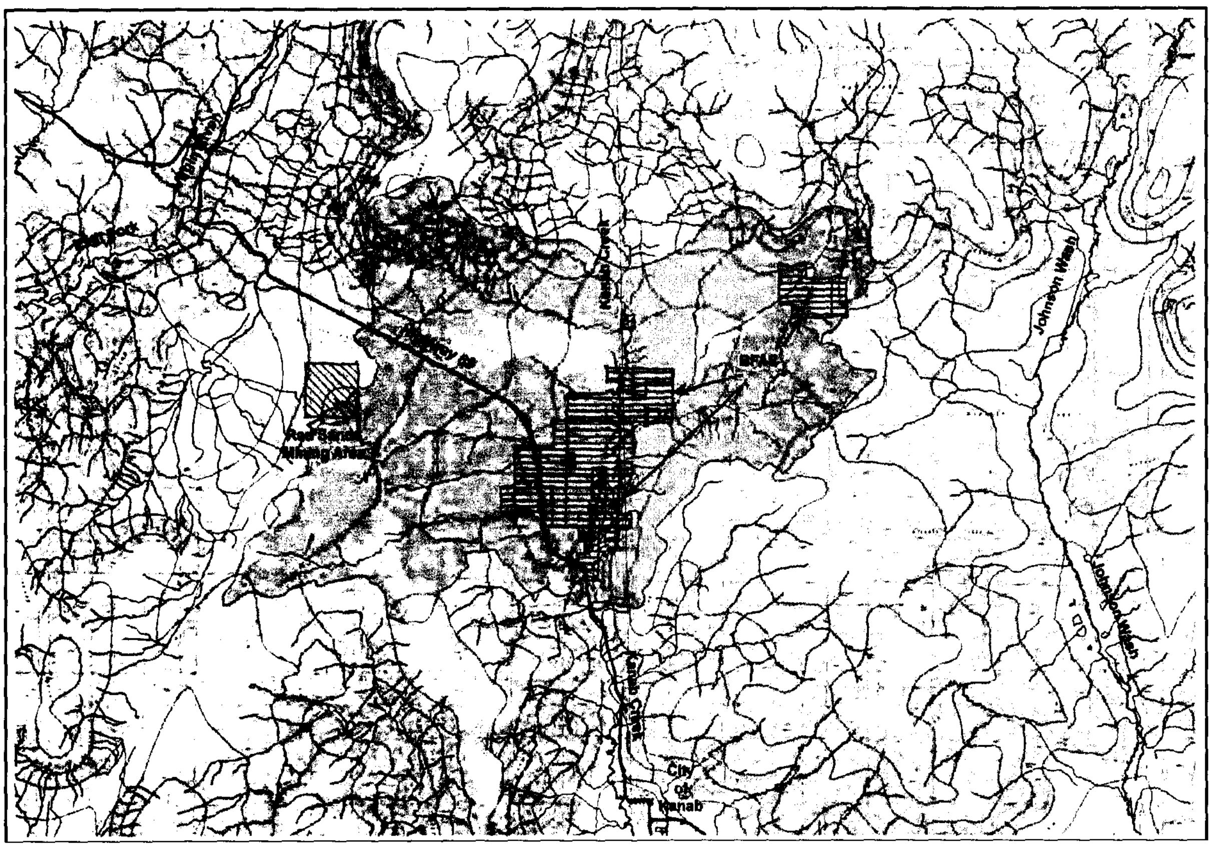

Figure 1. Topographic map of the Best Friends Animal Society-Canyon Operations (BFAS) and the Jurassic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system showing the Preliminary Water Budget (PWB) area discussed in Section 3.

The study area is located between the White Cliffs to the north, the East Fork Virgin River watershed and Sevier Fault to the west, Johnson Wash watershed to the east, and the Vermillion Cliffs above the Town of Kanab to the south (Figures 1 and 2). The delineation of the study area is based on the nature and extent of the major hydrogeological systems present, the surface hydrology of the area, and water resources related land use considerations. The area covers the central Kanab Creek watershed as delineated in the GIS files downloaded from the data portal of the Natural Resources Conservation Service (NRCS, 2019). The study distinguishes between three hydrologic entities: 1) East Fork Virgin River watershed and groundwater subsystems referred to in Heilweil and Freethey (1992) as the Zion Block; 2) Central Kanab Creek watershed and groundwater subsystems referred to in Heilweil and Freethey (1992) as the western and central part of the Kanab Block; and 3) Johnson Wash Watershed and groundwater subsystems referred to in Heilweil and Freethey (1992) as the eastern part of the Kanab Block. The combined central Kanab Creek Watershed and Jurassic Navajo Sandstone aquifer underlying the central Kanab Creek region, referred to as the Jurasic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system, will be the setting for the water budget to be developed in Phase 2 of this study.

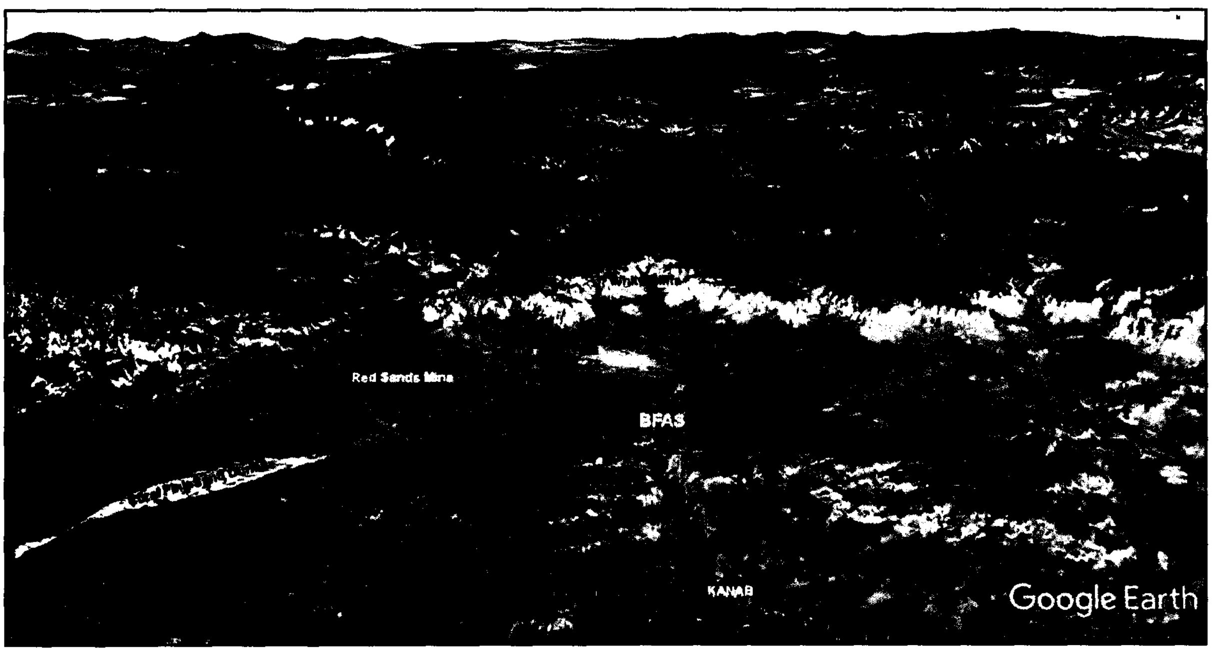

Figure 2. View of the regional setting of the Best Friends Animal Society-Canyon Operations (BFAS) near Kanab, Utah. (Source: Google Earth, imagery date July 2015).

The HESA of the surface water and groundwater systems in the BFAS study area makes extensive use of existing GIS databases and maps of geologic, hydrogeologic and hydrologic characteristics, collected specifically for this study. Additional data layers and evaluations were needed to illustrate the HESA – particularly with respect to the hydrogeological characteristics of the rock types present and the significance of hydrostructures. The results of the HESA of the JNKN hydrologic system are documented in Section 2 of this report. These results provide the base the water budget quantification of Phase 2 described in Section 3 of this report.

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In conducting this study and preparing this report, extensive use has been made from data layers collected in a Geographical Information System (GIS) using the ESRI® ArcMap™ software. The data sources included Utah AGRC (Automated Geographic Reference Center), Utah Division of Water Rights (UDWR), Utah Division of Environmental Quality (Utah DEQ), Utah Geological Survey (UGS), U.S. Geological Survey (USGS), Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture, NOAA National Centers for Environmental Information, and others. In addition, HSA/HHI has prepared a number of data layers specifically for this report through interpretation of existing data sets and field reconnaissance.

It should be noted that that this report will not obviate the need for additional hydrogeologic analysis on a site-specific/parcel-specific basis by mine site developers and/or BFAS, or in any water right, water supply, geotechnical, or environmental study requiring due diligence. The information in this report is intended to be used as indicator only, as part of a multi-step resource evaluation and land use decision-making process, and to provide a starting point for further study of the sustainability and vulnerability of the BFAS's surface water and groundwater resources. The information provided in this report, together with the data base developed for Phase 1 and 2, constitutes the base for the Phase 3 study.

2 DEVELOPMENT OF A CONCEPTUAL MODEL OF THE HYDROLOGIC SYSTEM OF THE BFAS SPRINGS AND WELLS (BFAS) STUDY AREA

HESA is an approach used to conceptualize and characterize relevant features of hydrologic and environmental systems, integrating aspects of climate, topography, geomorphology, groundwater and surface water hydrology, geology, ecosystem structure and function, and the human activities associated with these systems into a holistic, three-dimensional dynamic conceptual site model (CSM). This watershed-based, hierarchical approach is described by Kolm and others (*1996*) and codified in ASTM D5979 Standard Guide for Conceptualization and Characterization of Ground Water Systems *(ASTM 1996(2014))*. The CSM of the BFAS study area covers elements of climate, topography, soils and geomorphology, surface water characteristics, hydrogeologic framework, hydrology, and anthropogenic activity as related to the surface water and groundwater systems in the study area.

Based on field surveys and a preliminary HESA, a number of hydrogeologic subsystems were identified in the vicinity of the BFAS study area. Each of these subsystems has a unique hydrogeologic setting and groundwater flow system and the most relevant subsystem, the JNKC hydrologic system, is described in detail in forthcoming sections of the report. Current anthropogenic modifications of the natural hydrologic features in these subsystems are minimal, and are primarily related to municipal and domestic water use (Town of Kanab, and BFAS wells and septic systems), and agricultural practices and irrigation (surface water diversions and irrigation return flow). A brief discussion of potential modification of natural flow patterns and impacts on water budgets and water quality, particularly salinity, from agricultural, urbanization and mining activities is included.

2.1 Climate

The climate in the study area has both local and regional components and includes effects of elevation and slope aspect (*i.e.*, steepness and orientation with respect to the prevailing winds and sun exposure). The climate in the study area would be semi-arid to arid in its entirety if not for the presence of the White Cliffs to the north. These cliffs and the region beyond, rising more than 1000ft above the BFAS operations and proposed Red Sands Mine site, capture significant moisture from passing storm systems in the form of rain and snow. The relevant Western Regional Climate Center weather station for the study area is KANAB, UT (COOP 424508) for Period 1981-2010 (WRCC 2019). These data will be used in the water budget analysis and potential effects of climate change in a later phase of this study (Table 1).

Data from the NWS COOP network, the NRCS (Natural Resources Conservation Service) SNOTEL network, and local, state, regional, and federal networks were used to prepare a map of spatially distributed precipitation corrected for elevation using PRISM (Parameter - elevation Regression on Independent Slopes Model) developed by Oregon State University for the NRCS (Figure 3). As these data sources show, there is a gradual precipitation gradient from about 15 inches annually at Kanab, UT in the far southern boundary of the BFAS study area to about 17 inches near the White Cliffs.

KANAB, UTAH

NCDC 1981-2010 Monthly Normals

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max. Temperature (F)	48.2	52.5	60.2	67.9	78.0	88.0	93.0	90.0	83.2	71.1	57.4	47.8	69.9
Highest Mean Max. Temperature (F)													
Year Highest Occurred													
Lowest Mean Max. Temperature (F)													
Year Lowest Occurred													
Mean Temperature (F)	36.3	40.1	46.1	52.5	61.2	70.0	76.2	74.3	67.0	55.8	44.2	36.0	55.1
Highest Mean Temperature (F)													
Year Highest Occurred													
Lowest Mean Temperature (F)													
Year Lowest Occurred													
Mean Min. Temperature (F)	24.4	27.7	32.0	37.1	44.3	52.0	59.4	58.6	50.9	40.6	30.9	24.3	40.2
Highest Mean Min. Temperature (F)													
Year Highest Occurred													
Lowest Mean Min. Temperature (F)													
Year Lowest Occurred													
Mean Precipitation (in.)	1.66	1.39	1.52	0.99	0.55	0.34	1.06	1.51	1.51	1.59	1.20	1.37	15.19
Highest Precipitation (in.)													
Year Highest Occurred													
Lowest Precipitation (in.)													
Year Lowest Occurred													
Heating Degree Days (F)	890.	697.	586	376.	152.	24.	0	1.	41.	289.	625	897.	4578.
Cooling Degree Days (F)	0.	0.	0.	1.	33.	174.	347	289.	102.	5.	0.	0.	952.

Western Regional Climate Center, wrcc@dri.edu

Table 1. Average monthly and annual maximum and minimum temperature and precipitation for KANAB station (COOP 424508) for period 1981-2010. (Source: Western Regional Climate Center (WRCC 2019).

Precipitation type (rainfall versus snowfall), amount, and temporal and spatial distribution are important for determining the amount of recharge that a groundwater system may receive, particularly when it consists of the thick unconsolidated materials or shallow, permeable bedrock under unconfined conditions. The distribution of average annual precipitation is an important indicator of the climate of a particular area, and in the case of the BFAS study area, the climate is semi-arid. There is a natural recharge potential in the topographically level to gently undulating uplands, mostly from rain and some snow throughout the late fall, winter, and spring, and a moderate to large natural recharge potential from both rain and snow in the fracture-controlled drainages, for example West Fork Three Lakes and Red Canyon drainages, and Kanab Creek canyon. The summer months are characterized by high evaporation rates and are too desiccated for significant groundwater infiltration and recharge in the valley floors and rims, with the exception of an occasional localized intense summer storm, especially on irrigated (high soil moisture content) lands and in the channels of the drainages. Thus, most of the natural groundwater recharge in the near-surface aquifers in the uplands occurs during only in the late fall, winter and early spring (October to April). It should be noted that the entire study area has groundwater recharge potential; even the driest areas probably receive approximately 1-2 inches of recharge annually. This is important when considering the ultimate groundwater system flow directions and areas of groundwater recharge, and for calculating water budgets.

Figure 3. The spatial distribution of the average annual precipitation for the period 1981-2010 in the BFAS study area. (Source: NRCS, 2019).

2.2 Topography and Geomorphology

The BFAS Canyon Operations complex is located in the Colorado Plateau physiographic province, and is geographically known as the Wygaret terrace (Freethey, 1988). The surface elevation in the JNKC study area ranges from about 1,500 m (≈5,000 ft) in the Vermillion Cliffs to about 1,800 m (≈6,000 ft) at the base of the White Cliffs (Figures 1 and 2). This landscape is characterized between the White Cliffs and Kanab as topographically flat-to gently rolling terraces dissected locally by deep canyons of Kanab Creek and its tributaries resulting in locally discontinuous terrain. The result is for surface water and shallow groundwater systems to be localized (*i.e.,* non-regional) within this area. Where Kanab Creek has not penetrated the various aquifers, underlying regional groundwater systems, such as the Jurassic Navajo Lambs Tongue (Jnl) and the northern part of the Jurassic Navajo (Jn) aquifers, they are non-dissected and maintain a regional flow system.

The topography of the study area has three distinct terrains: 1) gently sloping, poorly dissected, eolian and pedogenic deposits (such as proposed for mining) on continuous widespread terrace tops and flat areas, for example in the Red Knoll region, in the northern, western, and eastern areas of the study area, and on the tops of mesa areas between the drainages; 2) greatly dissected, connected, and continuous fractured bedrock features (stream drainages) with cliffs, hillslope fans and mass wasting features (particularly sand deposits and fans along and below these rimlands); and 3) continuous alluvial valley bottoms, mostly sandy materials, associated with the principal drainage of Kanab Creek and tributaries (Figures 1 and

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2). The non-dissected uplands promote localized groundwater system continuity. The fractured uplands promote discontinuity in groundwater systems resulting in discharge zones in the form of springs and seeps to the surface water systems. The continuous alluvial valleys promote continuity between the streams and the alluvial materials.

The deeper bedrock groundwater systems, if not topographically dissected by the surficial processes or affected by regional geologic structure and uplift activity, will be continuous and regional in nature. However, all of the deeper bedrock groundwater systems are affected by the regional geologic structure, and there is no continuity in the deeper bedrock systems east-west across the region at this location (to be discussed in later sections of the report), but, there is continuity in the deeper bedrock systems north-south. Therefore, these deeper bedrock systems in the BFAS study area do receive regional groundwater recharge and are recharged by, or are discharging into, the local shallow groundwater systems depending on the geomorphic geometry. Most of the alluvial terraces, fans, and river bottoms in the study area are connected, but are isolated topographically from the rest of the region. This results in discrete and localized groundwater systems and can result in discrete and localized springs and connections to surface water systems. This concept is important in identifying various segments of the water budget.

The topographic gradients in the BFAS study area can be divided into three types: 1) steep gradient bedrock slopes (greater than 2% slope) mostly in the dissected bedrock regions (dissected Wygaret plateau) and flanks of the surrounding rimlands (White Cliffs); 2) steep gradient unconsolidated materials slopes (greater than 2%) including the talus and alluvial fans forming beneath the rimlands of Kanab Creek and tributaries and along the exposed bedrock of the White Cliffs to the north; and 3) low gradient (less than 2% slope) fan, terrace levels, and alluvial valley bottoms associated with the uplands and valley bottoms of Kanab Creek (Figures 1 and 2), and eolian and pedogenic soils atop undissected bedrock plateaus (Red Knoll for example). The topographic gradient is useful in estimating the surface of the water table, for estimating the amounts of infiltration versus overland flow and interflow (rapid, shallow subsurface runoff), and for estimating residence times for subsurface water to be in contact with bedrock that may supply salt resulting in declining water quality.

2.3 Surface Water Characteristics

The BFAS study area contains one prominent local watershed draining to the Colorado River via Kanab Creek (Figure 1). Streams can be gaining flow (from groundwater, rapid surface runoff, and interflow), or losing flow (to groundwater, diversions or evaporation through phreatophyte vegetation), dependent on local hydrology, hydrogeology, irrigation practices, and time of year. Central Kanab Creek, in the study area, is mostly dependent on groundwater interactions either as gaining or losing stream reaches, or surface water events originating locally, or regionally in the Pink Cliffs and White Cliffs regions (Figure 4).

The Central Kanab Creek drainage originates in three regions: Pink Cliffs, White Cliffs, or locally as groundwater discharge in the form of springs and gaining reaches of streams (Freethey, 1988) (Figure 4). Kanab Creek drainage area enters the study area as an ephemeral channel except for two types of events: snow melt runoff and/or a precipitation event causes surface water to flow into the central Kanab Creek system from the north. Groundwater infiltration from the stream bed occurs during these events resulting in channelized groundwater recharge into the stream alluvium and the underlying bedrock. The central and lower parts of Kanab Creek is perennial where stream flow originates from spring flow and groundwater discharge from the stream bed and bedrock into the stream channel. Groundwater is also discharged by phreatophytes along these gaining stream reaches.

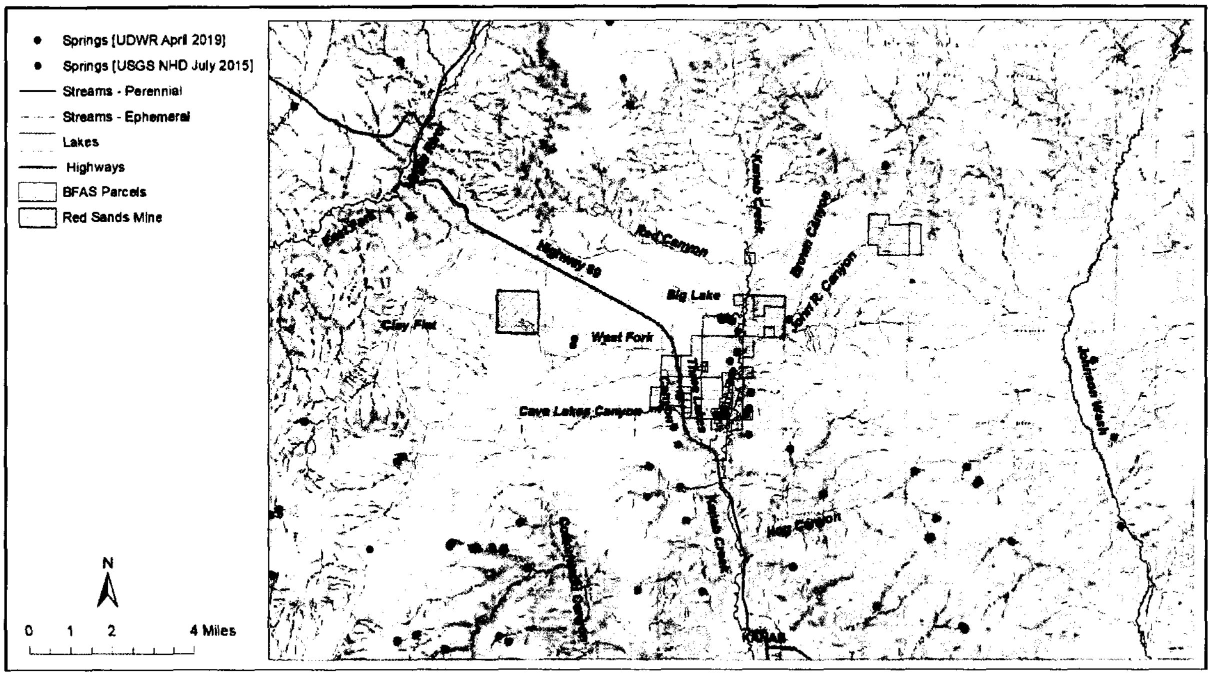

Figure 4. Location of perennial and ephemeral stream segments, lakes, (sub-)watersheds, and springs in the BFAS study area. (Sources: NRCS 2019; Utah AGRC 2019).

The gaining and losing dynamics of these streams are influenced by seasonal events, with bank full conditions occurring during the spring runoff, and low water conditions occurring during the rest of the year. In addition, some storm events of various durations and amounts can affect the yearly and seasonal flows. USGS Gage 09403600, located on Kanab Creek north of the Town of Kanab and just south of the BFAS entrance, has recorded yearly and monthly flow data, and Table 2a and 2b illustrate these daily, seasonal, and annual events for Kanab Creek at that location. Table 2a shows that during the period 2001-2018, the average yearly discharge at that location was 9.4 cubic feet per second (6,805 acre-ft/yr), and that the range 5.97 – 19.4 cubic feet per second (4,322 – 14,045 acre-ft/yr) was highly variable. There was no significant trend for wetter versus drier years in that short period of time. Table 2b shows that during the period 2001-2018, the monthly discharge was also highly variable, with the winter/spring months of February, March, April, and May having the highest flows due to events or snowmelt runoff, and the summer months having the lowest flows. It should be noted that on occasion, a major precipitation event or snowmelt runoff event could occur that not only boosts the recorded flows, but also could be responsible for a major groundwater recharge event. Five such flows occurred during the period 2001 – 2018, four in the winter: 1) March 2008: 40.1 cubic ft/sec; 2) December

2010: 57.4 cubic ft/sec; 3) March 2011: 50.1 cubic ft/sec; and 4) February 2017: 66.7 cubic ft/sec; and one at the end of the summer period 5) September 2014: 49.4 cubic ft/sec.

USGS 09403600 KANAB CREEK NEAR KANAB, UT

Available data for this site: Time-series: Annual statistics GO

Kane County, Utah
Hydrologic Unit Code 15010003
Latitude 37°06'02", Longitude 112°32'50" NAD27
Drainage area 194 square miles
Gage datum 5,060 feet above NGVD29

Output formats
HTML table of all data
Tab-separated data
Reselect output format

Water Year	00060, Discharge, cubic feet per second
Period-of-record for statistical calculation restricted by user	
2001	8.29
2002	5.97
2003	9.12
2004	6.90
2005	19.4
2006	7.36
2007	6.78
2008	9.56
2009	6.53
2010	8.99
2011	16.3
2012	6.67
2013	7.70
2014	10.8
2015	9.35
2016	10.5
2017	13.3
2018	6.09

** No Incomplete data have been used for statistical calculation

Table 2a. Yearly discharge of Kanab Creek at USGS Gage 09403600 at Kanab Creek bridge, near Kanab, Kane County, Utah for the period 2001-2018. (Source: USGS-NWIS, 2019).

USGS 09403600 KANAB CREEK NEAR KANAB, UT

Available data for this site: Time-series: Monthly statistics GO

Kane County, Utah
Hydrologic Unit Code 15010003
Latitude 37°06'02", Longitude 112°32'50" NAD27
Drainage area 194 square miles
Gage datum 5,060 feet above NGVD29

Output formats
HTML table of all data
Tab-separated data
Reselect output format

00060, Discharge, cubic feet per second,
Monthly mean in ft3/s (Calculation Period: 2001-01-01 -> 2018-12-31)

Period-of-record for statistical calculation restricted by user

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	7.43	6.92	17.5	12.6	5.62	4.56	4.08	5.69	10.1	5.12	5.54	5.98
2002	5.16	5.05	8.64	7.65	7.46	5.29	6.11	4.18	4.77	6.25	7.11	6.47
2003	9.21	12.8	29.5	8.15	7.26	6.01	4.74	6.24	5.70	3.58	6.16	7.61
2004	5.94	7.28	14.0	7.99	5.94	4.62	6.28	7.80	5.52	12.0	11.6	5.07
2005	40.2	21.0	41.9	45.9	25.4	8.44	5.52	8.13	5.50	8.09	7.22	6.59
2006	8.49	5.94	15.8	13.8	5.17	4.05	4.11	3.94	5.01	8.81	7.65	8.36
2007	8.14	9.62	8.61	6.89	5.01	4.54	3.96	3.99	5.75	5.40	5.38	7.90
2008	11.4	9.67	40.1	8.18	6.65	5.01	4.76	4.91	4.99	4.98	6.02	7.15
2009	7.50	10.6	14.8	6.06	4.95	4.12	5.85	3.15	3.41	5.34	5.91	8.93
2010	6.37	7.65	16.8	28.5	5.79	4.77	4.90	7.39	3.69	18.6	7.44	57.4
2011	5.86	7.49	50.1	16.3	6.87	5.29	5.61	6.22	4.95	6.10	6.67	6.24
2012	6.94	7.71	8.05	5.16	6.13	5.42	5.18	10.7	4.67	6.24	6.75	7.00
2013	7.82	7.72	8.84	11.0	7.08	4.92	5.67	8.61	6.64	5.11	8.11	6.38
2014	5.27	8.35	10.7	6.25	7.20	6.19	4.51	12.9	49.4	5.96	5.32	6.37
2015	7.35	6.71	21.0	10.2	7.43	8.81	9.27	8.44	15.2	16.1	5.20	5.40
2016	6.36	14.6	19.2	11.1	5.81	4.11	5.01	12.4	20.6	7.18	7.52	6.62
2017	9.92	66.7	24.0	15.0	7.35	4.85	4.57	3.96	4.03	4.19	5.55	7.94
2018	7.86	7.02	6.13	5.18	5.00	7.26	5.77	11.7	3.80	9.63	6.79	6.34
Mean of monthly Discharge	9.4	13	20	13	7.3	5.2	5.6	7.2	9.1	7.7	6.6	9.9

Table 2b. Monthly discharge of Kanab Creek at USGS gage 09403600 at Kanab Creek bridge, near Kanab, Kane County, Utah for the period 2001 - 2018. (Source: USGS-NWIS, 2019).

2.4 Springs and Seeps

Springs and seeps indicate places where water flows naturally from a rock or the soil onto the land surface or into a body of surface water. These features represent the contact between (saturated) groundwater and the land surface at that location. Springs usually emerge from a single point and result in a visible and measurable flow of water, or contribute measurably to the flow of a stream or the volume of a reservoir or pond. Seeps tend to be smaller than springs, have a more distributed character, and often show no visible runoff, especially in this semiarid climate where, in many cases, the water emerging in seeps is lost to evapotranspiration. In semiarid climates like the BFAS study area, springs and seeps may be identified by the presence of phreatophyte vegetation away from streams. Springs and seeps may be expressions of discharge of shallow groundwater from an unconfined aquifer, or of discharge from deeper aquifers at the contact between (more) permeable and (nearly) impermeable formations at or near the land surface, in fracture zones, or through karst conduits.

The BFAS study area contains a number of springs, seeps, and gaining reaches of streams as identified by previous publications, Google Earth analysis, field reconnaissance, and analysis of information from the State of Utah Water Rights Database (Figure 4). Most of the smaller springs and gaining reaches of streams are found in the upper reaches of Kanab Creek and its tributaries, and the larger springs are located in bedrock along the margins of Kanab Creek Canyon (Figure 4). Of particular interest to this study are West Fork springs, Three Lakes springs, Kanab Creek springs, Cave Lakes Canyon springs, Big Lake springs, and Red Canyon springs (Figure 4), which are mostly located at the Jn/Jkt contact in bedrock above and near the Kanab Creek and tributaries downgradient from the proposed Red Sands mine (Figure 4). A detailed discussion of springs and seeps in the JNKC area and their relationship with the local groundwater systems is presented in section 2.5.

2.5 Hydrogeologic Framework

Bedrock and unconsolidated materials have traditionally been classified as either aquifers or aquitards based upon being able to provide sufficient water for irrigation and industrial and municipal consumption. In this context, an aquifer is a permeable body of rock that is saturated with water and is capable of yielding economically significant quantities of water to wells (human and agricultural use) and springs (human and ecological use). A low-permeability formation overlying an aquifer is often called an aquitard or confining unit. As the terms "aquifer" and "aquitard" are rather ambiguous (e.g., what are economically significant quantities? or how confining is a low-permeability unit with respect to the transport of contaminants?), the use of these terms may be replaced by that of the term hydro-stratigraphic unit or hydrogeologic unit, in combination with terms qualifying the permeability and/or saturation of the unit (e.g., saturated, high-permeable hydrogeologic unit). A hydrogeologic unit is a geologic formation, part of a formation, or a group of formations with similar hydrologic characteristics (e.g., similar permeability characteristics and storage capacity). It should be noted that hydrogeologic units may not equate to geological units such as formations, formation members, and formation groups due to the frequently encountered variability of the flow characteristics of such geologic units. The term aquifer in this report is used to indicate a significant source of water supply from hydrogeologic units, and may include the qualifier potential (i.e., potential aquifer) when parameter uncertainty exists, especially with respect to average saturated thickness and water table fluctuations.

From a groundwater flow and water supply perspective, the most important property of rocks is the incorporated pore space and related permeability. The pore space, which defines the amount of water storage within a hydrogeologic unit, may be contemporaneous with the rock formation (primary or matrix porosity), or due to secondary geological processes, such as fracturing, faulting, chemical solution, and weathering (secondary porosity, fracture/karst porosity). The degree of connectivity and the size of the pore openings define the permeability of the rock, that is, the ease with which fluid can move through the rock. As with porosity, permeability may be primarily matrix based (matrix permeability), fracture and/or karst based (fracture/karst permeability), or may be a combination of both.

Unconsolidated sediments and clastic materials, as found in the BFAS study area, and observed on the pedogenic and eolian deposits, mass wasting colluvium and talus, and alluvial floodplains in Kanab Creek and its tributaries, are geologically very young and consist primarily of clays, silts, sands, and gravels. They are generally very porous and permeable, but can be quite variable in their thickness, continuity, and hydraulic properties. For example, field observations revealed that the thickness of the unconsolidated sediments in the BFAS study area ranges from less than 1 ft to greater than 100 ft. (Spangler and others, 1993). Estimates of hydraulic conductivity (K) of these unconsolidated materials range from 0.1-10 ft/day (Qal) and from 1 to 100 ft per day (Qes) (Heath, 1983). These hydrogeologic units, if found in large quantities would most likely contain the greatest amount of groundwater. In the BFAS study area, these units are either localized in small areas (stream bottoms), or are observed in large quantities in the upland areas as unsaturated sand dunes and pedogenic deposits (which are proposed to be mined).

Consolidated sedimentary rock, by comparison, is often quite porous, but variable in permeability. Most fine-grained detrital rocks like shale, claystone, and siltstone may have relatively high matrix porosities, but very low permeabilities (Davis and DeWiest, 1966). These fine-grained bedrock hydrogeologic units are the dominant confining layers of sedimentary groundwater systems, with small hydraulic conductivity values typically less than 0.01 ft per day. Coarser-grained sedimentary rock, such as sandstone, can pair relatively high matrix porosity with significant permeability, and may contain significant amounts of groundwater.

The hydraulic properties of sedimentary rock may be largely enhanced when fractures and faults are present (Davis and DeWiest, 1966). As a case in point, the sandstones rocks in and near the BFAS study area that are affiliated with the entrenched drainages have enhanced permeability due to fracture and fault density and connectivity along these drainages. Significant secondary porosity and permeability are developed through faulting, fracturing, and weathering of the sedimentary rock, especially in association with active faults, fracture zones, and near-surface stress-release.

2.5.1 Hydrogeologic Units of the BFAS Study Area

There are two significant groups of hydrogeologic units in the BFAS study area: 1) Quaternary unconsolidated clastic materials (Figure 5; Table 3), which are predominantly Stream Alluvium (Qal) and Eolian Sand (Qes); overlying 2) Mesozoic bedrock units (Figure 5; Table 3), including the following potentially water-bearing units: fractured and matrix Upper Navajo Formation (Jn), and fractured and matrix Lamb Point Tongue of the Navajo Formation (Jnl). Table 3 and Appendix A lists the hydrologic characteristics of these units, and show that most of these units have low matrix hydrologic conductivity and have springs with variable well yields. By comparison, the Carmel Formation (Jc), Tenney Canyon Tongue of the Kayenta Formation (Jkt), and Kayenta Formation main body (Jk) may act as thick, poorly transmissive confining layers *(Freethey, 1988; Heilweil and Freethey, 1992)*.

Figure 5. Map showing the hydrogeologic units and hydro-structures in the BFAS study area.

From a water supply perspective, the unconsolidated clastic sediments, specifically when composed of larger size particles (>2.5 mm or 0.1 in) and observed to have sufficient saturated thickness and horizontal continuity, provide a significant and accessible water supply. The water supply function of bedrock units is largely dependent on rock type, large-scale structure and degree of fracturing, layer geometry and orientation, and the spatially variable hydrologic inputs and outputs, and may vary significantly dependent on location. The focus of this HESA was on the deeper bedrock units that have been tapped for water supplies in areas where the shallow unconsolidated aquifers cannot supply adequate quantities of water for the landowners or are the source of major springs for BFAS and Town of Kanab water supplies, and the relations of these hydrologic systems to the surface water systems of Kanab Creek and its tributaries.

Geological Unit	Hydro-geological Unit	Hydro-geological Unit Symbol	Composition	Hydrogeological Characteristics
Alluvium	Unconfined Alluvial Aquifer	Qal	Stratified, moderately to well-sorted clay, silt, sand, and gravel deposits in large active drainages; mapped along Kanab Creek and its major tributaries, includes alluvial-fan and colluvial deposits too small to map separately, and alluvial terrace deposits as much as 10 feet (3 m) above modern channels: 0 to 30 feet (0–9 m) thick.	High matrix permeability, high storativity, easily transmits water. Acts as and aquifer where saturated. Water tables have moderate to high fluctuation.
Eolian Sands	Unsaturated Eolian Sands	Qes	Well-to very well sorted, very fine to mediumgrained, well-rounded, mostly quartz sand derived principally from the Navajo Sandstone; commonly deposited in irregular hummocky mounds on the lee side of ridges, primarily on the main body of the Navajo Sandstone and on gentle slopes of the Lamb Point Tongue of the Navajo Sandstone, but also deposited on alluvial-terrace (Qat) deposits where side canyons widen; 0 to 20 feet (0–6 m) thick.	Unsaturated, highly permeable and porous sand. High storativity where saturated. Increases recharge to underlying bedrock units where thick. Water tables seasonal only.
Carmel Formation	Carmel Confining Unit	Jc	Interbedded limestone, limey shale, and siltstone (at the base).	Low matrix permeability; may transmit water where fractured. Acts as confining layer.
Navajo Sandstone	Upper Navajo Aquifer	Jn	Greyish-white to greyish-orange; very fine to medium grained; massively cross-bedded, well cemented cliff forming quartz sandstone.	Moderate matrix permeability, moderate storativity. Permeability and storativity increased when fractured. May yield significant discharge to wells, springs and seeps. Acts as major Water tables fluctuate seasonally and moderately.
Tenny Canyon Tongue of the Kayenta Formation	Tenny Canyon Confining Unit	Jkt	Interbedded pale to reddish brown; interbedded mudstone and siltstone with thinly bedded laminar quartz sandstone; ledgy slope former	Low matrix permeability and storativity; permeability and storativity increased when fractured; may transmit water where fractured. Acts as confining aquifer
Lamb Point Tongue of the Navajo Formation	Lamb Point Aquifer	Jnl	Greyish-white to greyish-orange; very fine to fine grained; massively cross-bedded cliff forming quartz sandstone.	Moderate matrix permeability and storativity. Permeability and storativity increased when fractured. May yield significant discharge to wells, springs and seeps. Acts as major aquifer. Being confined, potentiometric surface fluctuates minimally
Kayenta Formation main body	Kayenta Confining Layer	Jkm	Reddish brown siltstone and mudstone; interbedded with fine-to medium grained sandstone; interformational thin beds of limestone and conglomerate.	Low matrix permeability and storativity; may increase permeability and storativity where fractured; may transmit water where fractured. Acts as confining layer.
Moenave, Wingate, Chinle & Moenkopi Formations	Older Hydro Units	Jm; Jw; TRc; TRm	Interbedded sandstones, siltstones, claystones, limestones.	Various aquifers and confining layers not separated out for this study

Table 3. Correlation of geological and hydrogeologic units in the BFAS study area.

Additionally, water quality is also an issue that is addressed, both in discerning the nature of the shallow and deeper groundwater systems, the nature of the interactions between these two types of groundwater systems with Kanab Creek, Three Lakes, and Big Lake, and in the assessment of water protection of springs and water wells for the BFAS water supply.

The Quaternary unconsolidated clastic units (Qes and Qal in Table 3 and Figure 5) are a mixture of fine and medium sand sized materials in the eolian deposits, and are predominantly a mix of coarse, medium, and fine sand sized materials with some gravels in the larger channels of the alluvial deposits. The eolian units, which are moderately to highly permeable, are recharged by infiltration from precipitation that is non-uniformly distributed due to the slope steepness, slope aspect, and to position in the landscape; and the alluvial units, which are also highly permeable, by flow in ephemeral stream channels and losing streams in perennial reaches where favorable. The eolian unconsolidated units are primarily unsaturated or seasonally saturated, and the alluvial units are variably to fully saturated, based on spatial location and seasonal precipitation events. There is lateral and vertical groundwater flow connection between the unconsolidated materials and the underlying bedrock formations that is critical for understanding the hydrologic systems and water quality of the BFAS study area.

The thickness and surface distribution of the eolian sediments is variable, and ranges from less than 1 ft to greater than 100 ft in the northern and central part of the BFAS study area (Figure 5). The thicknesses of the unconsolidated alluvial material in Kanab Creek is also variable, and commonly ranges from 1 – 100 ft. The subsurface distribution of alluvial thickness is indicative of the faulting and fracturing associated with Kanab Creek and its tributaries with subsequent erosion and filling of fault and fracture zones with sands and gravels.

The Mesozoic bedrock units (Figure 5; Table 3) includes the following potentially water-bearing units: fractured and matrix Upper Navajo Formation (Jn), and fractured and matrix Lamb Point Tongue (Jnl). Table 3 and Appendix A lists the hydrologic characteristics of these units, and show that most of these units have low matrix hydrologic conductivity and have springs with variable well yields. The Upper Navajo Formation has a saturated thickness in the study area of 200-250 feet as observed in the Town of Kanab wells (Heilweil and Freethey, 1992). The Lamb Point Tongue has a thickness of about 100 ft between the Sevier Fault and Kanab Creek (Heilweil and Freethey, 1992).

The Upper Navajo Sandstone bedrock (Jn) has both matrix flow and fracture flow. The horizontal hydraulic conductivity of the matrix (Khm) ranges are in the range of 0.1 – 6.0 ft/day, while vertical hydraulic conductivity of the matrix (Kvm) are in the range of 0.01 – 5.0 ft/day, whereas the horizontal fracture flow is estimated to have a hydraulic conductivity (Khf) of 7.55 ft/day, and the vertical fracture flow is estimated to have a hydraulic conductivity (Kvf) of 0.5 ft/day (Heilweil and Freethey; 1992). In other studies of the Navajo aquifer, the fracture flow has ranges estimated from 5.0 -20.0 ft/day (from Freethey, 1988; Freethey and Cordy, 1991). The Lamb Point Tongue has similar ranges and values: Kh estimated at 0.002 – 4.2 ft/day; Kv estimated at 0.005 – 2.2 ft/day (Freethey, 1988). By comparison, the Tenney Canyon Tongue (Jkt) confining unit has considerably lower ranges and values: Kv estimated at 0.005 – 0.42 ft/day (Freethey, 1988).

2.5.2 Hydro-structures of the BFAS Area

Geologic faults and fracture zones, sometimes expressed at the surface as lineaments or linear drainage segments, may influence the hydrogeology and hydrologic systems of the BFAS study area, including Kanab Creek and its tributaries (Figure 5). These hydrostructures underlie the drainages in the bedrock systems, primarily the Upper Navajo aquifer (Jn) and Lambs Tongue aquifer (Jnl), and are most likely associated with preferential groundwater flow along fault and fracture zones that are observed or hypothesized to transmit groundwater either vertically or laterally along the fault or fracture planes or zones. These structures may serve as distinct hydrogeologic units, may enhance the permeability of sections of bedrock hydrogeologic units, may connect multiple hydrogeologic units together, or may restrict the thickness and flow of overlying unconsolidated deposits resulting in springs and groundwater discharge areas. These hydro-structures, if "open", may also result in connectivity between deeper groundwater systems and the streams, which may be a concern if future water well drilling or surface water diversion occurs. Each fault and fracture zone should be evaluated for the following characteristics: 1) fault and fracture plane geometry, including the vertical or horizontal nature of the fault/fracture plane and the relations of rock types and geometry on both sides of the structure; and 2) the transmissive nature of the fault/fracture plane or fault/fracture zone, including the nature of fault gouge, if any (clay, gravel), and tectonic setting of fault/fracture plane or zone (extension or compression). The fault/fracture plane geometry is important to evaluate if groundwater can move horizontally across the zone from one transmissive unit to another, or whether the groundwater is forced to move vertically upward to the surface, in many cases, or downward into a different hydrogeologic unit, or laterally parallel to the fault and fracture zone like a geotechnical French drain. The tectonic setting helps determine whether the fault/fracture plane is "open"—able to easily move water (extension), or "closed"—not able to easily move water (compression).

Hydrostructures, which are defined by folds, faults and fracture zones, control the location of Kanab Creek and the accompanying tributaries, including Red Canyon, Big Lake Canyon, West Fork Three Lakes Creek, Three Lakes Creek, Cave Creek, John R Canyon, Brown Canyon, and Hog Canyon among others. These hydrostructures can exist sub-regionally and regionally if structural and topographic continuity exist (Figures 5). The main regional fault and fracture zone structures are the Sevier Fault, the Kanab Creek fracture zone, and the Johnson Wash fault zone (Figure 5). These features dip almost vertically and strike from the north to south (Figure 5).

The Sevier fault zone, which dissects the Upper Navajo hydrogeologic unit, forms a closed hydrogeologic and hydrologic system boundary along the west side of the BFAS study area due to the discontinuity of hydrogeologic units across the feature. This hydrostructure is a hydrologic block that prevents most shallow groundwater in the Upper Navajo aquifer from flowing across east to west near Red Knoll. The other two north-south hydrostructures: the Kanab Creek fracture zone with accompanying faults; and the Johnsons Wash fault zone function as French drains (high K zones with groundwater storage) where groundwater moves both vertically and horizontally along the axis of the structure. In the northern part of the BFAS study area, the Kanab Creek fracture zone is open and a French drain that moves groundwater vertically down into the Upper Navajo aquifer and deeper Lambs Tongue aquifer as a recharge zone. From Red Canyon to below the confluence with John R and Brown Canyons, the Kanab Creek French drain (high K zone with groundwater storage) is open, but serves as a vertical collector of Upper Navajo aquifer water discharged to Kanab Creek (gaining stream) and a horizontal conduit for shallow groundwater flow to the south. Finally, the Kanab Creek fracture zone (high K zone with groundwater storage) is open south of the Big Lake confluence to the Kanab Creek bridge and Three Lakes Canyon confluence where the groundwater is vertically transmitted to/from the Lambs Tongue as recharge/discharge, and a horizontal conduit for shallow groundwater to the south.

By comparison, the fault splay off of the Kanab Creek fracture zone, which is the Three Lakes Creek fault zone and drainage, serves as a partial barrier to ground water flow that has resulted in the formation of the Three Lakes (Figure 5). However, groundwater at that location continues to flow eastward across that feature to daylight as springs in the BFAS part of the Kanab Creek French Drain (Figure 5).

The Johnson Wash fault zone functions as a French drain (Figure 5) and serves as a collector for shallow groundwater from the Upper Navajo aquifer. That drainage, however, is in a different groundwater system and watershed than the BFAS study area.

An east-west trending fracture set that serves as hydro-structures occurs in the BFAS study area (Figure 5). These features, including West Fork Three Lakes Creek, Cave Creek, Hog Canyon, and Big Lake, are open and function as French drains (high K zones with groundwater storage) that allow groundwater in the shallow Upper Navajo aquifer to travel to the fractures, and then travel along the fractures to discharge zones.

2.6 Groundwater Flow Systems

Groundwater flow is the movement of water from the earth's surface into the subsurface (groundwater infiltration and recharge), through the subsurface materials (groundwater flow and storage), and from the subsurface back to the Earth's surface (groundwater discharge), expressed in terms of flow directions, patterns and velocities. The driving force for groundwater flow is a difference in piezometric "head" or groundwater levels, as expressed, for example, by the slope of the water table. The general Conceptual Site Model (CSM) of the groundwater flow system consists of 1) water inputs (recharge); 2) storage in and movement through subsurface hydrogeologic units (groundwater flow); and 3) water outputs (discharge). The general Conceptual Site Model (CSM) is helpful to determine the water balance of the groundwater flow system, which is the quantitative balance of the water inputs with the water outputs. Natural recharge is based on climate and soils resulting in infiltration of precipitation and snowmelt. Groundwater interaction with streams, vegetation (evapotranspiration), and human activity (irrigation, urbanization, wells and individual sewage disposal systems, reservoirs and ponds, oil and gas activity, mining, dewatering) will affect groundwater movement to varying degrees. The CSM also incorporates topography (steepness, slope aspect, degree of landscape dissection), geomorphology, and soil and rock properties. Because of the time-space variance of these inputs and outputs, a groundwater system often shows significant variations in water levels, water storage, flow velocities, and flow patterns. Some of the variations are seasonal; others may be related to multi-year periods of above-average or below-average precipitation. This results in variations in the availability of water from these hydrogeologic units.

Based on the HESA approach (*Kolm and others, 1996*), and previously collected supporting data, the regional, sub-regional, and local scale groundwater flow systems are delineated. The broad hydrologic system inputs include: 1) infiltration of precipitation as rain and snowmelt; 2) areas of losing perennial and ephemeral streams (for example, reaches of the Kanab Creek in the BFAS study area, reaches of ephemeral streams on the sides of the White Cliffs and Johnson Wash/Kanab Creek divide); 3) infiltration and runoff from water bodies (Three Lakes, Big Lake); and 4) horizontal and/or vertical inter-aquifer transfer of groundwater between unconsolidated materials and bedrock systems (for example between the Kanab Creek alluvium and the Upper Navajo bedrock). The general hydrologic flow subsystems, including the undissected uplands terrace level, hillslope, and valley bottom type geomorphic systems, consist of a combination of, among others, the following hydrologic processes: 1) surface runoff (channel and/or overland flow) and rapid near-surface runoff (interflow or shallow through-flow); 2) saturated groundwater flow in parts of the bedrock units and alluvial valley bottoms; 3) groundwater discharge to springs and seeps, and directly to gaining streams; 4) groundwater recharge from losing streams; 5) discharge by plants as evapotranspiration; and 6) discharge by pumping wells. In general, shallow groundwater flow in these systems is with topography away from upland tops, along the axis of the upland tops, and/or towards the valley bottoms, perpendicular to the major streams. Where permeable bedrock units underlie the uplands, hill slopes, and valley bottoms, recharge by groundwater moving from unconsolidated hydrogeologic units into the bedrock hydrogeologic units may force the groundwater into a more regional or sub-regional pattern determined by geological structure, independent from local topography and hydrography. However, the groundwater subsystems of the BFAS study area are a complex mix of bedrock aquifers, and predominantly shallow unsaturated upland top and hillslope eolian and colluvial systems, and valley bottom alluvial aquifer systems underlain by either bedrock aquifers, or more confining hydrogeologic units. Locally and sub-regionally, various hydro-structures may influence interconnectivities of the shallow units with deeper bedrock systems, and there is a regional system underneath due to hydrogeologic, structural, and geomorphologic (including topographic) connectivity.

The Jurassic Navajo Kanab Creek hydrologic system (JNKC), located in the core of the BFAS study area (Figure 6), is a complex mix of fractured and faulted Navajo Sandstone (Jn), Eolian Sand (Qes), Sandy alluvium (Qal), Sandy Miscellaneous Unconsolidated deposits (colluvium, eolian, alluvium mixture), and hydro-structures which form the robust groundwater system and surface water system that is directly connected to the BFAS and Town of Kanab springs and wells (Figures 4, 5 and 6). This hydrologic system is hydraulically connected to the Kanab Creek Lower Alluvium system and to the Jurassic Navajo Lamb Tongue regional hydrologic system down valley and underneath (discussed in forthcoming paragraphs).

As springs are discharge points of groundwater flow systems, their presence in the BFAS study area provide clues about these groundwater flow systems, including the role of the hydrogeological units, hydro-structures, and the effects of natural and anthropogenic recharge on flow and water quality. The location of springs and seeps in the BFAS study area were identified using topographic maps and the Utah State water rights records, augmented by field reconnaissance. The locations of these springs are discussed in Section 2.3 (Figure 4). The springs are plotted with the distribution of the hydrogeologic units to determine the hydrologic systems relationships (Figure 7).

Figure 6. Plan view of the shallow groundwater flow system directions on top of the hydrogeologic units of the BFAS study area.
The small arrows are local groundwater flow directions. The larger blue arrows show groundwater flow direction along major hydro-structures.

There are three spatial distributions of springs, based on spring location with respect to hydrogeologic location, that are informative for the analysis of the surface water and groundwater systems in the BFAS study area. The first type of springs is located in the alluvium in the Kanab Creek and tributary channels, including the springs by Red Canyon, John R. Canyon, and Brown Canyons, and in the alluvium of West Fork Three Lakes near the proposed mine site (Figure 7). These springs emanate from the Upper Navajo bedrock system (Jn), and represent the culmination of the groundwater flow in that part of the Jn hydrologic system and the beginning of flow in the Quaternary alluvium of Kanab Creek and tributaries. These springs are also the beginning of the tributaries of the Kanab Creek surface water systems, which will affect the entire JNKC hydrologic system.

The second group of springs is observed throughout the BFAS area at the contact between the Upper Navajo aquifer (Jn) and the Tenney Canyon Tongue (Jkt) confining unit. These include the BFAS springs in Kanab Canyon on both sides of the stream, springs in Hog Canyon, and in Cave Lakes Canyon (Figure 7). These springs are bedrock discharge areas where the Upper Navajo aquifer (Jn) is deeply fractured or faulted and the groundwater finds a preferential flow path from the bedrock to the surface enhancing the surface water flow regimes (gaining streams). Downgradient of these springs, the surface water may eventually return to a different groundwater system as recharge.

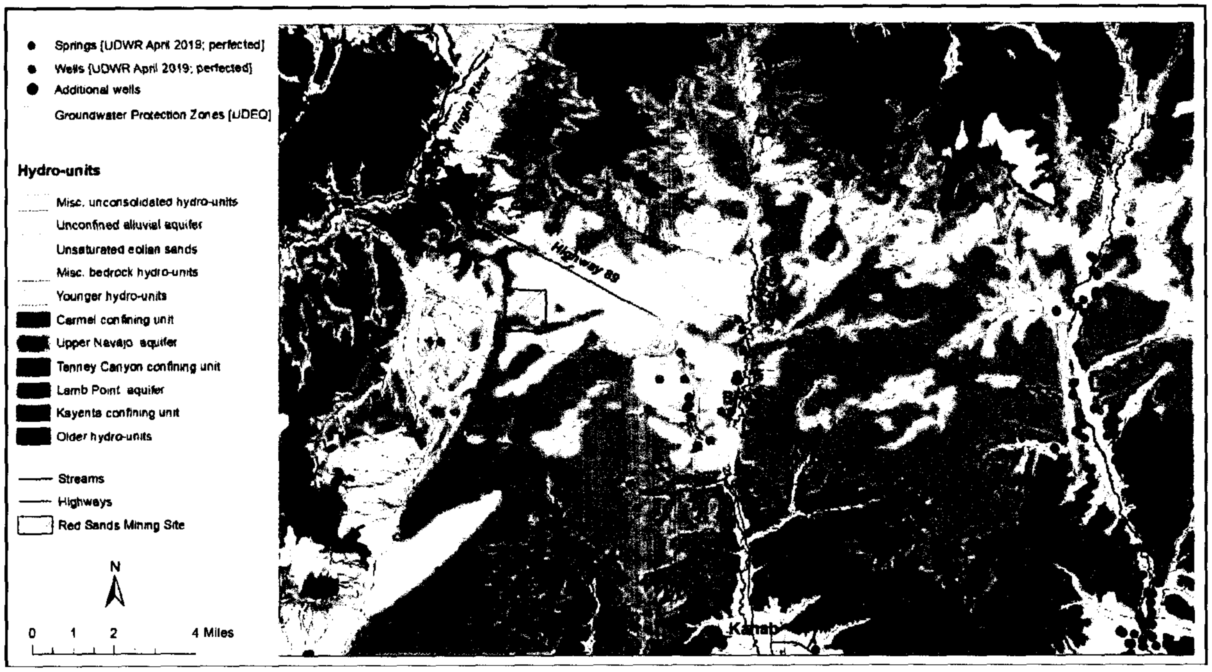

Figure 7. Plan View of the location of wells, springs, source protection zones, and streams on top of the hydrogeologic units of the BFAS study area.

The third group of springs, which include the largest groups of lakes: three Lakes, is located in bedrock along the margin of Three Lakes Canyon (Figure 7). These major springs are groundwater discharge areas where the Upper Navajo aquifer (Jn), due to blocking hydro-structures, force groundwater to daylight to the surface enhancing the surface water flow regimes at that location (Figure 7). Downgradient of these major springs, the surface water quickly flows back into the Jn bedrock system as groundwater recharge. The groundwater then flows to the BFAS springs and wells in the Kanab Creek Canyon (Figures 6 and 7).

2.7 Groundwater System Conceptual Site Model of the JNKC Hydrologic System

The Jurassic Navajo Kanab Creek Hydrologic system (JNKC) is a complex mix of fractured and faulted Navajo Sandstone (Jn), Eolian Sand (Qes), sandy Stream Alluvium (Qal), sandy miscellaneous unconsolidated deposits (colluvium, eolian, alluvium mixture), and hydro-structures (fault and fracture zones) forming the robust groundwater system and surface water system that is directly connected to the BFAS and Town of Kanab springs and wells (Figures 4, 5, 6 and 7). This hydrologic system is hydraulically connected to the Kanab Creek Lower Alluvium system and to the Jurassic Navajo Lamb Tongue regional hydrologic system down valley and underneath.

As stated in Section 2.5.1, there are two significant groups of hydrogeologic units in the BFAS study area: 1) Quaternary unconsolidated clastic materials (Figure 5; Table 3), which are predominantly Stream Alluvium (Qal) and Eolian Sand (Qes); overlying 2) Mesozoic bedrock units (Figure 5; Table 3), including the following potentially water-bearing units: fractured and matrix Upper Navajo Formation (Jn), and fractured and matrix Lamb Point Tongue (Jnl). Table 3 and Appendix A lists the hydrologic characteristics of these units, and show that most of these units have low matrix hydrologic conductivity and have springs with variable well yields. By comparison, the Carmel (Jc), Tenney Canyon Tongue (Jkt), and Kayenta (Jk) units may act as thick, poorly transmissive confining layers (Freethey, 1988).

As stated in Section 2.5.2, the main regional fault and fracture zone structures are the Sevier Fault, the Kanab Creek fracture zone, and the Johnson Wash fault zone (Figure 5), which dip almost vertically and strike from the north to south (Figure 5). The Sevier fault zone, which dissects the Upper Navajo hydrogeologic unit, forms a closed hydrogeologic and hydrologic system boundary along the west side of the BFAS study area due to the discontinuity of hydrogeologic units across the feature. The other two north-south hydrostructures: the Kanab Creek fracture zone with accompanying faults; and the Johnson Wash fault zone are open and function as French drains (high K zones with groundwater storage) where groundwater moves both vertically and horizontally along the axis of the structure depending on location. By comparison, the fault splay off of the Kanab Creek fracture zone, which is the Three Lakes Creek fault zone and drainage, serves as a partial barrier to ground water flow that has resulted in the formation of the Three Lakes (Figure 5). However, groundwater at that location continues to flow eastward across that feature to daylight as springs in the BFAS part of the Kanab Creek French drain (Figure 5). The Johnson Wash Fault Zone functions as a French drain (Figure 5) and serves as a collector for shallow groundwater from the Upper Navajo aquifer. The east-west trending fracture set including West Fork Three Lakes Creek, Cave Creek, Hog Canyon, and Big Lake, are open and function as French drains (high K zones with groundwater storage) that allow groundwater in the shallow Upper Navajo aquifer to travel to the fractures, and then travel along the fractures to discharge zones.

The shallow Quaternary unconsolidated materials in this subsystem are located in two strategic locations: directly along the main channels of streams (Qal) and as deposits of various thickness on the uplands (Qes) (Figure 5 and Table 3). These highly-permeable deposits are homogeneous, mostly fine to medium grained sand, and locally derived from the weathering and eolian deposits of the Upper Navajo (Jn) bedrock.

As stated in section 2.5.1. the Upper Navajo Sandstone bedrock (Jn) has both matrix flow and fracture flow. As the fracture permeability is significant higher than the matrix permeability, fracture flow will dominate travel times and will be most important for contaminant studies and well/spring protections, as well as estimating groundwater storage and recharge rates.

The general aspects of groundwater flow in the Quaternary unconsolidated materials have been discussed in Section 2.5. Specifically, the presence of Eolian Sand (Qes) facilitates enhanced groundwater recharge by infiltration of precipitation (snow and rain) to the bedrock underneath. The Quaternary Stream Alluvium (Qal) in the Kanab Creek channel and tributaries is closely aligned with the stream levels except where the stream is gaining, in which case the groundwater levels may be higher reflecting water moving from the bedrock into the stream.

Recharge to the Upper Navajo Sandstone in the JNKC hydrologic system is by infiltration of precipitation (snow and rain) directly into bedrock, or through the eolian sand cover on the surface of the uplands and interfluve tops; by north-south and east-west trending fracture-controlled ephemeral stream channels, and by losing reaches of flowing streams (Figure 6). These ephemeral channels include upper Kanab Creek, upper Brown and John R. drainage, and upper Red Canyon drainage (Figure 6).

Groundwater flow in the Upper Navajo aquifer is strongly fracture controlled, and moves from the drainage divides in the same direction as the stream with various stream reaches being gaining or losing depending on topography, bedrock hydrogeology, hydro-structures, and saturated thickness of the bedrock. Most of the streams are French drains where groundwater flows parallel to the surface feature, and discharges into the gaining streams. There is also groundwater discharge from the bedrock locally mostly by phreatophytes.

The sub-regional groundwater flow direction is from west to east around and near Red Knoll, and east to west from the Johnson Wash groundwater divide (Figure 6). The High K Zone flow systems of Kanab Creek, West Fork Three Lakes drainage, and Cave Creek drainage collect most of the groundwater flow system which ultimately ends in the Kanab Creek main channel system (Figure 6).

The connectivity and interactions of Kanab Creek, and the Town of Kanab and BFAS wells and springs, with the groundwater flow paths of the JNKC hydrologic system, that may be impacted by the Red Sands Mine in the western parts of the study area, are extremely complex, and warrant detailed illustration. A map showing the locations of a series of detailed hydrogeologic and hydrologic system cross-sections illustrating the groundwater movement and discharge of the lower JNKC hydrologic system and the relationship to the proposed Red Sands mining operation and water extraction from the JNKC aquifer is shown in Figure 8. They are based on the modified geologic cross-sections presented in Freethey (1988); Heilwall and Freethey (1992); and Spangler et al. (1993). These detailed cross-sections illustrate potential groundwater pathways and potential changes in aquifer function due to the proposed Red Sands mining and groundwater extraction sites (Figures 9a, 9b, 9c,10a, 10b, and 11).

Groundwater discharges out of the JNKC hydrologic system in three notable places due to the hydrogeology and the complex hydrostructures: 1) The Kanab Creek fracture zone/French drain that receives groundwater to various springs and seeps along its path including the Red Canyon upper Kanab Creek springs where the perennial Kanab Creek begins, and at the BFAS springs along the central parts of the canyon including Big Lake near the BFAS Headquarters (Figure 6); 2) The Three Lakes discharge zone in Three Lakes Canyon; and 3) The West Fork Three Lakes discharge zone that delivers groundwater to the City of Kanab (Figure 6). At these locations, groundwater moves vertically upward onto the surface as discharge at springs, and the surface runoff from the springs flows over bedrock in channels down into the Kanab Creek surface water and alluvial aquifer system (Figures 9a, 9b, 9c,10a, 10b, and 11).

Figure 8. Map showing the locations of the cross-sections representative for the Conceptual Site Model in the BFAS study area on top of hydrogeologic units and hydro-structures.

Figure 9a specifically illustrates the groundwater flow path and connectivity of the groundwater system from the area of the proposed Red Sands mine and water well - prior to its operation - in the Upper Navajo aquifer along the fracture zone that contains the West Fork Three Lakes drainage to the Town of Kanab wells, and to the springs and wells at the BFAS site in Kanab Canyon. The West Fork Three Lakes fracture zone is illustrated as a French drain or "drain like structure". The atmospheric water recharges the groundwater system at the proposed mine site by infiltration of precipitation through the bedrock directly, or through the eolian deposits (Qes), which enhances recharge to the bedrock system (Figure 9a). In the undisturbed state, groundwater then flows to the east preferentially in the West Fork Three Lakes fracture zone to discharge into the West Fork drainage as a perennial stream, or continue along the preferred groundwater zone through the hydro-structure. Groundwater is then consumed by phreatophytes as a discharge function. The Town of Kanab also has wells in this drainage, which is another form of groundwater discharge from the Upper Navajo aquifer (Figure 9a).

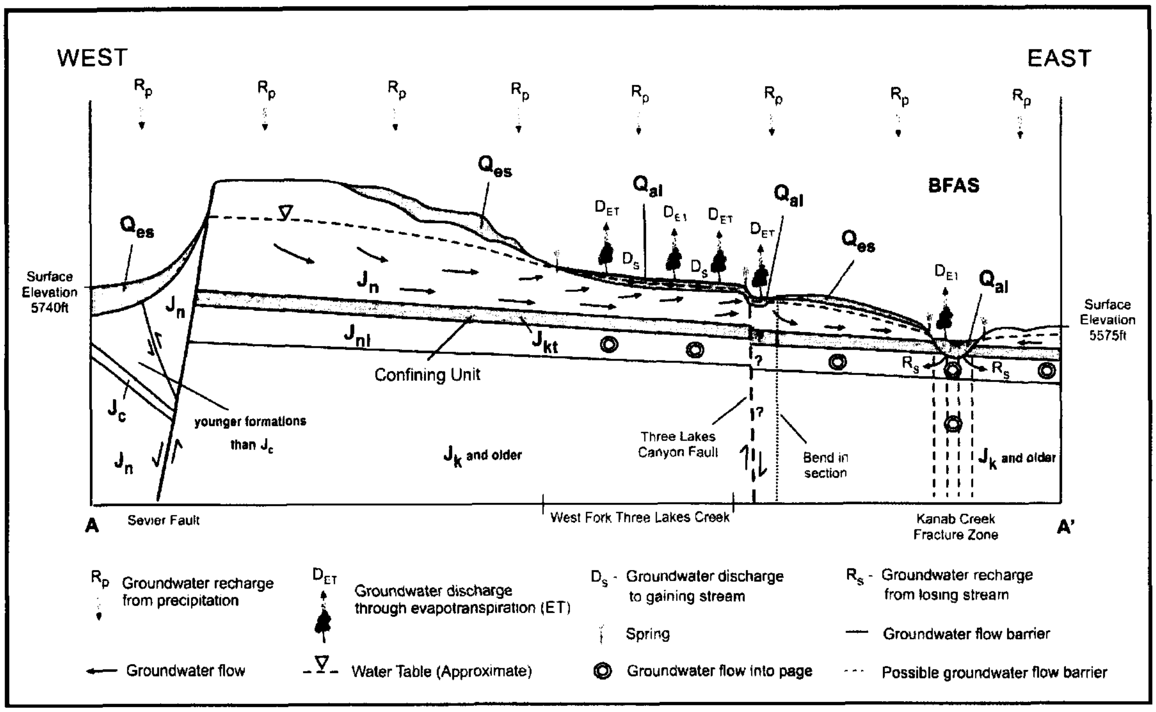

Figure 9a. Schematic pre-development east-west cross-sectional view of West Fork Three Lakes part of the Conceptual Site Model of the JNKC hydrologic system in the BFAS study area (cross-section A-A' in Figure 8).

The Three Lakes Canyon fault creates a partial block to groundwater flow, and groundwater is discharged into Three Lakes Canyon creating the three surface water bodies (Figure 9a). Groundwater may also be traveling vertically in the Three Lakes Canyon fault zone to connect with the deeper Lamb Point Tongue aquifer (Figure 9a). The remainder of the groundwater in the Upper Navajo Aquifer travels east to discharge as springs or by wells in Kanab Canyon at the BFAS site.

Figure 9b and 9c illustrate the potential disruption of well pumping at the Red Sands mine site. Figure 9b illustrates a well located in the Upper Navajo aquifer where pumping creates a cone of depression that travels preferentially along the West Fork Three Lakes Creek. Note that the perennial stream dries up, there is a potential decline in the productivity of the Town of Kanab wells, there is a reduction in the phreatophytes (habitat destruction) and that the water levels decline down gradient causing a decline in the springs at Three Lakes Canyon, a decline in lake levels and lake habitat, and a decline in the BFAS springs at the west side in Kanab Canyon (Figure 9b). The removal of eolian sand at the mine site will reduce the groundwater infiltration and increase the evapotranspiration significantly resulting in further declines in water tables downgradient.

Figure 9c illustrates a well located in the Lambs Point Tongue, a confined aquifer system located underneath the Upper Navajo aquifer and Tenney Canyon Tongue confining layer, and the potential disruption of water supply in the overlying Upper Navajo aquifer. Pumping of the

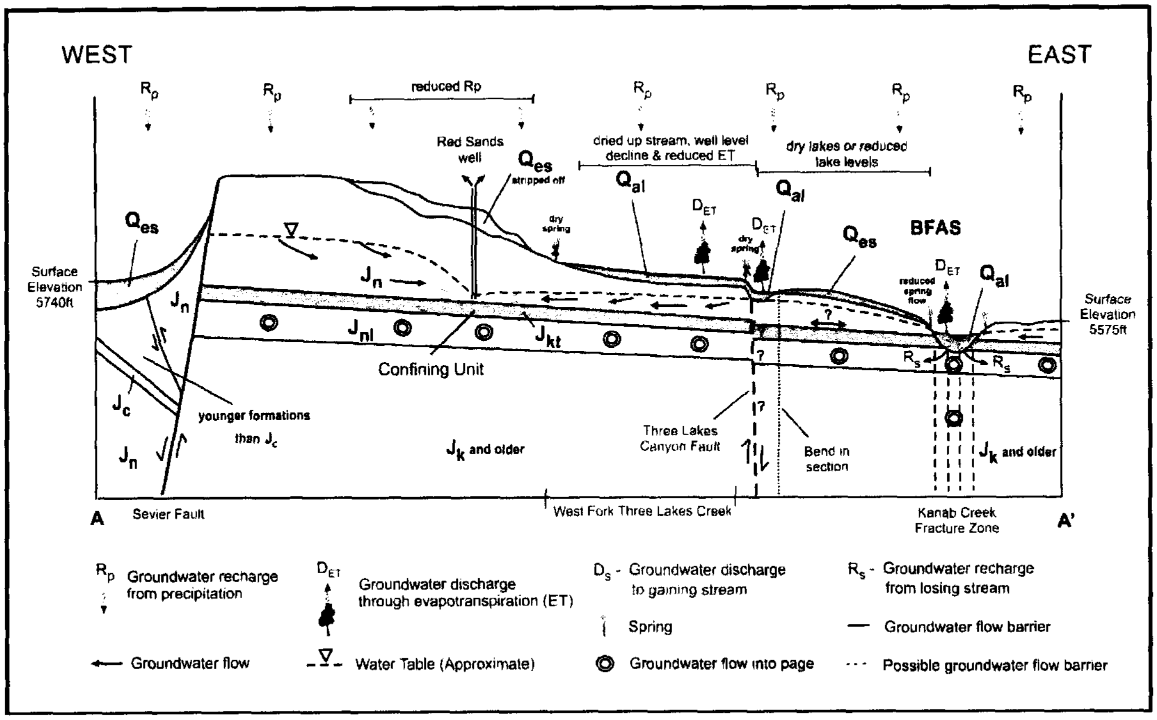

Figure 9b. Schematic post-development east-west cross-sectional view of West Fork Three Lakes part of the Conceptual Site Model of the JNKC hydrologic system in the BFAS study area (cross-section A-A' in Figure 8). Red Sands mining well is located in the Jn aquifer.

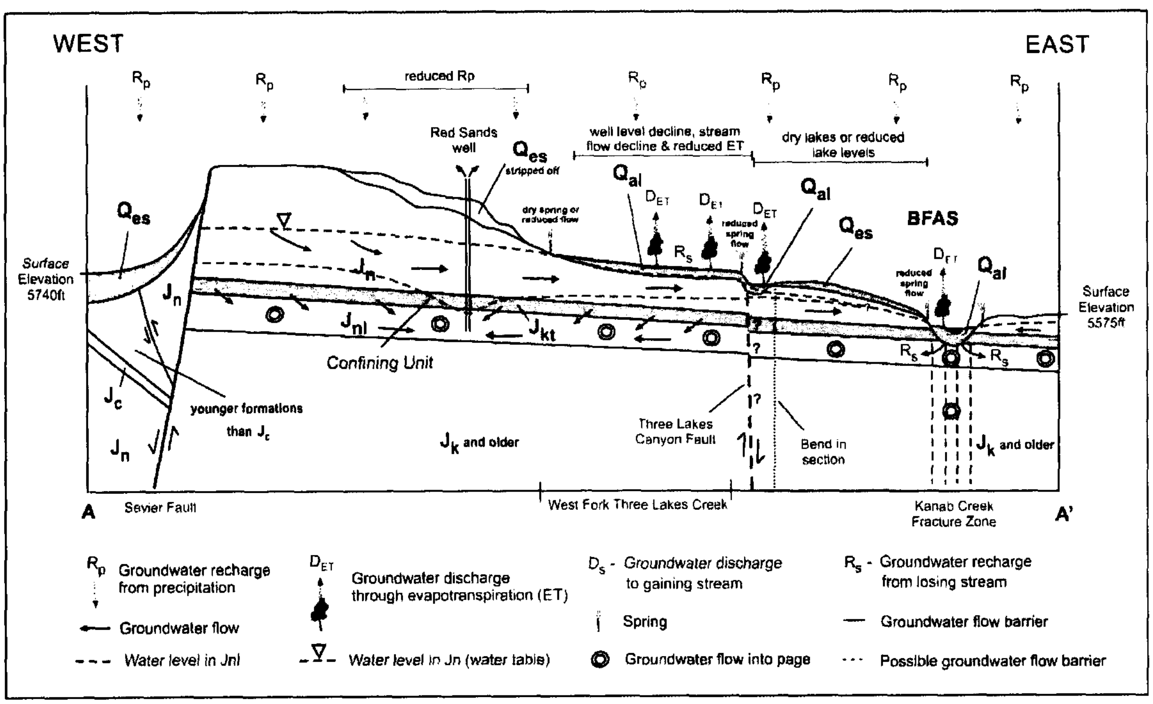

Figure 9c. Schematic post-development east-west cross-sectional view of West Fork Three Lakes part of the Conceptual Site Model of the JNKC hydrologic system in the BFAS study area (cross-section A-A' in Figure 8). Red Sands mining well is located in the Jnl aquifer.

Lambs Point Tongue aquifer will most likely result in groundwater "leaking" (leakance) from the Upper Navajo aquifer through the Tenney Canyon Tongue confining layer due to the increased pressure caused by well pumping. This will cause water level and head declines in both aquifer systems, and declines in spring discharge to the BFAS and Three Lakes Canyon springs, a decline in lake levels in Three Lakes Canyon, a decline in discharge to the stream (if not totally drying up the stream) in the West Fork Three Lakes Canyon, and a decline in groundwater discharge to the Town of Kanab wells and BFAS wells and springs. Most likely, the phreatophytes in the West Fork Three Lakes Canyon will decline and die. The most drastic case may have the Three Lakes in Three Lakes Canyon go dry, and the endangered species associated with these lakes may decline or vanish.

Figure 10a specifically illustrates the groundwater flow path and connectivity of the groundwater system from the proposed Red Sands mine and water well in the Upper Navajo aquifer along the matrix and subsurface Big Lake fracture zone to the springs and wells at the Big Lake BFAS site in Kanab Canyon. The Big Lake fracture zone is illustrated as a French drain or "drain like structure". The atmospheric water recharges the groundwater system at the mine site by infiltration of precipitation through the bedrock directly, or through the eolian deposits (Qes), which enhances recharge to the bedrock system (Figure 10a). In the undisturbed state, groundwater then flows to the east preferentially in the Big Lake fracture zone to discharge into the Big Lake valley as a perennial stream, or continues along the preferred groundwater

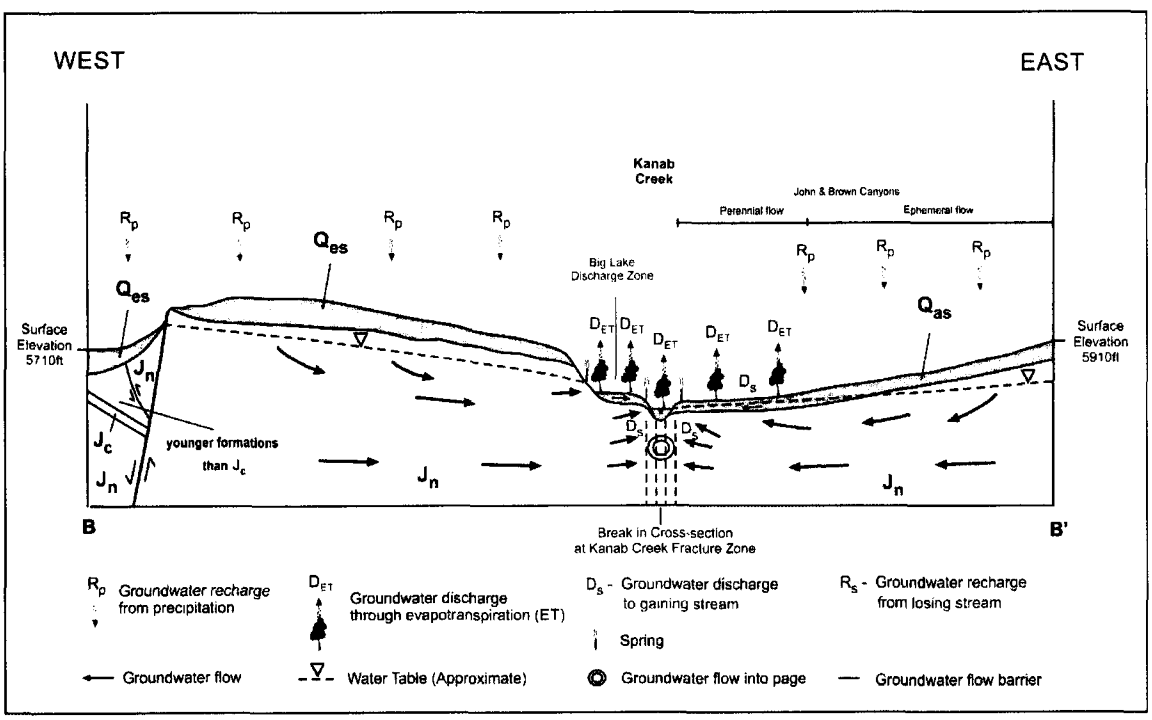

Figure 10a. Schematic pre-development east-west cross-sectional view of part of the Conceptual Site Model of the JNKC hydrologic system in the vicinity of Big Lake and Kanab Creek in the BFAS study area. (Cross Section B-B' in Figure 8).

zone through the hydrostructure. Groundwater is then consumed by phreatophytes or evaporated off the Big Lake surface as a discharge function. BFAS also has wells in this drainage, which is another form of groundwater discharge from the Upper Navajo aquifer (Figure 10a). The runoff from the groundwater discharge is to Kanab Creek, as is additional recharge to the Kanab Creek directly from the Jn aquifer upstream.

Figure 10b illustrates the potential disruption of mining activities at the Red Sands mine site. Figure 10b illustrates a well located in the Upper Navajo aquifer where pumping creates a cone of depression that travels somewhat preferentially along the Big Lake fracture zone. Note that Big Lake springs and lake levels initially decline and Big Lake could eventually dry up, there is a potential decline in the productivity of the BFAS wells and Kanab Creek flow, and there is a reduction in the phreatophytes (habitat destruction) in the BFAS area as water levels decline (Figure 10b). The removal of eolian sand at the mine site with reduce the groundwater infiltration and increase the evapotranspiration significantly resulting in further declines in water tables downgradient in these same places.

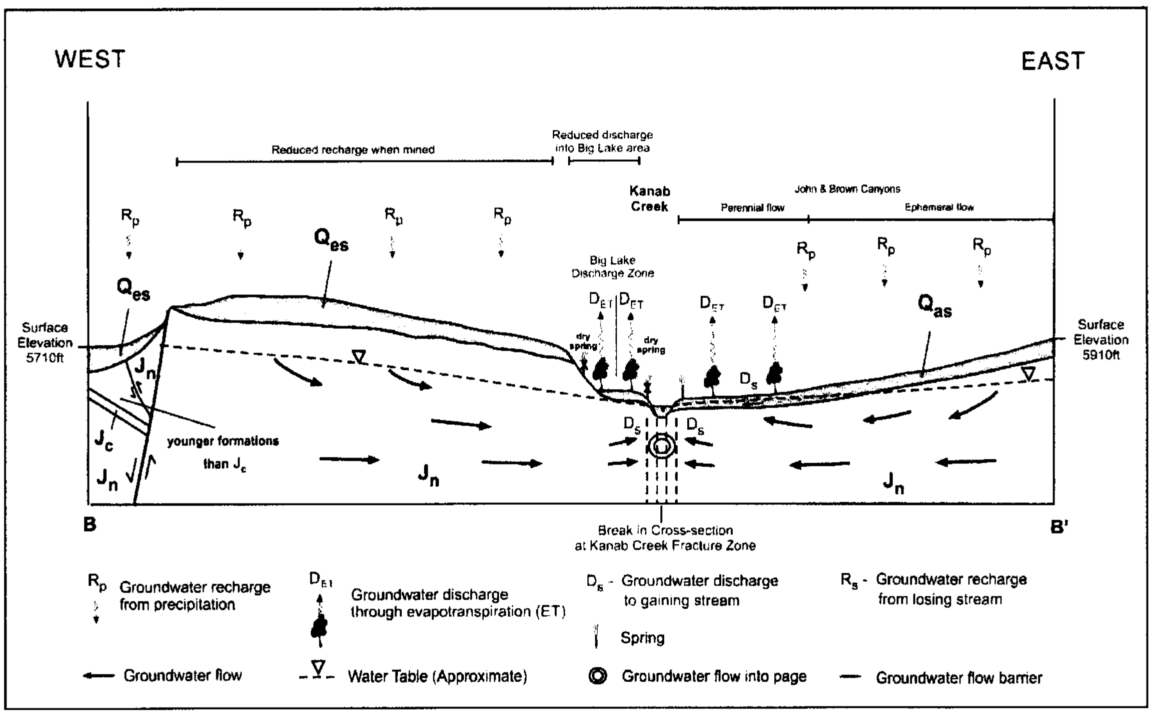

Figure 10b. Schematic post-development east-west cross-sectional view of part of the Conceptual Site Model of the JNKC hydrologic system in the vicinity of Big Lake and Kanab Creek in the BFAS study area (Cross Section B-B' in Figure 8). Red Sands mining well is located in the Jn or Jnl aquifer.

Figure 11 specifically illustrates the groundwater flow path and connectivity of the Upper Navajo groundwater system to the Kanab Creek surface water system, and can be used to project the effects of the proposed Red Sands mine and water well in the Upper Navajo aquifer along the matrix and subsurface Red Canyon fracture zone to the springs in Kanab Canyon. The Kanab

Creek fracture zone is illustrated as a French drain or "drain like structure". The atmospheric water recharges the groundwater system in the Kanab Creek area by infiltration of precipitation through the bedrock directly, through the eolian deposits (Qes), which enhances recharge to the bedrock system, and by focused linear recharge from the Kanab Creek stream bed to the aquifer in the northern ephemeral stream reaches during runoff events from intense precipitation episodes or snowpack runoff (Figure 11). In the undisturbed state, groundwater then flows to the north in the Jn regional system away from the BFAS study area, or flows south to discharge from Jn into the Kanab Creek alluvial aquifer (Qal). Some Jn groundwater potentially recharges the deeper Jnl aquifer vertically through the Kanab Creek French drain. The Qal Groundwater is then consumed by phreatophytes or discharges into the Kanab Creek as surface runoff (gaining stream). BFAS also has wells in this drainage, which is another form of groundwater discharge from the Upper Navajo aquifer (Figure 11). The runoff from the groundwater discharge is to Kanab Creek, as is additional recharge to the Kanab Creek directly from the Jn aquifer upstream. Below the Jkt hydrogeologic unit, Kanab Creek and the Qal aquifer are directly connected to the Jnl aquifer where either both gain water from Jnl discharge locally, or both provide recharge water to the Jnl regional aquifer system (Figure 11).

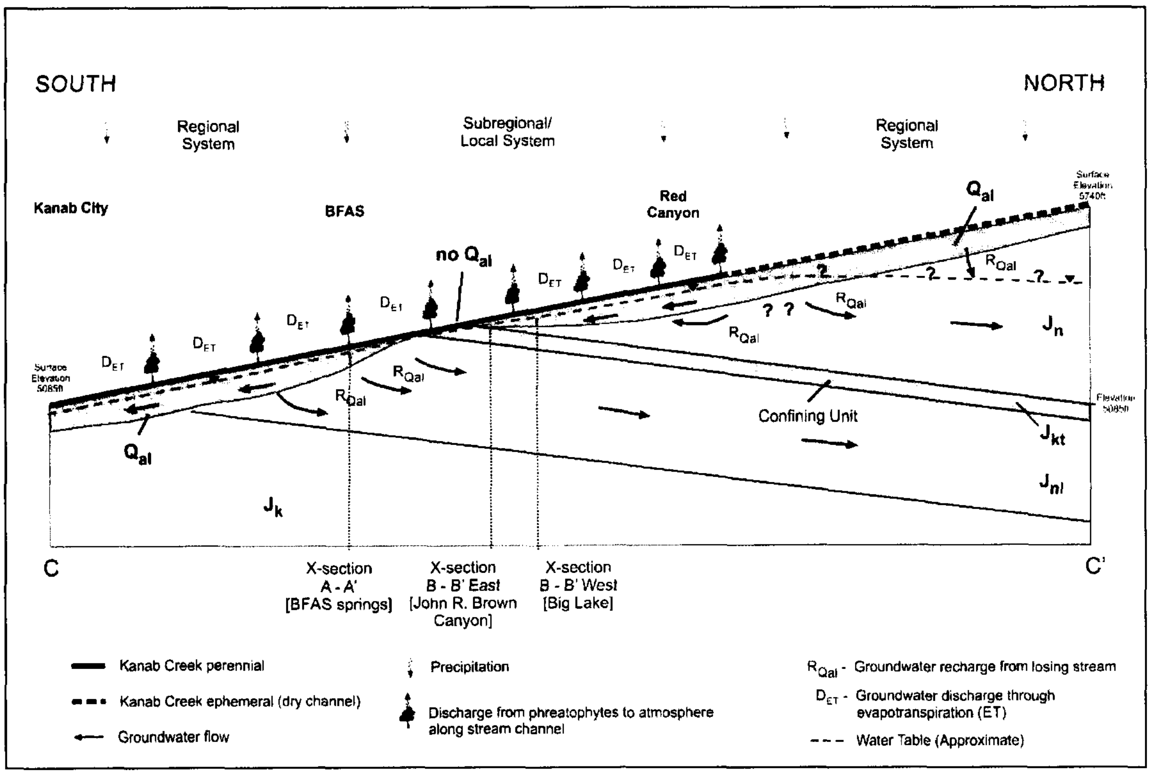

Figure 11. Schematic north-south cross-sectional view of part of the Conceptual Site Model of the JNKC hydrologic system along Kanab Creek in the BFAS study area (C-C' in Figure 8).

The potential disruption of mining activities at the Red Sands mine site would be the decline of surface water flow in Kanab Creek directly in the north region, or/and decline of surface water flow in the central regions of Kanab Creek due to cascading effects of spring and lake level declines in the Three Lakes and Big Lake regions, and the decline of BFAS spring runoff from spring discharge along the west side of Kanab Creek Canyon (Figures 9b, 9c, and10b). The removal of eolian sand at the mine site with reduce the groundwater infiltration and increase the evapotranspiration will significantly result in further declines in water tables downgradient in these same places, therefore affecting the Kanab Creek flow in the upper and central reaches of the BFAS study area.

3 PRELIMINARY WATER BUDGET OF THE JURASSIC NAVAJO AQUIFER - KANAB CREEK (JNKC) HYDROLOGIC SYSTEM IN THE BFAS STUDY AREA

In section 2 of this report, the hydrogeology of the Jurassic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system in the BFAS study area and stream flows and the groundwater flow system have been discussed. In addition, precipitation data relevant for the BFAS study area have been collected in table and map format. Likewise, the major elements of the dynamics of the hydrogeologic system -- groundwater input or recharge areas, groundwater output or discharge areas, and the (internal) groundwater flow system -- have been determined. Well and spring data to quantify groundwater output have been collected from various sources. Published groundwater level data have enabled the determination of groundwater flow direction and amount of water storage in the groundwater system, which can be used to calculate groundwater flux and storage over time.

In order to further understand how the JNKC hydrologic system works, and to determine quantitatively if the hydrologic system is properly analyzed, a water budget has been developed for the JNKC hydrologic system. The hydrologic system water budget, or water balance, is the quantitative listing of the surface water and groundwater inputs and outputs, and changes in internal storage over a particular period of time. In its most simple form, the period of time is chosen such that the internal storage changes are so small that they do not have to be taken into account. Considering climatic variability, often a multi-year period with averaged inputs and outputs is selected to determine the water budget for a particular hydrologic system. The water budget inputs should be equal to or "balance" the water budget outputs. The selection of the time period for which to calculate the water budget depends, among others, on the nature of the climatic variability, and the availability of climatic and hydrologic records. Frequently this is done for a one- or multi-year period to capture a full cycle of seasons, or multi-year trends. For shorter periods of time, such as the growing season, water budget calculations may involve estimating the release from or addition to internal storage. This may also be the case if there is a systematic dewatering of an aquifer involved for, for example, over-pumping (i.e., “mining” of groundwater). The change in storage could be seasonal changes in measured water tables, long term decline in groundwater levels, or changes in (surface water) reservoir water levels.

The first step in determining a water budget for the JNKC hydrologic system is to determine the hydrologic system conceptual model using HESA. With HESA, individual components of the hydrologic system are analyzed, followed by evaluating the aggregate of components and their interactions, to locate and quantify relevant hydrologic subsystems. The results of the HESA for the JNKC hydrologic system are given in Section 2 of this report. Step 2 in determining the water budget is setting up a logic diagram based on the conceptual model to show all the significant hydrologic components and processes, including the external hydrologic system inputs, outputs, and internal components or storage areas, and exchanges between internal components. Step 3 is to subset the overall conceptual model area to a manageable area where quantification of the hydrologic system will be most practical and accurate given the available data and the landscape terrain measurability (i.e., estimates of inputs and outputs where engineering data is not available or not practical/cost-effective at this time).

3.1 Water Budget Logic Diagram

The diagram shown in Figure 12 shows the relevant generalized components and processes identified during the HESA of the JNKC hydrologic system. In this diagram, hydrologic and hydrogeologic units or storage components are represented by boxes and the hydrologic exchange processes or fluxes by arrows. Note that the processes internal to the hydrologic units, such as atmospheric flow, stream flow, and groundwater flow, are not included. The main hydrologic units are: 1) atmosphere; 2) surface water system (streams and lakes/reservoirs); 3) unsaturated zone (between ground surface and water table); 4) shallow groundwater zone (saturated valley-fill unconsolidated sediments); and 5) deep groundwater zone (bedrock hydrogeologic units and hydrostructures). Figure 12 also shows the process-type interactions between these hydrologic units. These processes can be quantified as fluxes or flow rates such as precipitation rates (L/T), groundwater recharge (L/T), spring discharge (L^3/T), groundwater discharge to/recharge from streams (L^3/T/L'), and well discharge (L^3/T). It should be noted that many of the processes are difficult to measure or estimate and introduce significant uncertainty in water budget calculations when used.

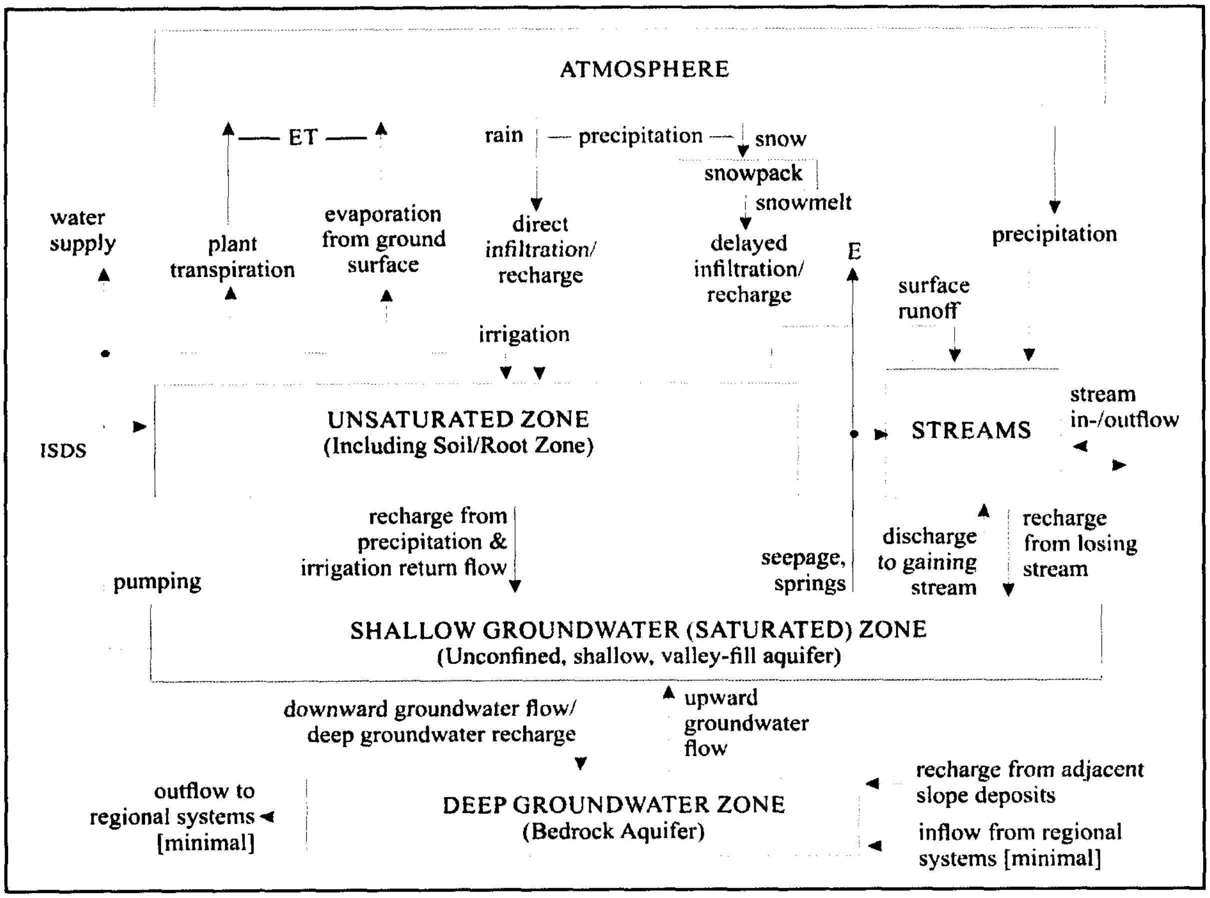

Figure 12. Generalized hydrologic system components and processes.

Often, to get a better understanding of the water budget components and reduce uncertainty, the complex set of hydrologic units and processes shown in Figure 12 is simplified by reducing the number of units and processes based on HESA evaluated significance of, and data availability for each of these components. For example, a water budget may focus on surface water and its interaction with the atmosphere. In that case, the subsurface units and processes, depicted in Figure 12 as the unsaturated zone, the shallow groundwater zone, and deep groundwater zone, and related processes would be represented by a single gain or loss flux. In the same fashion, a focus on the groundwater system may replace the atmosphere, streams, and unsaturated zone by inputs and outputs only, and any change in storage would be limited to the shallow and deep aquifers.

The Conceptual Site Model resulting from the HESA of the JNKC hydrologic system, together with the location of the Kanab Creek stream flow gage and other stream flow characteristics, provided guidance on how to delineate the water budget area and how to simplify the complex hydrologic system components and process illustrated in Figure 12 in preparation of a preliminary water budget for JNKC hydrologic system.

3.2 Preliminary Water Budget for the JNKC Hydrologic System

A preliminary water budget (PWB) for the JNKC hydrologic system is calculated based upon the information collected and analyzed, and the HESA-based conceptual model of the JNKC hydrologic system determined in Phase 1 of this project as reported in Section 2. The selection of the area within the BFAS study area for which the water budget is determined, is based, in part, on 1) the locations of the USGS stream gage on Kanab Creek; 2) the watershed boundaries of Kanab Creek and tributaries (Figure 4); 3) the hydrogeologic and hydrostructural boundaries of the Navajo Aquifer as determined by HESA (Figure 5); and 4) the location of relevant anthropogenic activities (diversions, domestic, municipal and agricultural water use, planned Red Sands mining related withdrawal; Figure 7). The water budget area is outlined in Figures 1, 6 and 13.

The surface and subsurface hydrologic systems or storage components and the hydrologic exchange processes or fluxes considered relevant for the PWB of the relevant section of the JNKC hydrologic system were derived from the conceptual model developed in the HESA as illustrated in Figure 13 (hydrogeological units) and Figure 14 (boundary conditions) and are shown in the diagram in Figure 15. The significant inputs of the PWB are: 1) groundwater inflow (i.e., underflow) at western boundary from recharge in area between the PWB boundary and the first closed hydrostructure of the Sevier Fault zone; 2) recharge by infiltration of precipitation (rain and snow) across the entire PWB area using the concept of hydro zones explained later in this report; 3) direct surface runoff from precipitation to streams; 4) Kanab Creek inflow at Northern PWB boundary from nearby springs; and 5) groundwater leakage from Jnl through Kanab Creek French drain towards Kanab Creek. Note that precipitation itself and evapotranspiration (ET) for the area not covered by riparian vegetation is not included in the PWB, but is discussed in following sections.

The outputs of the PWB are: 1) consumptive use by riparian vegetation; 2) evaporation from open water (Big Lake and Three Lakes); 3) consumptive use BFAS wells and springs (production minus return flow); 4) municipal use (Kanab City wells and springs); 5) domestic consumptive use (non-BFAS private wells); 6) Kanab Creek outflow at Southern boundary (at USGS gage near highway bridge); and 7) groundwater underflow at Southern boundary (in Qal in Kanab Creek canyon). Figure 15 shows a diagrammatic representation of these water budget components. It should be noted that the groundwater inflow components "irrigation return flow" and "septic tank leach field infiltration" shown in Figure 15 are considered small enough not to be taken into consideration for the PWB. Also, springs within the PWB area not included in consumptive use components are considered internal fluxes and are not incorporated in the global PWB. Each of these terms are discussed in detail in following sections.

Figure 13. Map showing the location of the preliminary water budget (PWB) area of the JNKC hydrologic system on top of the hydrogeologic units of the BFAS study area.

Several sources of published data provided input into the PWB: 1) precipitation data from NOAA's National Centers for Environmental Information and the Natural Resources Conservation Service provided long-term data and spatial distribution for calculation of recharge and direct runoff to streams; 2) USGS stream gage data collected at the highway bridge across Kanab Creek provided a long-term data set regarding stream flows; 3) adjudicated maximum spring and well use information culled from the State of Utah Division of Water Rights data base, together with spring and well data from BFAS and the City of Kanab, provided a first approximation of public and private consumptive use in the JNKC hydrologic system; and 4) Phreatophyte consumptive use measurements published by Muckel and Blaney (1945) provided data regarding outputs due to natural vegetation effects in the JNKC hydrologic system.

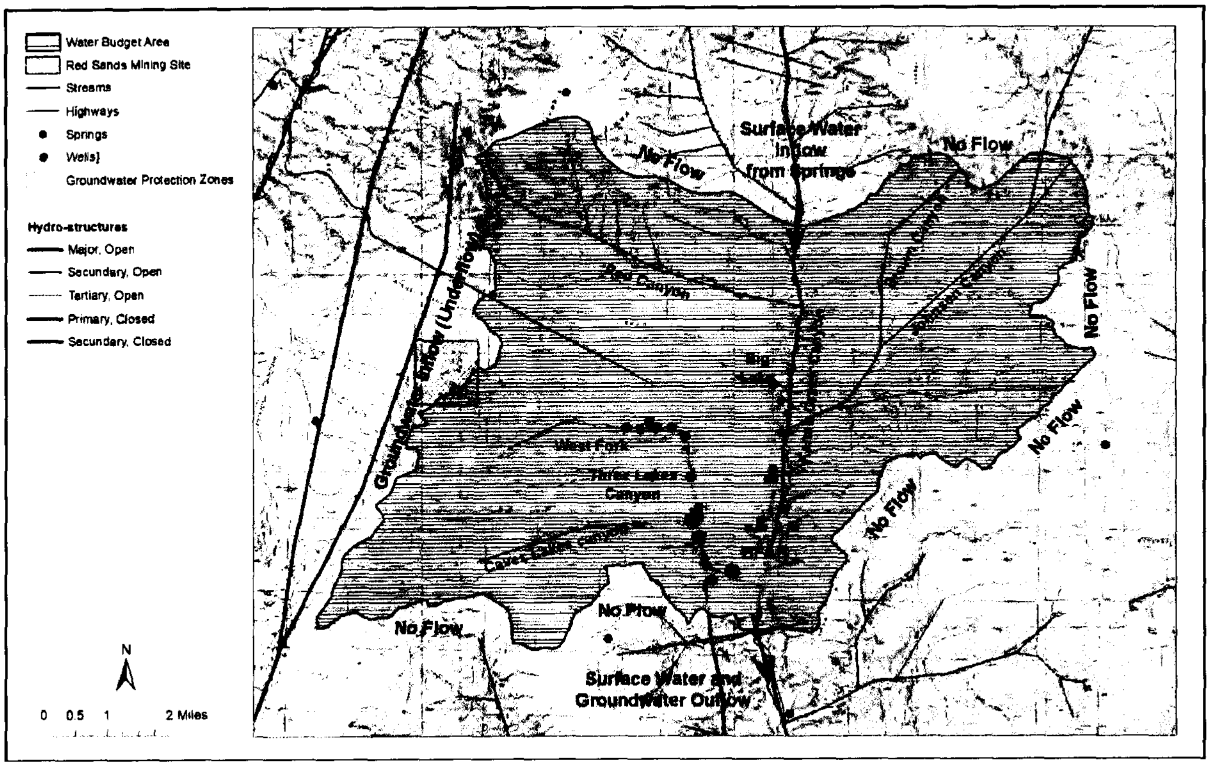

Figure 14. Map showing the location of the Preliminary Water Budget (PWB) area with boundary conditions, and well and spring locations, and source protection zones.

3.3 Approach to Preliminary Water Budget Calculations

The identified data sets mostly provide a "snap shot" of a particular variable in time and were gathered at various, non-compatible moments in time. The challenge in this project is to extrapolate from measured values where necessary and to estimate quantities from "soft" information. The starting point is the determination of the current annual averaged water budget components before any withdrawal is initiated at the Red Sands mining site, resulting in a "pre-development" PWB (Table 4). The estimated pre-development direct runoff to streams (the "balance" or "closing" term), together with adjustments to some of the other water budget components, will be used in Phase III of this project for calculating post-development water budgets with the planned Red Sands withdrawal included. Because of uncertainties regarding the actual location and depth of the Red Sands well, two post-development scenarios will be developed in Phase III: 1) withdrawal in the Jn aquifer; and 2) withdrawal in the Jnl aquifer with leakage from the Jn aquifer above.

In order to quantify some of the components of the preliminary water budget for the BFAS study area given the sparseness of published data, the JNKC hydrologic system was spatially categorized into 9 types of hydro zones based upon the hydrogeology and geomorphology, groundwater and surface water hydrology, and distribution of phreatophytes (Figures 14 and 16, Appendix A). Hydro Zone 1 is the phreatophyte zone with gaining stream reaches and phreatic consumptive use. Hydro Zone 2 is the riparian high-K (high permeability) fracture zone (i.e., French Drain) and is characterized by fractured canyon type recharge and storage; note that this zone overlaps the phreatophyte discharge zone, but extends between opposite canyon walls beyond the riparian vegetation. Hydro Zone 3 covers the deep sand on Jn matrix (non-fractured) area and represents very slow recharge and small storage. Hydro Zone 4 is the thin sand on Jn matrix (non-fractured) area and also represents very slow recharge and small storage. Hydro Zone 5 is the dry wash high-K fracture zone having the same hydro functions as zone 2, but having insignificant phreatophyte discharge occurring in the same area. Hydro Zone 6 is the Qal in Lower Kanab Canyon/Upper Kanab Canyon zone with groundwater storage and losing stream sections in the lower canyon and gaining stream sections in the upper canyon. Hydro Zone 7 is the Jnl outcrop in Lower Kanab Creek canyon. Hydro Zone 8 is the recharge area for western boundary underflow and Hydro Zone 9 covers the open water evaporation.

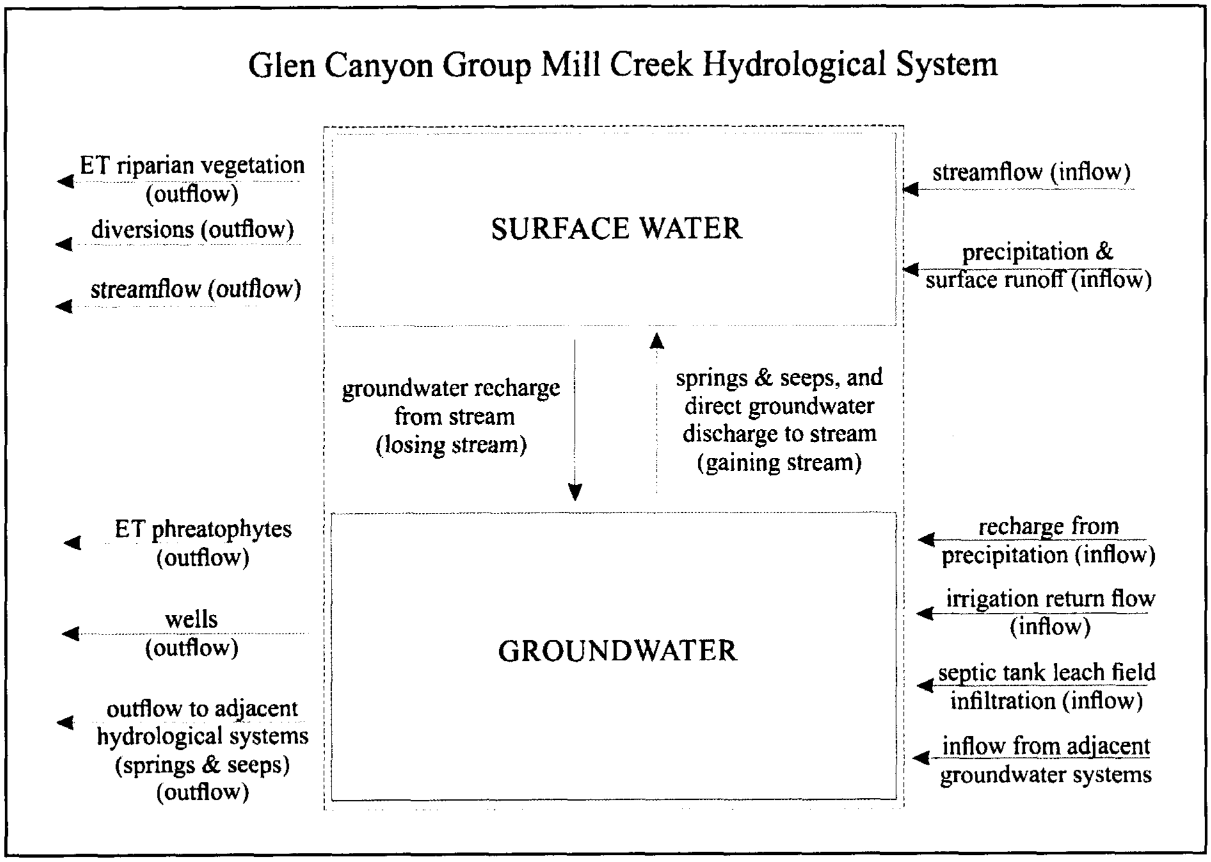

Fig 15. Simplified diagram of inflows and outflows for the JNKC hydrologic system in the PWB area.

3.4 Groundwater Recharge and Direct Runoff to Streams

Average annual precipitation in the BFAS study area ranges from about 13 inches to about 19 inches (Figure 3). To evaluate recharge, three recharge scenarios have been evaluated as a function of the spatial distribution and amount of precipitation in each hydro zone: 1) low estimate using 10% of precipitation for all hydro zones; 2) a high estimate using 20% of precipitation for all hydro zones; and 3) a "best" estimate using 15% of precipitation for all hydro zones. The average annual precipitation was calculated for each hydro sub-zone in both inches and acre-ft for the period 1981-2010 by overlaying the hydro zone GIS layer with the precipitation GIS layer. The calculations of the recharge term in the PWB for the Jn aquifer and the Jnl aquifer are listed in Appendix A and can be summarized as follows: 1) the low estimate for recharge in the Jn aquifer is 4940 ac-ft/yr, the high estimate is 9881 ac-ft/yr, and the "best" estimate used in the PWB is 7587 ac-ft/yr; 2) the low estimate for (direct) recharge in the Jnl aquifer (in the central-south part of the PWB area) is 125 ac-ft/yr, the high estimate is 250 ac-ft/yr, and the "best" estimate used in the PWB is 188 ac-ft/yr (Table 4). Note that the "best" estimate for recharge in both the Jn and Jnl aquifers amounts to about 15 % of overall precipitation in the PWB area or 2.3 inches/yr. Note that groundwater recharge of 1-3 inches per year are common estimates in groundwater modeling and water budget studies for these types of environments.

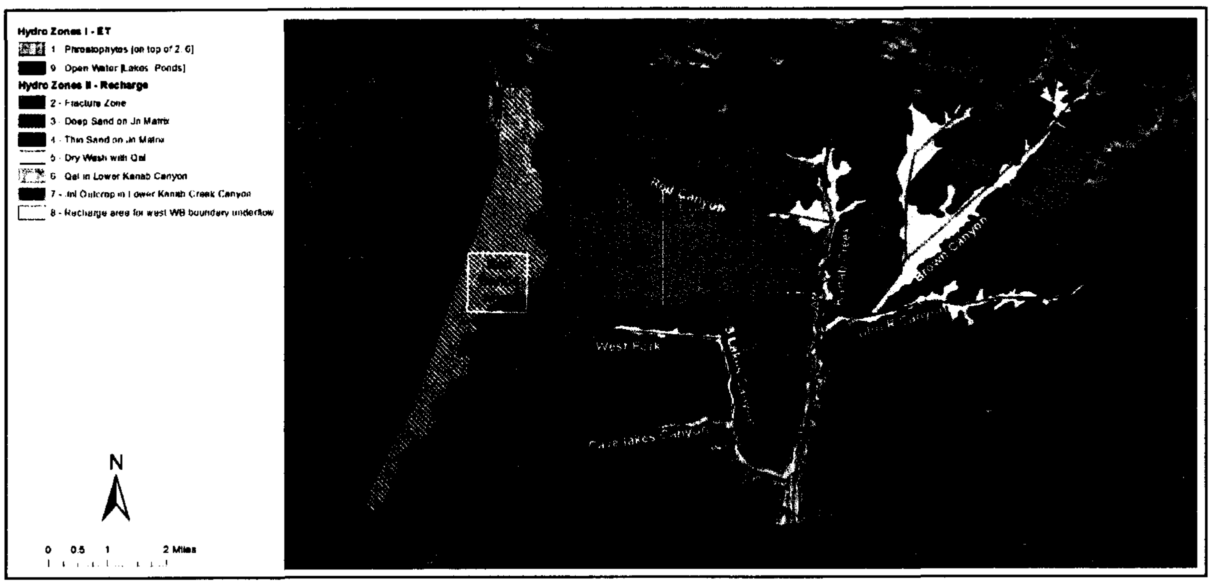

Figure 16. Map showing the location of the Preliminary Water Budget (PWB) area and the hydro zones of the JNKC hydrologic system.

The Preliminary Water Budget closing term (i.e., balancing term) for the pre-development scenario (Table 4) consists of direct runoff of precipitation to streams and amounts to 3905 ac-ft/yr. This term will be used in the post-development scenarios in Phase III where the closing term will be the release from groundwater storage (see also Section 3.12). Note that direct evapotranspiration (ET) in the PWB area (excluding riparian vegetation), calculated as precipitation minus groundwater recharge and direct runoff to streams, amounts to about 39,860 ac-ft/yr. All these numbers are based on 30-year averages for the climate period 1981-2010.

WATER BUDGET COMPONENT	IN (ac-ft yr)	OUT (ac-ft/yr)
Direct runoff to streams (interflow) Balance term (section 3.4)	3905	-
Recharge of Jn aquifer (hydro zones 3,4,5) Calculated (see spreadsheet) (section 3.4)	7587	-
Groundwater underflow in Qal in Kanab Creek Canyon at northern boundary Estimated (section 3.5)	0	-
Kanab Creek inflow at northern boundary Estimated from spring flow in area (section 3.6)	180	-
Consumptive use riparian vegetation Calculated (see spreadsheet) (section 3.7)	-	3817
Evaporation from open water (Big Lake & 3 Lakes) Calculated (see spreadsheet) (section 3.8)	-	33
Consumptive use BFAS wells and springs (production minus return flow) Water rights minus return flow & production data from BFAS (section 3.9)	-	100
Municipal use Production data from Kanab City (section 3.9)	-	1500
Domestic consumptive use Estimated (section 3.9)	-	minor
Misc. diversions	-	none
Kanab Creek outflow at southern boundary Using USGS gage data 2001-2018 (section 3.6)	-	6820
Groundwater underflow in Qal in Kanab Creek Canyon at southern boundary Calculated (section 3.5)	-	(0.017 – 3.35) 3
Groundwater recharge to Jnl in south-central PWB (into deeper rock moving north) Calculated (see spreadsheet) Note: Not included in total for Jn/Qal (section 3.10)	(188)	(188)
Groundwater leakage from Jnl through Kanab Creek French drain into Kanab Creek Unknown (section 3.10)	unknown	0
Groundwater inflow at western boundary from recharge of area between PWB boundary and first closed hydrostructure of the Sevier Fault Zone (underflow) Calculated (see spreadsheet) (section 3.5)	601	-
Groundwater leakage from Jn into Jnl through Jk Calculated (section 3.10)	-	0
Groundwater release from storage (for future use predicting effects of pumping at Red Sands Mine) (Phase III)	-	-
TOTALS	12273	12273

Table 4. Preliminary pre-development water budget estimates for Jn/Qal in PWB area.

3.5 Groundwater Underflow

There are three sections of the PWB area border were cross-boundary underground flow or underflow may exist: 1) groundwater inflow at the northern boundary in Qal in Kanab Creek Canyon); 2) groundwater outflow at the southern boundary in Qal in Kanab Creek Canyon; and 3) groundwater inflow at the western boundary from recharge in area between PWB boundary and first closed hydrostructure of the Sevier Fault Zone.

Underflow in Qal at the northern PWB boundary in Kanab Creek Canyon is minor as Kanab Creek is ephemeral from the PWB boundary on northwards. Water entering the subsurface in this part of Kanab Creek Canyon will move downwards to recharge the Jn aquifer which in this area has a northwards regional flow direction.

The basis for the calculation of groundwater underflow at the southern boundary of the PWB area in Kanab Creek Canyon (Figure 14) is Darcy's Law:

$$Q = KIA;$$

where Q is discharge per unit time; K is hydraulic conductivity of the fractured Hydrogeologic Unit; I is dH/dL or hydraulic gradient (change in head H over a distance L); and A is cross-sectional area. Q will be the groundwater input/inflow into the water budget. K is determined by aquifer tests, which reveal a range of values with a high of 10 ft/day for shallow fractured bedrock in the PWB area (Heilweil and Freethey, 1992). Hydraulic gradient is determined using the topographic gradient (which is about equal to groundwater gradient) at the southern PWB area boundary of 0.004. As the K decreases with depth to a very low value at 200 ft or more, an effective depth of 100 ft (geomorphic estimate) is used; together with a width of 100 ft (measured with Google Earth), this results in a cross-sectional area of 10,000 sq.ft. Using the high value of K of 10 ft/day, this results in a conservative groundwater underflow flux estimate (outflow) of about 3 ac-ft/yr (Table 4).

Underflow at the western PWB area boundary is derived from recharge to Jnl in the area between the Sevier Fault Zone and the western PWB area boundary and is estimated at 601 ac-ft/yr (Table 4, Appendix A).

3.6 Kanab Creek Surface Water Inflow and Outflow

By choosing watershed boundaries for most of the PWB area boundary, surface water in- and outflow in the PWB is limited to Kanab Creek. The northern PWB boundary intersects Kanab Creek at the location where the southward flowing ephemeral creek becomes perennial from the discharge of local springs. These spring discharges determine the long term creek inflow at this boundary for an average of about 180 ac-ft/yr (UDWR 2019). The southern boundary of the PWB area intersects Kanab Creek at USGS gage 09403600 near the Highway 89 bridge (USGS NWIS, 2019). The average annual flow at this gage for the period 2001-2018 is 6820 ac-ft/yr (outflow) (Table 4).

3.7 Consumptive Use by Riparian Vegetation

Muckel and Blaney (1945), Mayboom (1964), and Gatewood and others (1950) determined that riparian vegetation (notably Cottonwoods, Willows, and Tamarisk) had consumptive use ranging from 40 – 93 in/year depending upon percentages of each species present, the healthiness or stress level of the vegetation, and the location in the ecosystem (seeps, springs, stream bottoms and floodplains). A recent study by Crowley (2004) on the Matheson Wetland Preserve located near the City of Moab, Utah inventoried the published data regarding consumptive use of riparian vegetation in the Moab, Utah area, and calculated consumptive use of vegetation at that location. For the purposes of calculating the preliminary water budget of the JNKC hydrologic system, Muckel and Blaney's (1945) mixed riparian category of 60 – 92.7 in/year was used to calculate the Phreatic Consumptive Use Low estimates (60 in/yr) and the Phreatic Consumptive Use High estimates (92.7 in/yr) for the Hydro Zone Type 1 Phreatophyte areas as digitized from recent aerial photography. This resulted in a range of 3000-4635 ac-ft/yr. Taking the increased stresses on water availability for the riparian vegetation into consideration, the average value of 3817 ac-ft/yr is used in the PWB (Tables 4, Appendix A).

3.8 Lake Evaporation (including Three lakes and Big Lake)

Open water (lakes) area is 10 acres. With an average annual evaporation of 54 inches and an average annual precipitation of 15.6 inches this amounts to a PWB loss of 33 ac-ft/yr (outflow) (Table 4, Appendix A).

3.9 BFAS Consumptive Use and City of Kanab Municipal Use

The value for municipal use by the City of Kanab was culled from well and spring data provided by the City and indicate an average pre-development municipal use of about 1500 ac-ft/yr (Table 4). Note that excess runoff from the City springs flowed directly into the Kanab Creek tributaries as an internal hydrologic system transfer from groundwater to surface water.

Consumptive use (i.e., loss to the hydrologic system) data on BFAS wells and springs was derived from the UDWR water rights data base of about 120 ac.fy/yr , corrected for irrigation return flow and infiltration of grey water (septic systems) and checked against BFAS production data and amounts to about 100 ac-ft/yr (Table 4). With the very limited number of additional private wells and absence of additional irrigation in the PWB area additional domestic consumptive use has been considered minor.

3.10 Leakance into or from Jnl in Kanab Creek Fracture Zone and through Jk Confining Unit

According to modeling results published by Heilweil and Freethey (1992) there is a discharge in the southern part of Kanab Creek Canyon in the PWB area from the Jnl aquifer into Kanab Creek. At this time, it is unknown how much acre-ft/yr this amounts to and further data collection and analysis is recommended. In addition, there may be downward leakage from the

Jn aquifer through the Jk confining unit into the Jnl aquifer in the entire area covered by the Jn aquifer. In the current version of the PWB this term is set at 0. Again, further data collection and analysis is recommended

3.11 PWB and the JNKC Hydrologic System: Discussion of Uncertainty

There are many uncertainties in these preliminary calculations, so further data collection and analysis is needed and should be planned. The significance of the PWB is that it shows that the Jn aquifer is primarily recharged locally by precipitation within the PWB area and in the area between the western PWB boundary and the eastern edge of the Sevier Fault Zone.

Many of the components of the PWB calculations include large uncertainties. The most reliable data are the USGS stream flow data in Kanab Creek at the highway crossing, the springs and wells production data from BFAS and the City of Kanab, and the precipitation data from NOAA used to develop various recharge scenarios. However, these data sets do not cover equal time periods. All other data sets provide a "snap shot" of a particular variable in time as they were gathered at various, non-comparable moments in time or were estimated and should be considered a first approximation, subject to refining by further field studies.

Consumptive use by phreatophytes (riparian vegetation) is variable seasonally and annually by changes in species composition, species health, spatial distribution of vegetation, and length of growing season among other factors. An estimate of annual evapotranspiration for a water budget misses the seasonal effects of water usage and water availability, as well as multi-year natural or anthropogenic variations in water availability. However, for the cost and effort, it is difficult to improve on the studies that have been published. A possible follow-up study may focus on the changes over time in riparian vegetation coverage using historical aerial photography.

Spring discharge measurements are based on State of Utah Water Rights data which allude to the available groundwater that is measured at the source when the water right was secured, often without consideration of seasonal and multi-year variability. The actual daily and seasonal flow of the springs is for the most part unmeasured and may fluctuate significantly. Improvements of the springs related PWB terms may be obtained by more regular measuring of the discharge of some of the larger springs, such as the ones at the northern boundary in Kanab Creek Canyon.

4 PRELIMINARY GROUNDWATER STORAGE CALCULATIONS FOR THE JNKC HYDROLOGIC SYSTEM IN THE PWB STUDY AREA

4.1 Groundwater Storage Quantification

Groundwater is potentially stored, either as part of the saturated zone of the aquifer or the unsaturated zone above the aquifer in the pore spaces between the sand grains of unconsolidated eolian, pedogenic, colluvial, or alluvial materials (Qes, Qae, or Qal), in the pore spaces of the sedimentary bedrock, or in the multiple-scale hydro-structures including fractures, fracture zones, bedding planes, faults, or fault zones. Groundwater that is stored in the pore spaces is considered matrix water and may be in considerable amounts in unconsolidated materials (such as the Kanab Creek alluvium) or may be in very small amounts in well consolidated bedrock (such as the non-fractured Upper Navajo aquifer). Groundwater that is stored in the hydro-structures may be in very small amounts in micro-fractures or may be in considerable amounts in large scale fracture and faults zones (for example, the West Fork Three Lakes Fracture Zone and the Kanab Creek Fracture Zone). Most of the unconsolidated materials that form the Eolian deposits and soils of the Red Knoll area, for example, are unsaturated and the amount of groundwater storage is small. By comparison, the unconsolidated materials in the bottom of the Kanab Creek gorge are saturated, and their storage is significant as indicated by the extensive phreatophyte vegetation that is observed.

There are multiple descriptors of storage in aquifers. Storativity or the storage coefficient is the volume of water released from storage per unit decline in hydraulic head in the aquifer, per unit area of the aquifer. Storativity is a dimensionless quantity, and ranges between zero and the effective porosity of the aquifer, or the percentage of open space in a unit of rock from which water can be drained under gravity. For a confined aquifer or aquitard, storage is described by specific storage, i.e., the volume of water released from one unit volume of the aquifer under one unit decline in head. Specific storage is related to both the compressibility of the aquifer and the compressibility of the water itself. Volumetric specific storage (or volume specific storage) is the volume of water that an aquifer releases from storage, per volume of aquifer, per unit decline in hydraulic head (Freeze and Cherry, 1979).

In hydrogeology, volumetric specific storage is much more commonly encountered than mass specific storage. Consequently, the term specific storage generally refers to volumetric specific storage. The compressibility terms relate a given change in stress to a change in volume. Specific yield, also known as the drainable porosity, is a ratio, less than or equal to the effective porosity, indicating the volumetric fraction of the bulk aquifer volume that a given aquifer will yield when all the water is allowed to drain out of it under the forces of gravity. Specific yield is primarily used for unconfined aquifers since the elastic storage component is relatively small and usually has an insignificant contribution. Specific yield can be close to effective porosity, but there are several subtle things which make this value more complicated than it seems. Some water always remains in the formation, even after drainage; it clings to the grains of sand and clay in the formation. Also, the value of specific yield may not be fully realized for a very long time, due to complications caused by unsaturated flow.

4.2 Approach and Calculation of Groundwater Storage for the JNKC Hydrologic System

The JNKC Hydrologic system is a complex mix of nonfractured, fractured and faulted Upper Navajo Sandstone (Jn), Eolian Sand (Qes), Alluvium (Qal), and hydrostructures (fault and fracture zones) which form the robust groundwater system. The Upper Navajo aquifer has both matrix flow and fracture flow. The matrix flow has ranges estimated from 0.1 – 5.0 ft/day (approximated from Freethey, 1988); and the fracture flow has ranges estimated from 5.0 -20.0 ft/day (from Freethey, 1988; Freethey and Cordy, 1991). Therefore, fracture flow will dominate travel times and will also be most important for estimating groundwater storage.

The Upper Navajo aquifer and Alluvial aquifers are mostly unconfined or water table conditions and are characterized with specific yield estimates. The Upper Navajo bedrock has both matrix specific yield (small) estimates and fracture specific yield (large) estimates. The matrix specific yield estimates range from 5 – 10 %; the fracture flow specific yield estimates range from 10 – 20% (Appendix A). Therefore, fracture flow areas will be most important for estimating groundwater storage and will be the areas that need the most protection for water quality and water quantity. The Alluvial aquifers have matrix specific yield estimates ranging from 10 – 20% (Appendix A).

The JNKC groundwater system is classified as five different hydro zone types of storage based on the hydrogeology and hydrostructures identified (see Figure 16 for hydro zone location): 1) Zone 2: Riparian Fracture Zone (High-K zone) Kanab Creek, fractured canyon storage, area variable, depth 300-500 feet, specific yield (Sy) range 10% – 20%; and Zone 2: Riparian Fracture Zone (High-K zone) Kanab Creek tributaries, fractured canyon storage, area variable, depth 200-300 feet, specific yield (Sy) range 10 – 20%; 2) Zone 3: Deep Sand on Jn Matrix, matrix storage, area variable, depth 200 - 250 feet, specific yield (Sy) range variable with area 5 - 10%; 3) Zone 4: Thin Sand on Jn Matrix, matrix storage, area variable, depth 200 - 250 feet, specific yield (Sy) range variable with area 5 - 10%; 4) Zone 5: Dry Wash, fractured canyon dry wash with Qal storage, area variable, depth ranges from 200 feet – 300 feet, specific yield (Sy) range 10% - 20%; and 5) Zone 6: Qal in Lower Kanab Canyon/Upper Kanab Canyon, area variable, depth ranges 50 – 100 feet, specific yield (Sy) range 10 – 20% (Appendix A). Low variable storage was estimated using low Sy percentages as a minimum, and high variable storage was estimated using the high Sy percentages as a maximum. Each hydro zone had an estimated volume (GIS area multiplied by depth), and the hydro zone volume was multiplied by the hydro zone Sy to yield a hydro zone storage value (Appendix A).

The calculations show that the JNKC groundwater system has a variable storage low of 43,462 ac-ft, and a variable storage high of 114,188 ac-ft (Appendix A). Hydro zones 3, 4 and 5 (Figure 16) had the largest amount of storage with 9269/23,173 ac-ft , 26.015/65,038 ac-ft., and 5436/16,308 ac-ft respectively. These three hydro zones are located along the critical groundwater flow paths that directly affect the yields and water quality of the City of Kanab wells, and the BFAS Springs and Wells (Figures 5, 8, 9a, and 10a). The earlier Town of Kanab and BFAS Springs and Well Protection Plans previously identified these hydro zones as critical (Figure 7).

It should be cautioned that the storage or underground reservoir is primarily a measure of how robust and sustainable the JNKC hydrologic system is under the current climatic and human use conditions. If the reservoir is significantly reduced by aquifer development, the hydraulics of the system will be affected initially by stream flows (riparian habitat both aquatic and vegetation), and by a rapid reduction of spring flows and well yields. In addition, the effects of reduced recharge to the aquifer system by reduction of the sand cover or climate change will rapidly affect the recharge and storage functions of hydro zones 3 and 4, which are critical to the Town of Kanab wells, and BFAS wells and springs.

4.3 Storage and the JNKC Hydrologic System: Discussion of Uncertainty

There are many uncertainties in these preliminary calculations, so further analysis is needed, benefitting from more rigorous and continuous data collection. The primary significance of the storage calculations is that there is a significant amount of groundwater stored in the JNKC hydrologic system, particularly in hydro zones 3, 4, and 5, that is directly connected to the Town of Kanab wells, and the BFAS wells and springs. This storage is accumulated by groundwater recharge from infiltration of precipitation enhanced by the Eolian sand cover, particularly in hydro zones 3 and 4.

The largest uncertainties in the storage calculations is the correct delineation of each hydro zone area (volume), and the correct attribution of specific yield to each hydro zone. In order to reduce uncertainty, Specific yield ranges were assigned to each hydro zone based on published results of other studies, and hydrogeologic judgement by the investigators.

Basically, the pre-development PWB represents a stable system that is equilibrated between inputs and outputs, and may have short-term deficits alleviated by decline in storage which in turn is replenished in wet years. With the advent of the Red Sands mining operation and its planned well, a long-term deficit is compensated by decline in various discharge components and a release from storage, which may not be compensated by extra recharge in wet years. It should be noted that the decline in storage is not equally distributed across the PWB area and may focus on the area of pronounced withdrawals.

5. CONCLUSIONS AND RECOMMENDATIONS

This report presents the findings of Phase 1 and Phase 2 of a 3-phase project focused on improving the understanding of the hydrogeological setting of the water supply sources for the Best Friends Animal Society – Canyon Operations (BFAS), the quantification of the water resources available to BFAS, and updating the BFAS springs and wells protection against mining activities with regards to water supply and contamination. In Phase 1, a Hydrologic and Environmental System Analysis (HESA) of the central Kanab Creek watersheds was completed to identify the hydrological systems of specific importance to the sustainability of the BFAS springs and wells as water supply for the Canyon Operations. It was concluded that the BFAS water supply was mainly dependent on the hydrologic system formed by the central Kanab Creek Watershed and the Upper Navajo aquifer underlying the surrounding region, including Red Knoll. This hydrologic system, referred to as the Jurassic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system, was chosen in Phase 2 of the project as the setting for the quantification of the water resources available to BFAS, resulting in a preliminary global water budget (PWB) of the entire JNKC hydrologic system.

The Jurassic Navajo Aquifer - Kanab Creek (JNKC) hydrologic system is a complex mix of fractured and faulted Navajo Sandstone rock, Eolian (wind-deposited) and Pedogenic Sand, Alluvium, and hydro-structures (fault and fracture zones that are either conductive or a barrier to groundwater flow). Fracture flow will dominate travel times and will be most important for contaminant studies and well/spring protections, as well as estimating groundwater storage and recharge rates. Recharge to the Upper Navajo aquifer in the JNKC hydrologic system is by infiltration of precipitation (snow and rain) directly into bedrock, or through the eolian sand cover on the surface of the uplands and interfluve tops; by north-south and east-west trending fracture-controlled ephemeral stream channels, and by losing reaches of flowing streams. Groundwater flow in the Upper Navajo aquifer is strongly fracture controlled, and moves from the drainage divides in the same direction as the stream with various stream reaches being gaining or losing depending on topography, bedrock hydrogeology, hydrostructures, and saturated thickness of the bedrock. Most of the streams are French drains where groundwater flows parallel to the surface feature, and discharges into the gaining streams. The sub-regional groundwater flow direction is from west to east around and near Red Knoll, and east to west from the Johnson Wash groundwater divide. The High K Zone flow systems of Kanab Creek, West Fork Three Lakes drainage, and Cave Creek drainage collect most of the groundwater flow system which ultimately ends in the Kanab Creek main channel system. Groundwater then discharges out of the JNKC hydrologic system into the Kanab Creek fracture zone/French drain that receives groundwater to various springs and seeps along its path including the Red Canyon upper Kanab Creek springs where the perennial Kanab Creek begins, and at the BFAS springs along the central parts of the canyon including Big Lake near the BFAS Headquarters, the Three Lakes discharge zone in Three Lakes Canyon, and the West Fork Three Lakes discharge zone that delivers groundwater to the City of Kanab.

Detailed cross-sections are provided to illustrate potential groundwater pathways and potential changes in aquifer function due to the proposed Red Sands mining and groundwater extraction sites. Regardless of whether the Red Sands wells are located in the Upper Navajo aquifer, or the Lamb Point Tongue aquifer, or a combination of both aquifers, the impacts to the

Town of Kanab wells, and BFAS wells and springs are significant. The West Fork Three Lakes perennial stream and spring dries up. There is a potential decline in the productivity of the Town of Kanab and BFAS wells. There is a reduction in the phreatophytes (habitat destruction). There is a water level decline notable along the groundwater flow paths down gradient of the mine and well site causing a decline in the springs at Big Lake and Three Lakes Canyons, a decline in lake levels and lake habitat, a decline in the BFAS springs in Kanab Canyon, and ultimately a reduction of surface water flow in Kanab Creek. The removal of eolian sand at the mine site will reduce the groundwater infiltration and increase the evapotranspiration significantly resulting in further declines in water tables downgradient.

The HESA completed in phase 1 showed that the JNKC hydrologic system is a well-defined system for which the boundary conditions and internal surface water–groundwater interactions are relatively well-understood and quantifiable to various degrees of accuracy. In order to estimate the upper bounds of the water resources present in the JNKC hydrologic system, a preliminary (global) water budget (PWB) has been developed for the JNKC hydrologic system, focused on the external inputs (inflows) and outputs (outflows). In addition, an analysis was made of the storage capacity of the Jurassic Navajo aquifer in the PWB area. The delineation of the PWB area is based on the location of BFAS springs and wells including Big Lake and Three Lakes, the location of the stream gage in Kanab Creek, and the natural boundaries of the JNKC hydrologic system, and covers almost the entire JNKC hydrologic system as determined in the HESA of Phase 1. The PWB area is bounded by the low permeability Sevier Fault to the west, the groundwater divides to the southwest, north, east, and southeast, and the Jn bedrock exposures to the south, and includes additional outcrop exposures of Jurassic Lambs Point Tongue of the Navajo Fm and Kanab Creek alluvium to the south so that the Kanab Creek gage could be used in the water budget.

There is one distinct time period evaluated in the JNKC hydrologic system water budget: pre-mine development, which is present-day. The significant inputs of the PWB are: 1) groundwater inflow (i.e., underflow) at western boundary from recharge in area between the PWB boundary and the first closed hydrostructure of the Sevier Fault zone; 2) recharge by infiltration of precipitation (rain and snow) across the entire PWB area using the concept of hydro zones explained later in this report; 3) direct surface runoff from precipitation to streams; 4) Kanab Creek inflow at Northern PWB boundary from nearby springs; and 5) groundwater leakage from Jnl through Kanab Creek French drain towards Kanab Creek. The outputs of the PWB are: 1) consumptive use by riparian vegetation; 2) evaporation from open water (Big Lake and Three Lakes); 3) consumptive use BFAS wells and springs (production minus return flow); 4) municipal use (Kanab City wells and springs); 5) domestic consumptive use (non-BFAS private wells); 6) Kanab Creek outflow at Southern boundary (at USGS gage near highway bridge); and 7) groundwater underflow at Southern boundary (in Qal in Kanab Creek canyon).The post-development JNKC water budget of Phase 3 will have the same type of inputs as the pre-development water budget, but has an additional outflow term, the mining operation water use (developed wells for mining water supply).

Phase 3 will evaluate the projected water use post-development, which are future projections to determine the impacts of sand mining on water supply, groundwater recharge changes, and potential groundwater/surface water contamination. Pre-mine development or current use has limited municipal, domestic and irrigation demand and kept most of the JNKC hydrologic system of the Red Knoll recharge region in its natural state, a period that in this report is referred to as the pre-mine development present day phase. Starting as early as 2020, the start of the mining of frack sands in the Red Knoll area, together with the initiation of a steady increase in mining water use at some specified rate, well location, and well depth, and the removal of the sands and vegetation, which are part of the JNKC recharge units and function, will represent a significant increase in the anthropogenic withdrawals from the JNKC hydrologic system that could continue up to 50 years. This latter period will be evaluated as Phase 3, and will be referred to as the projected-development phase.

Using the precipitation data sets for 1981-2010 for the Kanab, Utah area, a series of potential recharge and consumptive use by riparian vegetation scenarios have been evaluated based on detailed knowledge of the hydrogeology and landscape characteristics. The best recharge estimate for the Upper Navajo aquifer is 7587 ac-ft/yr, and the best recharge estimate for the Jnl aquifer (in the central-south part of the PWB area) is 188 ac-ft/yr., which amounts to 15 % of overall precipitation in the PWB area or 2.3 inches/yr. The average consumptive use by riparian vegetation was estimated at 3817 ac-ft/yr. Direct runoff to streams was calculated at 3905 ac-ft/yr, and the Kanab Creek outflow determined by gage data was 6820 ac-ft/yr .

Many of the components of the PWB calculations include large uncertainties. The most reliable data are the USGS stream flow data at Kanab Creek at the Kanab Creek bridge below the BFAS operations, the springs and wells production data from the City of Kanab and BFAS, and the precipitation data from NOAA used to develop various recharge scenarios. All other data sets provide a "snap shot" of a particular variable in time as they were gathered at various, non-comparable moments in time and should be considered a first estimate, subject to refining by further field studies. Another area where significant cost-effective improvements to the PWB can be made is more detailed and frequent monitoring of the Kanab Creek and Three Lakes surface water system (both the lakes region, and the West Fork of Three Lakes Canyon tributary, specifically in the vicinity of the Town of Kanab and BFAS wells and springs and above and below the area where the Town of Kanab and BFAS source protection zone intercedes with projected mining areas and water supply reductions due to mine pumping. Finally, more detailed monitoring of selected, "representative" springs, in the BFAS area, should be initiated to obtain an indication of the relationships over time between spring discharge, climate variations, and Kanab Creek runoff, as well as an insight in the resilience of the JNKC hydrologic system to external stresses.

The Upper Navajo (Jn) groundwater system is mostly unconfined, i.e., having a readily fluctuating water table, and the aquifer storativity is characterized by so-called specific yield. The Upper Navajo aquifer has both matrix specific yield (small) and fracture specific yield (large). The matrix specific yield estimates range from 5 – 10 %; the fracture flow specific yield estimates range from 10 – 20% As there is a significant presence of fracture zones in the JNKC system, fractures are the dominant feature in determining available groundwater storage. The results of GIS-based calculations show that the JNKC groundwater system has a storage minimum of about 43,462 ac-ft, and a storage maximum of about 114,188ac-ft, indicating significant uncertainty in the actual storage available in the JNKC groundwater system. Areas along the groundwater flow paths that directly affect the yields and water quality of the BFAS wells and springs, and the City of Kanab wells at the West Fork Three Lakes Canyon, Main Fork Three Lakes Canyon, Cave Creek Canyon, and Kanab Creek, have the largest amount of storage. The current BFAS source protection plans identify these hydro zones as critical, and the effects of the proposed mining and related well extraction on these protection zones will be evaluated in Phase 3 of this project.

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APPENDIX A. RECHARGE, CONSUMPTIVE USE BY RIPARIAN VEGETATION, AND STORAGE CALCULATIONS FOR HYDRO ZONES IN THE PWB AREA OF THE JNKC HYDROLOGIC SYSTEM

Hydro Zone Name	Hydro Zone Type Number	Length [ft]	Width [ft]	Area [Acres]	Hydro Function(s) [Discharge or Recharge; Storage]	Sub-Category Hydro Functions	Average Annual Precipitation (GIS) 1981-2010 Inches	Average Annual Precipitation (GIS) 1981-2010 Acre-ft	Phreatic Consumptive Use in/yr	Depth ft	K ft/day	Sy %	Recharge % of Precip
Phreatophytes	1			600	GW Discharge		15.6	780	60-92.7	25-50			0
Riparian Fracture Zone (High-K Zone) Kanab Creek	2	34405	200	158	GW Recharge/gaining stream reaches	Major, open	15.6	205		300-500	5-20	10-20	10-20
Riparian Fracture Zone (High-K Zone)	*2*	*213893*	*100*	*491*	*GW Recharge/gaining stream reaches*	Minor, open	15.6	638		200-300	5-20	10-20	10-20
Deep Sand on Jn Matrix	3			9269	GW Recharge/storage		15.6	12050		200-250	0.1-5.0	5-10	10-20
Thin Sand on Jn Matrix	4			26015	GW Recharge/storage		15.6	33820		200-250	0.1-5.0	5-10	10-20
Dry Wash Fracture Zone with Qal	5			2718	GW Recharge/storage		15.6	3533		200-300	5-20	10-20	10-20
Qal in Lower Kanab Canyon/Upper Kanab Canyon	*6*			*646*	GW Storage/Losing Stream Reaches Lower Canyon, *Gaining Stream Reaches Upper Canyon*		15.6	840		50-100	0.1-10	10-20	10-20
Total Recharge in Jn													
Jnl Outcrop in Lower Kanab Creek Canyon	*7*			*963*	GW Recharge from Precip, Qal and Kanab Creek to Jnl, *GW Losses to Underlying Aquifer*		15.6	1252		200	0.002-4.0	5-10	10-20
Total Recharge													
Recharge Area for West Boundary Underflow	8			3084	Inflow		15.6	4009					10-20
Open Water (Lakes, Ponds)	9			*10*	*Eo*	Open Pan Eo=54in/yr	15.6	13					
	Total			**43954**				**57141**					
type 1 is subarea of type 2				600				780					
type 8 is outside PWB area				3084				4009					
type 9 is subarea of zone 5				10				13					
Partial Overlap of Type 6 and 7				*616*				803					
	Net Total			**39642**				**51536**					
Total PWB acreage				38993									
Recharge into Jnl through Jkt in Upper Kanab Creek French Drain													

Hydro Zone Name	Recharge 1981-2010 *Low* Acre-ft/yr	Recharge 1981-2010 *Best Estimate* Acre-ft/yr	Recharge 1981-2010 *High* Acre-ft/yr	Recharge *in Jnl* [acre-ft/yr]	Phreatic Consumptive Use Low Acre-ft/yr	Phreatic Consumptive Use Average Acre-ft/yr	Phreatic Consumptive Use High Acre-ft/yr	Total Water Content Low Acre-ft	Total Water Content High Acre-ft	Variable Storage Low Acre-ft	Variable Storage High Acre-ft
Phreatophytes	0	0	0		3000	3817	4635				
Riparian Fracture Zone (High-K Zone) Kanab Creek	0	0	0					4739	15797	474	1580
Riparian Fracture Zone (High-K Zone)	0	0	0					9821	29462	982	2946
Deep Sand on Jn Matrix	1205	*1807*	*2410*					92690	231725	9269	23173
Thin Sand on Jn Matrix	3382	5073	6764					260150	650375	26015	65038
Dry Wash Fracture Zone with Qal	353	707	707					54360	163080	5436	16308
Qal in Lower Kanab Canyon/Upper Kanab Canyon	0	0	0					3230	12920	323	1292
Total Recharge in Jn	4940	7587	9881								
Jnl Outcrop in Lower Kanab Creek Canyon	125	188	250					9630	38520	963	3852
Total Recharge	**5065**	**7775**	**10131**								
Recharge Area for West Boundary Underflow	401	601	802					0	0	0	0
Open Water (Lakes, Ponds)	-33	-33	-33					0	0	0	0
Net Total								**434620**	**1141878**	**43462**	**114188**

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EXHIBIT 2

AREA 85 - KANAB and JOHNSON CREEKS

Updated: April 17, 2011

MANAGEMENT

There are three court decrees in this area, all dealing with the surface waters of Johnson Wash. They are the 1896 McCarty Decree, the 1909 Chidester Decree, and the 1926 Bates Decree. Water rights in this area were compiled into a Proposed Determination of Water Rights in 1974. No pre-trial order has been issued. Because this area is tributary to the Colorado River, the provisions of the 1922 Colorado River Compact and the 1944 Mexican Treaty apply. However, there are no interstate compacts which specifically apportion the waters of this area. In 1999, the State Engineer issued an Interim Policy for Evaluating Change Applications in the Johnson Canyon Drainage which details the criteria which will be used to evaluate changes in water rights, especially those proposing to convert decreed surface water rights to underground rights. There are no state-administered water distribution systems in this area. Click here to see statistics for this area.

SOURCES

Surface and Ground Water - Surface and underground waters of the area are considered to be fully appropriated. New diversions and uses must be accomplished by change applications based on valid existing water rights. Fixed-time projects must be accomplished by temporary change applications on valid existing water rights, which require annual renewal. Change applications proposing a change from surface to underground sources, or vice versa, will be critically reviewed to assure hydrologic connection, that there are no enlargements of the underlying right(s), and that there will be no impairment of other rights. The State Engineer allows that there may be limited unappropriated water available from bedrock aquifers in isolated locations. Applications proposing to appropriate such waters will be reviewed on their own merits.

GENERAL

Applications are advertised in the *Southern Utah News*. Filings that may involve the diversion of water in Utah for use in Arizona (export) would be subject to the special criteria the statutes require for such projects. The general irrigation diversion duty for this area, which the State Engineer uses for evaluation purposes, is 5.0 acre-feet per acre per year. The consumptive use requirement is determined from the publication Consumptive Use of Irrigated Crops in Utah, Research Report 145, Utah State University, 1994, unless the applicant submits other data for consideration. This area is administered by the Southwest Regional Office in Cedar City.

Other Requirements

The Water Right applicant is strongly cautioned that other permits may be required before any physical development of a project can begin and it is the responsibility of the applicant to determine the applicability of and acquisition of such permits. In order to avoid delays and ensure that Water Right approvals conform to applicable local ordinances, applicants should contact local governmental entities in advance to determine what ordinances are in place that affect the proposed project and to make sure that Water Right filings conform to those ordinances. The approval of a Water Right application does not imply any approval of a project by any other governmental entity. Approval of the project proposed in the Water Right application should be obtained from local governmental entities as necessary to implement a project.

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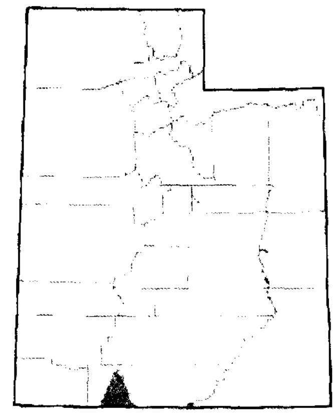
MODELING

Navajo Sandstone Ground-Water Flow Model; 1992.



Policy area in green, click on the map for more detail

DESCRIPTION

Located in the western section of Kane County, this area extends from T38S to T44S, where it meets Arizona. It is bounded on the west by the Virgin River drainage and on the east by the Paria River drainage. The highest point is at about 9,350 feet, along the divide with the Sevier River drainage, the lowest point is where Kanab Creek leaves the state at 4,800 feet, giving the basin a total relief of about 4,550 feet.

Click for Interactive Map

SCANNED SD

PREVIOUS PAGE UPDATES

None available.

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EXHIBIT 3

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Kanab City Fire Chief/City Manager
Kanab City
26 N. 100 E
Kanab, UT 84741
Ph 435-644-2534
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From: Hugh Hurlow <hughhurlow@utah.gov>
Sent: Monday, May 20, 2019 2:58 PM
To: jdecker@kanab.utah.gov
Cc: Paul Inkenbrandt <paulinkenbrandt@utah.gov>
Subject: Kanab City Wells

Joe,

Paul did some basic calculations to estimate the possible effects of a new pumping well in section 16, T42S R7W at the "Drill Hole" shown on the topographic map, on Kanab City's West Fork wells #3, 4, and 5, i.e. the logs you sent. He assumed withdrawal of 9680 acre-feet per year, the number you quoted me. This is 6000 gpm assuming continuous pumping. He used aquifer transmissivity and storativity from a published report by the U.S. Geological Survey which compiled hydraulic properties of the Navajo Aquifer in southern Utah from high quality aquifer tests (the publication I sent you). He assumed that transmissivity is the same in all directions, ignoring the possible effects of fracture systems on flow. We did not know the water level in the new well and assumed it would be 500 feet, and screened from 500 to 800 feet.

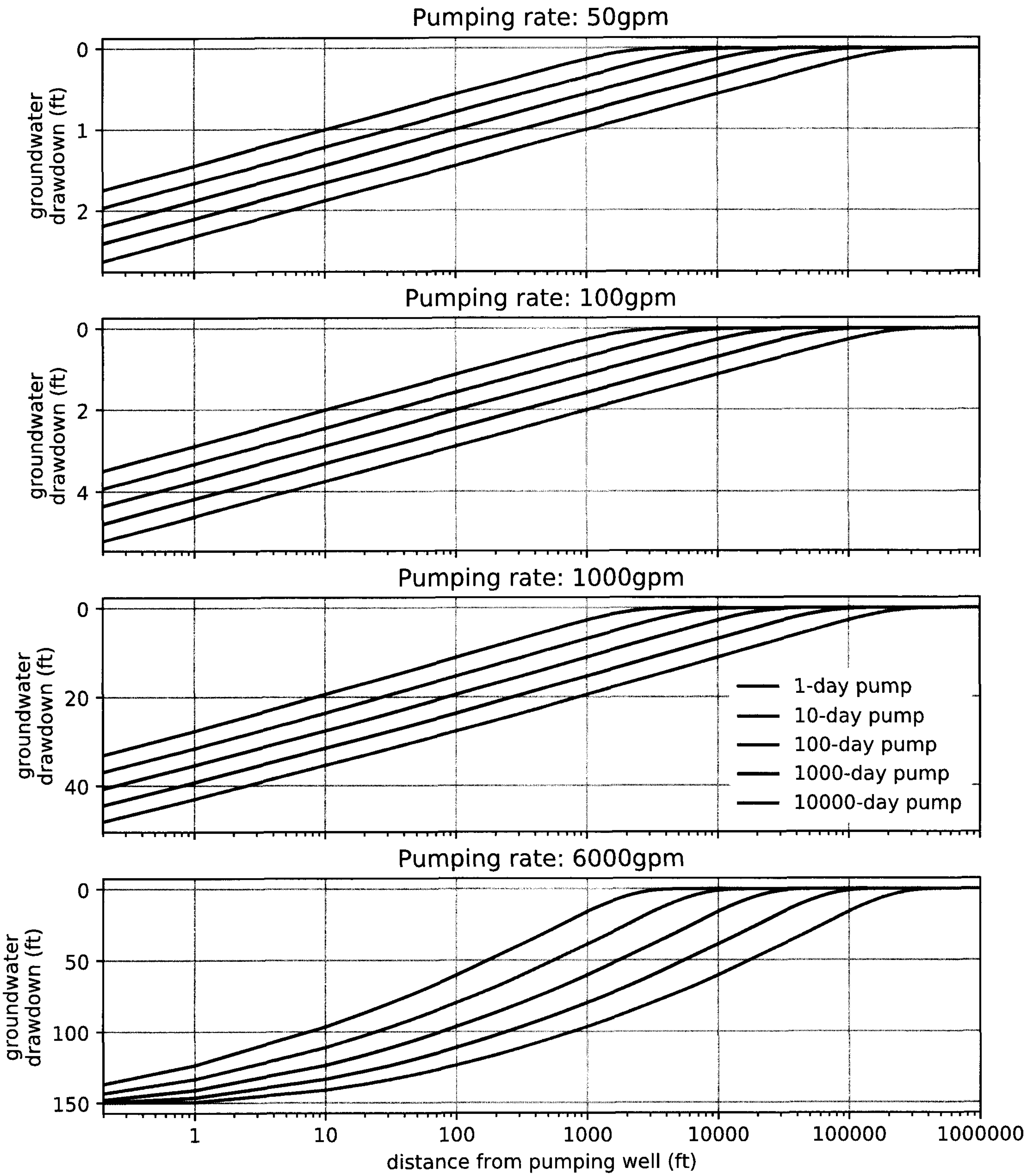
The results are on the attached sheets. The X-Y graph shows the effects of the new pumping on the existing Kanab City wells. This drawdown should be added to the observed drawdown in the Kanab City wells resulting from their pumping. For example, after 1000 days (just under 3 years) of pumping from the new well, drawdown in the Kanab City wells would increase by about 10 meters (about 33 feet). Drawdown would obviously be lower at lower pumping rates or fewer days of pumping. The map figure shows the spatial distribution of drawdown due to pumping at the new well after 200 days. The pump_dist_draw plots show how drawdown would increase over time with distance from the pumping well, at a variety of pumping rates.

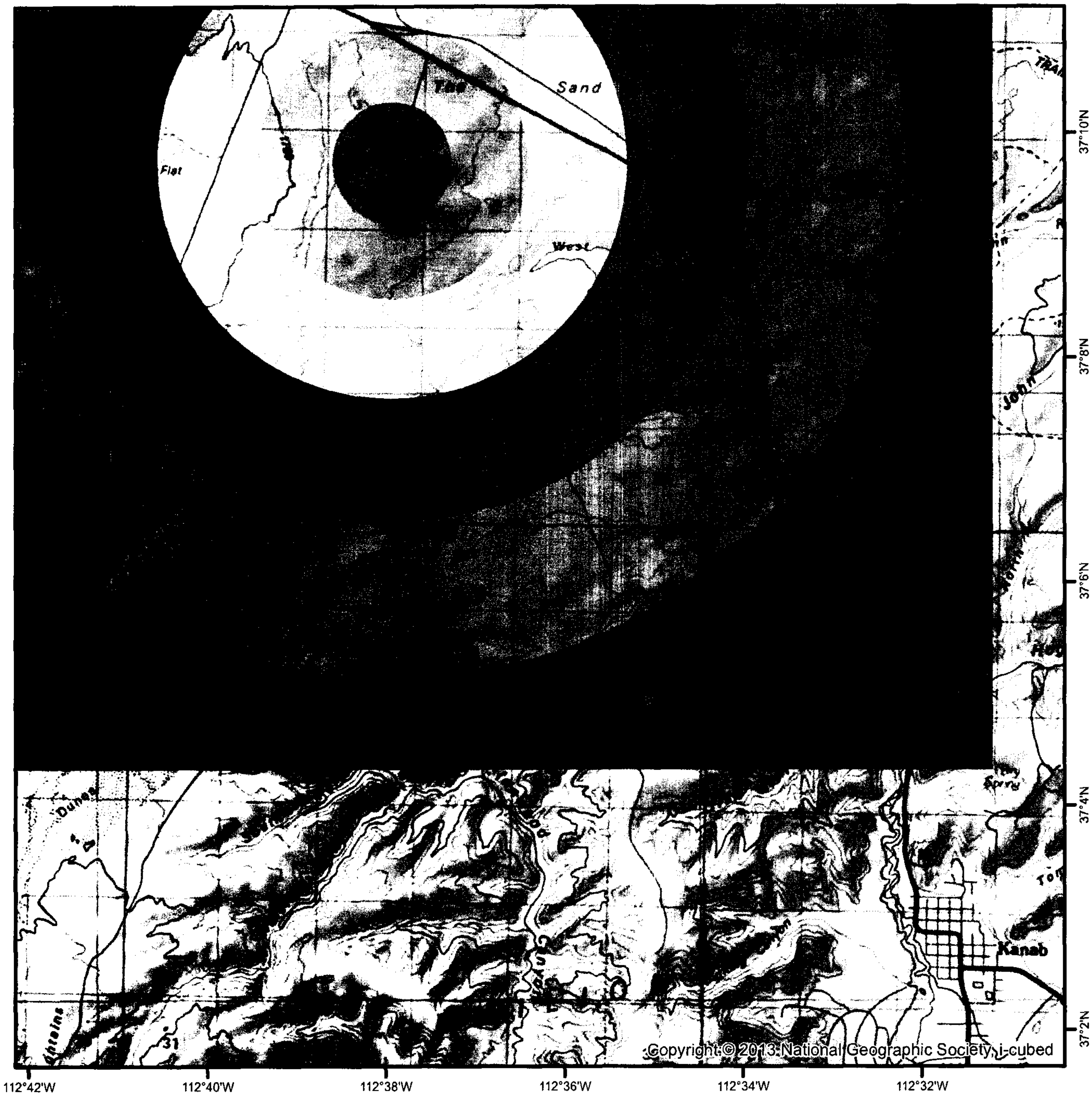
The accuracy of these estimates are limited by assumptions for the pumping rate and schedule and the hydraulic properties of the aquifer. We did not consider recharge, other groundwater withdrawals, possible impact on Kanab Creek, or implications for long-term life of the aquifer. All of these issues and more could be addressed in a longer study on which we would like to work with you if possible. For now, I hope these results help you to evaluate the situation.

-Paul & Hugh

--

Hugh Hurlow, Ph.D., P.G.
Groundwater Program Manager
Utah Geological Survey
1594 W North Temple
Salt Lake City UT 84114
801-537-3385
geology.utah.gov


Pumping rate: 50gpm
groundwater drawdown (ft)
0
1
2
Pumping rate: 100gpm
groundwater drawdown (ft)
0
2
4
Pumping rate: 1000gpm
groundwater drawdown (ft)
0
20
40
1-day pump
10-day pump
100-day pump
1000-day pump
10000-day pump
Pumping rate: 6000gpm
groundwater drawdown (ft)
0
50
100
150
1
10
100
1000
10000
100000
1000000
distance from pumping well (ft)



Explanation

N

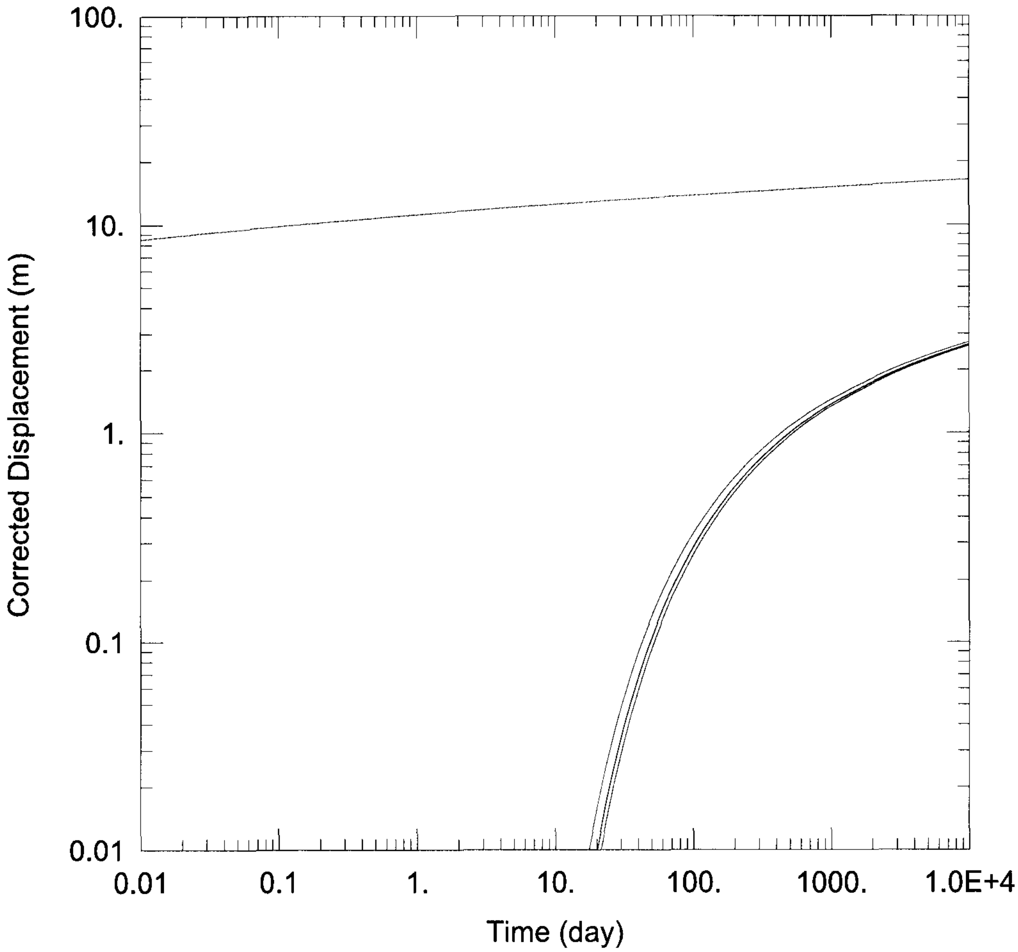
0 1 2 Miles

- ■ USGS Monitoring Well
- ▲ Kanab Source
- ● Proposed Well

Modeled Drawdown (743 gpm for 1 year)

meters

- 0.11 - 0.36
- 0.37 - 0.61
- 0.62 - 0.93
- 0.94 - 1.4
- 1.5 - 2.1
- 2.2 - 4.1



FORWARD MODEL

Data Set: G:\...\ForwardModel.aqt
Date: 05/21/19 Time: 09:05:35

PROJECT INFORMATION

Company: UGS
Client: Kanab
Project: Kanab New Well
Location: Kanab Utah
Test Well: Pump
Test Date: 2019

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Pump	354827	4113758

Observation Wells

Well Name	X (m)	Y (m)
▫ Pump	354827	4113758
▫ WF3	359747	4112177
▫ WF4	359223	4112198
▫ WF5	359533	4112081

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 6000. ft^2/day
Kz/Kr = 1.

S = 0.005
b = 120. m

EXHIBIT 4

FORM C-1 5000

ORIGINAL

CERTIFICATE OF APPROPRIATION OF WATER

STATE OF UTAH

APPLICATION NO. 28596 CERTIFICATE NO. 5692

NAME AND ADDRESS OF APPROPRIATOR KANAB CITY, KANAB, UTAH

SOURCE OF SUPPLY UNDERGROUND WATER IN KANE COUNTY, UTAH; COLORADO RIVER DRAINAGE AREA

QUANTITY OF WATER EIGHT HUNDRED EIGHTY-FIVE/ONE THOUSANDTHS (0.885) SECOND-FOOT PRIORITY OF RIGHT SEPTEMBER 29, 1956

PERIOD AND NATURE OF USE FROM JANUARY 1 TO DECEMBER 31 INCLUSIVE OF EACH YEAR FOR MUNICIPAL PURPOSES

Whereas, *It has been made to appear to the satisfaction of the undersigned that the appropriation of water has been perfected in accordance with the Laws of Utah;* **Therefore,** *Be it known that I,* WAYNE D. CRIDDLE *the duly appointed, qualified and acting State Engineer, by authority of the Laws of Utah, do hereby certify that said appropriator is entitled to the use of water as herein set out, subject to prior rights, if any, for diversion and use as follows, to wit:* The water appropriated is yielded by a pump well driven to a depth of 250 ft, cased from the top down 199 ft. with 12-in. diameter pipe, the remaining depth being uncased, situated N 273.7 ft. and E 1320.0 ft. from W¼ Cor. Sec. 19 T42S R6W SLBM. The water is diverted by means of a diesel-powered turbine pump, conveyed therefrom by means of 6-in. diameter pipe 190 ft. in a Southeasterly direction to a tee connection, where it is commingled with water appropriated under Application No. 24354. After thus being commingled, the water is conveyed Southerly through 6-in. and 8-in. diameter pipe 7258 ft. to a second tee connection, where it is commingled with other water not covered by this appropriation. After being thus being commingled, the water is conveyed Southeasterly a total distance of 29,526 ft. through 10-in. and 12-in. diameter pipe through the following sections: NE¼ Sec. 31, SW¼ Sec. 32 T42S R6W SLBM, through the center of Sec. 5, E½ Sec. 8, W½ Sec. 16 into W½ Sec. 21 T43S R6W SLBM, where it enters the corporate boundary of the City of Kanab, Utah. The water is distributed through the City's pipe mains or at times conveyed to 2 concrete reservoirs which float on the line having capacities of 1,000,000 and 365,000 gallons respectively, situated N10°30'E 2260 ft. from S¼ Cor. said Sec. 21. From the reservoirs, the water is returned to the city main through 1800 ft. of 6-in. diameter inlet pipe. The water appropriated is, during the aforesaid period, intermittently used, as a supplemental supply, for municipal purposes within the corporate boundary of the City of Kanab. Part of the water is, during the aforesaid period, intermittently used outside the corporate boundary for domestic purposes within the following legal subdivisions: 3 residences together with 4 commercial industrial plants in NW¼SW¼ Sec. 21, 4 residences in SW¼NW¼, 2 residences in NE¼SW¼, 4 residences in NW¼SW¼ Sec. 27, 1 residence in SE¼SE¼, 1 residence and a tourist court in SW¼SE¼ Sec. 28, 1 residence in NE¼NE¼, 2 residences in NW¼NE¼ Sec. 33, last aforesaid township and range. Part of the water is, during the irrigation season, intermittently used to irrigate lawns and gardens adjacent to the above-described residences, tourist court, and a cemetery, total area being 2.66 acres. Part of the water is, during the entire year, intermittently used to water 79 cattle, 6 horses, and 50 swine.

The works employed in this appropriation are to be operated and maintained in such manner and condition as will prevent waste of water.

In Witness Whereof, *I have hereunto set my hand and affixed the seal of my office this* 25th *day of* May, 19 60

Wayne D. Criddle

Wayne D. Criddle, STATE ENGINEER

SCANNED SD

EXHIBIT 5

January 14, 2019

David Ure
Tom Faddies
Utah School and Institutional Trust Lands Administration
675 500 South, Suite 500
Salt Lake City, Utah 84102

Re.: ML 53492-MP and ML 53491-MP, Request for Royalty Rate Reduction

Dear Mr. Ure and Mr. Faddies:

Southern Red Sands, LLC ("SRS") is the permittee under the above-referenced Mineral Materials Permits (collective, "Permits"). As you know from our discussions over the last six months, SRS is in the process of developing a silica sand mining operation for production of high quality hydraulic fracturing.

We have spent substantial time preparing proformas under various economic scenarios and have also consulted with a variety of potential customers. Through this process we have determined that in order for SRS to gain access to the funding in order to develop an economic hydraulic fracturing sand mining operation on the Permits, a reduction in the royalty rate is needed.[1] This is particularly true as SRS scales its operation. Therefore, the purpose of this letter is to request a royalty rate adjustment to a flat rate per ton as follows:

$1.00 per short ton for tons 0 - 2,000,000 produced from each Permit
$1.25 per short ton for tons 2,000,000 – 4,000,000 produced from each Permit
$1.50 per short ton for all tons over 4,000,000 produced from each Permit

Some of the factors that have led us to conclude that an economic sand operation on the Permits requires a reduced royalty include the costs associated with transportation to bring sand to market, the lack of proximity to a rail line, the geology of the silica despot, the costs associated with improvement of Red Knoll Road and connection of utilities, the capital expenditures required to construct a plant on the Permits, and the number of other competing silica sand operations coming on-line in the next 6-18 months.

While SRS was hopeful that we would be able to develop a successful project at the Permit's current royalty rate, the market analysis and geologic testing we have performed, coupled with bids from third party contractors for transportation and construction, have led us to conclude that

[1] The current royalty rate set forth in Section 2(B) of the Permits consists of "10% of Gross Value of the Mineral Commodity or $3.00 per ton, whichever is greater."

a successful silica operation on the Permits can only be achieved through a reduced royalty rate. Nonetheless, if SITLA agrees to our requested royalty, we are confident that we can develop a successful operation that will provide significant economic benefits to SITLA.

Please do not hesitate to contact me if you require any additional information about SRS or our project.

Sincerely,

M. Chad Staheli - CEO

4835-1832-1796v1

EXHIBIT 6

State of Utah
School and Institutional
Trust Lands Administration

SITLA

675 East 500 South, Suite 500
Salt Lake City, Utah 84102-2813
801-538-5100 Fax 801-355-0922
trustlands.utah.gov

David Ure
Director

January 31, 2019

Integrated Logistics, LLC
M. Chad Staheli
201 South Main Street, 20th Floor
Salt Lake City, UT 84111

RE: Mineral Materials Permit No. 53492 – Silica Sand
Township 42 South, Range 7 West, SLB&M
Section 16: 640 Acres

Dear Mr. Staheli,

The above listed mineral materials permit for industrial sands was approved effective April 1, 2017 for a five (5) year term. The School and Institutional Trust Lands Administration (SITLA) is supportive of the proposed use of the subject lands for the extraction and removal of silica sand for use in the oil and gas industry. Section 3(B) of the permit requires that the "Permittee shall pay Permitter a production royalty on the basis of 10% of the Gross Value of the Mineral Commodity or $3.00 per ton, whichever amount is greater." We have received and reviewed your letter dated January 14, 2019 asking for a reduction the royalty rate. While in general agreement, SITLA proposes amending the above listed permit as follows:

- Extend the permit an additional five (5) years, with the new expiration date being March 31, 2027.
- Permitter to pay an advanced royalty to SITLA in the amount of One Hundred Thousand Dollars ($100,000). This money will be due at the time of the proposed amendment and will be deductible from future production royalties.
- Production royalty rates will be amended as follows:
  - $1.00 per short ton for tons 0 to 2,000,000 produced from said permit
  - $1.25 per short ton for tons 2,000,000 to 4,000,000 produced from said permit
  - $1.50 per short ton for all tons produced above 4,000,000 from said permit
- The production royalty rate will be subject to annual adjustments. These annual adjustments will be tied to an appropriate Price Producer Index (PPI) as produced by the Bureau of Labor and Statistics.

SCANNED SD

- Include the conditional use permit recommendations of Kane County into the plan of operations to be approved by SITLA.
- Such other terms as may be appropriate and agreed upon by the parties.

The above proposed amendments would apply only to ML 53492-MP. A similarly structured amendment could apply to the other permit held by Integrated Logistics ML 53491-MP at some point in the future.

Additionally, our records indicate that Integrated Logistics, LLC is the permitted of record for ML-53492. If the company name has changed to Southern Red Sands, LLC or if there has been an assignment, please provide SITLA with the necessary information.

Please let us know if these terms are acceptable. We hope to see the proposed project be successful for all parties involved. We appreciate your continued support of SITLA and look forward to our continued business relationship. If you have any questions or comments, please contact us at 801-538-5100 or via email.

Sincerely,

Andy Bedingfield
Trust Lands Resource Specialist

EXHIBIT 7

February 12, 2019

Sent via e-mail

Andy Bedingfield
Utah School and Institutional Trust Lands Administration
675 500 South, Suite 500
Salt Lake City, Utah 84102

Re.: ML 53492-MP and ML 53491-MP, Request for Royalty Rate Reduction

Dear Mr. Bedingfield:

Southern Red Sands, LLC ("SRS") is in receipt of your letter dated January 31, 2019 ("Response Letter") regarding SRS's January 14, 2019 request for a royalty rate reduction under the above-referenced Mineral Materials Permits (collective, "Permits"). In the Response Letter, the Utah School and Institutional Trust Lands Administration ("SITLA") proposes that MP 53492 be amended in five specific ways, including the requirement that SRS pay an advanced royalty to SITLA in the amount of $100,000 ("Advance Royalty Payment") at the time of the amendment, which would be deductible from future royalty payments.

SRS is amenable to each of SITLA's proposed amendments, with the exception that, instead of a $100,000 Advance Royalty Payment, SRS proposes to make a $50,000 Advance Royalty Payment at the time of amendment, deductible from future payments. As SRS is in the capital-intensive project development stage, we are hoping to be able to put as much capital into the ground as possible in order to expedite production. An Advance Royalty Payment of $50,000 allows us to put more investment into the capital projects that are required for commercial operations.

If SITLA is agreeable to the proposed $50,000 Advance Royalty Payment, please let me know what additional information or materials SITLA needs from SRS in order to amend ML 53492 as proposed.

Sincerely,

M. Chad Staheli

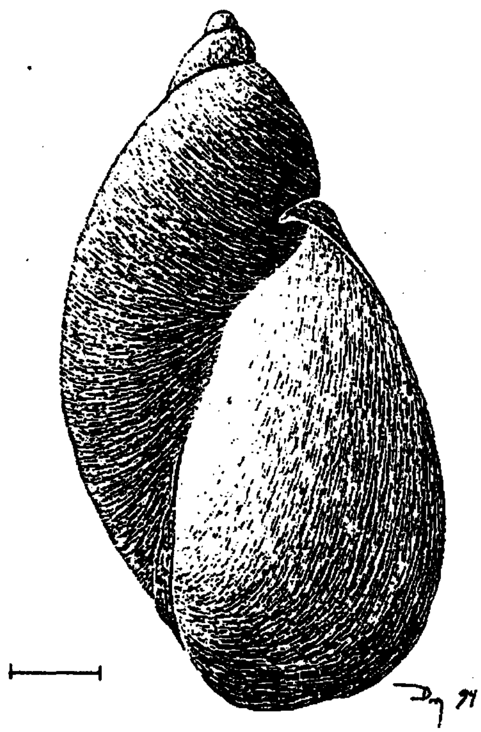
Cc:

4846-7619-5719v1

SCANNED SD

EXHIBIT 8

KANAB AMBERSNAIL
(*Oxyloma haydeni kanabensis*)



RECOVERY PLAN

U.S. Fish and Wildlife Service

Region 6/Region 2

1995

KANAB AMBERSNAIL

OXYLOMA HAYDENI KANABENSIS

RECOVERY PLAN

Prepared by

John L. England

U.S. Fish and Wildlife Service

Salt Lake City, Utah

for

Region 2

U.S. Fish and Wildlife Service

Albuquerque, New Mexico

and

Region 6

U.S. Fish and Wildlife Service

Denver, Colorado

Approved: Terry Terrell

DEPUTY Regional Director, Region 6, U.S. Fish and Wildlife Service

Date: 10/12/95

DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and other interested parties. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views or the official positions or approvals of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

LITERATURE CITATIONS

Literature Citation should read as follows:

U.S. Fish and Wildlife Service. 1995. Kanab ambersnail (Oxyloma haydeni kanabensis) recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 21 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
P.O. Box 6044
Bethesda, Maryland 20850

Telephone: 301/492-6430 or 1-800-582-3421

The fee for the plan varies depending on the number of pages of the plan.

Cover illustration by Douglas W. Moore.

EXECUTIVE SUMMARY

<u>Current Status</u>: The Kanab ambersnail is a rare endemic snail restricted to permanently wet areas within small wetlands of the Colorado Plateau. Three populations are known, two in southern Utah, the other within the Grand Canyon of Arizona. The two Utah populations are about 2.1 kilometers (1.3 miles) apart near the Utah-Arizona border in Kane County. The larger Utah population (which contains over 99 percent of the total number of individuals in Utah) occurs in Three Lakes Canyon about 10 kilometers (6 miles) northwest of the town of Kanab, Utah. This population inhabits wet meadow and marsh habitat (approximately 0.8 kilometers [0.5 miles] long) surrounding the "Three Lakes" ponds. The smaller Utah population is in a vegetated seep at the base of a sandstone cliff about 46 meters (150 feet) long and 15 centimeters (6 inches) wide near the main stem of Kanab Creek in Kanab Creek Canyon. The Arizona population occurs in a spring fed wetland at Vasey's Paradise generally above the 20,000 cubic feet per second water line of the Colorado River in Grand Canyon National Park. Vasey's Paradise is about 52 river kilometers (32 river miles) downstream from Lee's Ferry in Coconino County, and about 92 straight line kilometers (57 miles) southeast of the two Utah populations. Occupied habitat is about 840 square meters (1,005 square yards).

The Kanab ambersnail was discovered in 1909 at the "Greens" in the Kanab Creek drainage. The population at Three Lakes Canyon was estimated to contain 100,000 individuals in June 1990. During 1990 and 1991 this population experienced population and habitat lose due to wetland destruction and, to a limited extent, livestock trampling. The smaller Utah population (Kanab Creek Canyon) numbered over 300 individuals in the early 1980's. Its habitat has been dewatered within the past 10 years, and only three individuals were counted after an intensive search of its habitat in September 1990. No Kanab ambersnails have been observed since. This smaller Utah population may be extirpated.

The Arizona population at Vasey's Paradise was discovered in 1991. Preliminary population estimates indicate a population of about 16,000 individuals at this site. This population is thought to be relatively secure in relation to the Utah populations. Vasey's Paradise does, however, receive regular visitation from river runners because of its great natural beauty and the availability of fresh water at the site. This area also may be impacted by natural and human-caused variations in the flow of the Colorado River downstream from the Glen Canyon Dam.

<u>Recovery Objective</u>: The immediate objective of this recovery plan is to maintain viable populations of the Kanab ambersnail in the current range of the species. The long-term objective is to downlist and eventually delist.

<u>Recovery Criteria</u>:

<u>Conservation Criteria</u>: In order to prevent the species from becoming extinct, each Kanab ambersnail population and its habitat must be protected from loss of individuals and environmental degradation through sections 7 and 9 of the Endangered Species Act.

Downlisting Criteria: The Kanab ambersnail may be considered for downlisting to threatened when the above conservation criteria have been met and when the following criteria have been attained:

1. Locate and/or establish additional populations. Maintain 10 separate populations which have been demonstrated to have population numbers large enough to allow for the long-term viability of the population. This criteria is provisional. It is probable that this criteria will be modified as additional information is acquired concerning the species distribution, abundance, and stability of its separate populations.

2. The establishment of formal land management designations and/or implementation of land management plans which provide long-term, undisturbed habitat for the Kanab ambersnail for the above 10 populations.

Delisting Criteria: Delisting criteria will not be developed until there is sufficient information to do so.

Actions Needed:

1. Control activities that affect the habitat and populations of the Kanab ambersnail. These activities include the frequency, duration, magnitude, and timing of flood flows from Glen Canyon Dam and possible recreation in the area of Vasey's Paradise. Ensure that no unauthorized action harms all extant populations.

2. Acquire and restore the habitat of the Three Lakes population and acquire and/or protect other habitat suitable to the long-term viability of the Kanab ambersnail.

3. Inventory suitable habitat for Kanab ambersnail to determine existing population density and distribution of the species as well as potential recovery sites.

4. Determine the biological and ecological factors critical to the species conservation.

5. Locate or establish additional populations and establish ex situ breeding populations

6. Develop public awareness and appreciation for the conservation of the species.

Date of Recovery: unknown

Total Cost of Recovery: unknown

TABLE OF CONTENTS

I. INTRODUCTION

The Kanab ambersnail, Oxyloma haydeni kanabensis Pilsbry, is a rare endemic snail restricted to permanently wet areas within small wetlands of the Colorado Plateau. The snail was emergency listed under an emergency rule published on August 8, 1991 (56 FR 37671). Emergency rules are effective for 240 days. To remain on the endangered species list, the normal listing process of publishing a proposed rule, requesting and considering public/agency comments, and publishing a final rule must be followed. The Kanab ambersnail was proposed for listing as an endangered species, with critical habitat for the species' larger Utah population (Figure 1), on November 15, 1991 (56 FR 50824). A final rule listing the Kanab ambersnail as an endangered species under the authority of the Endangered Species Act, as amended, was published on April 17, 1992 (57 FR 13661). Designation of critical habitat was not finalized in the rule because the U.S. Fish and Wildlife Service (Service) did not have the necessary economic information. Critical habitat for the larger Utah population remains proposed until the Service either publishes a final rule to designate it or publishes a notice to withdraw the proposed critical habitat. The recovery priority of this subspecies is 6C (a subspecies with a high degree of threat and low recovery potential with a possibility of conflict with human activities).

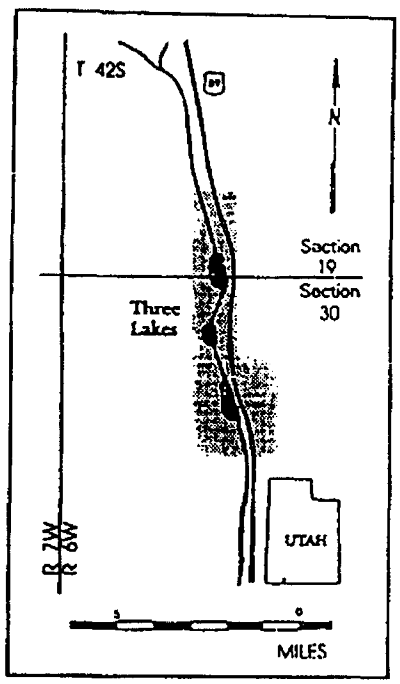


Figure 1. Proposed Critical Habitat for the Kanab Ambersnail (Oxyloma haydeni kanabensis). Utah, Kane County: Three Lakes Canyon, the "Three Lakes" ponds and adjacent wetlands and seeps in the E½ SE¼ SW¼ Sec. 19, E½ NE¼ NW¼ Sec. 30, E½ SE¼ NW¼ Sec. 30, and W½ SW¼ NE¼ Sec. 30, T.42S., R.6W., of the Salt Lake Meridian between U.S. Highway 89 and the sandstone cliffs west of the highway. Constituent elements include: Wetlands adjacent to water seeps in sandstone cliffs and surrounding the "Three Lakes" ponds and water seeps in sandstone cliffs.

This recovery plan was prepared in-house by the Service with technical input from biologists from the Bureau of Reclamation, National Park Service, and Arizona Game and Fish Department. The Kanab ambersnail draft recovery plan was sent to five species experts, with specific knowledge of the species and its ecosystem, for peer review. Two reviewers provided additional information concerning the species biology and distributional status. Their comments were incorporated into this final plan. The draft of this recovery plan was sent to the two private landowners of the species Utah habitat and to the National Park Service, the managers of the species public land habitat in Arizona, for their comment. One private landowner and the National Park Service commented on the proposed plan. Their comments were also incorporated into this final plan.

Private lands and individuals will be directly affected by the implementation of some recovery plan tasks. The Service will involve all interested and affected parties in the recovery plan implementation process through the development of a participation plan. As resources become available, all interested parties will be involved in the initiation of the various recovery plan tasks. This recovery plan, with its implementation schedule, will serve as the initial participation plan for this species.

A. DESCRIPTION

The Kanab ambersnail is a terrestrial snail in the family Succineidae. The empty shell is a light amber color. The live snail has a mottled grayish-amber to yellowish-amber colored shell. The shell is dextral (right handed spiral), thin-walled, with an elevated spire and a broad, patulous (expanded) aperture. Fully mature individuals are about 14 to 19 mm (0.5 to 0.75 inch) long, 7 to 9 mm (0.25 to 0.33 inch) in diameter, with 3.25 to 3.75 whorls in a drawn out spire. Its eyes are borne at the ends of long peduncles (stalks), while the tentacles are reduced to small protuberances at the base of the eye stalks (Pilsbry 1948, Clarke 1991).

Specimens of the Kanab ambersnail were first collected in 1909 by James Ferriss from: "The Greens", 10 kilometers (6 miles) above Kanab, Utah on Kanab Wash, on a wet ledge among moss and cypripediums" (Ferriss 1910, Pilsbry 1948). These specimens were originally placed in the species Succinea hawkinsi (Ferriss 1910, Chamberlin and Jones 1929). Henry Pilsbry (1948) transferred these specimens to the genus Oxyloma and erected the subspecies kanabensis in the species haydeni for them. Arthur Clarke (1991) notes that Pilsbry's decision to accord the Kanab ambersnail subspecific status was preliminary, and that, as Pilsbry himself noted, "its taxonomic status should be reevaluated." Clarke (1991) and Shei K. Wu (Colorado Museum of Natural History, Boulder, Colorado, pers. comm. 1992, 1995) suggest that the Kanab ambersnail may deserve full species status. Earle Spamer (Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, pers. comm. 1994) stated that current published mollusk checklists (Turgeon et al. 1988 and Groombridge 1993) treat the Kanab ambersnail at species level rather that as a subspecies, but until the criteria are derived and published by which the taxon can be shown to be a separate species it should continue to be called by its original name published by Pilsbry (1948): Oxyloma haydeni spp. kanabensis.

B. DISTRIBUTION

The existence of the Kanab ambersnail in Utah has been known since its discovery by Ferriss in 1909 (Ferriss, label information on type specimen, Philadelphia Academy of Sciences, 1909; Chamberlin and Jones 1929; Pilsbry 1948; and Clarke 1991). The Kanab ambersnail is currently known from three populations (Figure 2). The majority of the species total known population is located at Three Lakes about 10 kilometers (6 miles) NNW of Kanab in Kane County, Utah (Clarke 1991). This population inhabits wet meadow and marsh habitat (approximately 0.8 kilometers [0.5 miles] long) surrounding the "Three Lakes" ponds. Potential and occupied habitat is estimated by the Service at 2 hectares (5 acres).

A second, but much smaller, population is located in Kanab Creek Canyon about 10 kilometers (6 miles) north of Kanab, also in Kane County, Utah (Clarke 1991). This population occurs in a vegetated seep at the base of a sandstone cliff about 46 meters (150 feet) long and 15 centimeters (6 inches) wide near the main stem of Kanab Creek in Kanab Creek Canyon. This smaller population may be extirpated. No individuals have been collected or observed since 1990. The two Utah populations are about 2.1 kilometers (1.3 miles) apart near the Utah-Arizona border.

The third population is located at Vasey's Paradise along the Colorado River in the Grand Canyon in Coconino County, Arizona, about 52 river kilometers (32 river miles) downstream from Lee's Ferry and about 92 straight-line kilometers (57 miles) southeast of the two known Utah populations (Spamer and Bogan 1992, 1993b). This population was discovered recently by Spamer in 1991 (Spamer and Bogan 1992, 1993a, 1993b). Previous to 1991, the genus Oxyloma was unknown to the State of Arizona except in the fossil fauna (Bequaert and Miller 1973, Spamer and Bogan 1992, 1993a, 1993b). Potential and occupied habitat is estimated at about 840 square meters (1,005 square yards), (David Wegner, Glen Canyon Environmental Studies, Bureau of Reclamation, Flagstaff, Arizona, pers. comm. 1995). No other historical populations are known to have existed. Recent snail surveys within the Grand Canyon during 1994 and 1995 have failed to locate additional populations (Larry Stevens, Glen Canyon Environmental Studies, Flagstaff, Arizona, pers. comm. 1995).

C. POPULATION BIOLOGY

The Kanab ambersnail is a rare endemic snail restricted to permanently wet areas within small wetlands of the Colorado Plateau. Its population at Three Lakes Canyon was estimated to contain 100,000 individuals in June 1990. During 1990 and 1991 this population experienced habitat losses due to wetlands destruction and, to a limited extent, livestock trampling. In September 1994 a significant portion of its population was buried by silt deposited by runoff from a series of strong thunderstorms. The smaller Utah population (Kanab Creek Canyon) numbered over 300 individuals in the early 1980's. Its habitat has been dewatered within the past 10 years (Clarke 1991). Only three individuals were counted after an intensive search of the habitat in September 1990 and none have been observed since (U.S. Fish and Wildlife Service 1992). This population must be intensively surveyed before the Service can make a determination of extirpation. The size of the Arizona population has been estimated to be about 16,000 individuals (David Wegner, pers. comm. 1995).

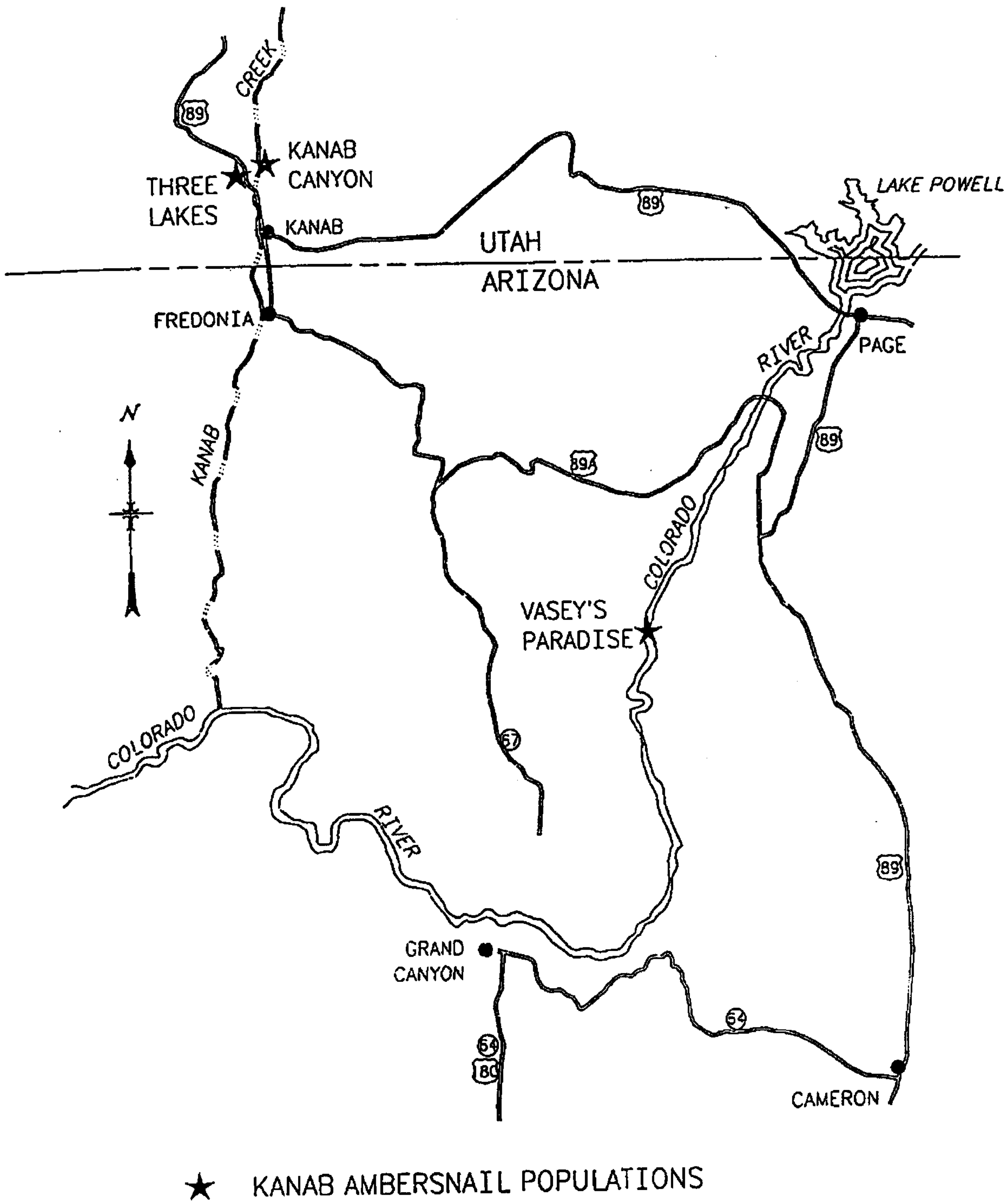


Figure 2. Distribution of the Kanab Ambersnail.

Great diversity in the size of individuals within the Utah populations early in the active growing season indicate that reproduction probably occurs throughout all warm, wet periods of the year and that the Kanab ambersnail overwinters as juveniles, sub-adults, and adults (Clarke 1991). Recent observations suggest that reproductive activity at Vasey's paradise is focused in summer months, with significant die-off of large individuals in late summer and autumn (Blinn et al. 1992). It is probable that the Kanab ambersnail has a life span of about 12 to 15 months (Clarke 1991).

D. HABITAT AND LIMITING FACTORS

The Kanab ambersnail lives in marshes watered by springs and seeps at the base of sandstone or limestone cliffs (Clarke 1991, Spamer and Bogan 1993a). It is restricted to a perennially wet soil surface or shallow standing water. The snails also are frequently seen just within the mouths of vole burrows. None have been found in drier areas, such as under logs or in other micro-habitats commonly frequented by other land snails (Clarke 1991).

The Utah populations are found in spring fed wetland habitats at the base of sandstone cliffs within the Kanab Creek drainage. The species habitat is characterized by the presence of cattail marshes dominated by _Typha domingensis_ (Clarke 1991) and sedge meadows dominated by _Juncus_ spp. (Peter Hovingh, private citizen, Salt Lake City, Utah, pers. comm. 1992; and Shei K. Wu, pers. comm. 1992). The Kanab ambersnail is most densely aggregated under fallen cattail stalks at the edges of cattail stands where they transition into wet sedge meadows. Cattails and dense sedge and grass meadows may provide crucial vegetative cover and food resources for the snails (Clarke 1991). Wetland grasses and sedges, if not overgrazed, also will provide suitable habitat for the species (Blaine Lunceford, Bureau of Land Management, pers. comm. 1991; Shei K. Wu, pers. comm. 1992; and Peter Hovingh, pers. comm. 1992). The American robin (_Turdus migratorius_) has been observed to feed on the Kanab ambersnail in Utah and may be the snail's principal natural predator (Clarke 1991). Robins are uncommon visitors along the Colorado River corridor in the Grand Canyon and thus are, not likely to be a significant predator to the Kanab ambersnail at Vasey's Paradise (Brown et al. 1984; Earle Spamer, pers. comm. 1995).

The Arizona population is found near a spring-fed wetland habitat within the gorge of the Grand Canyon above the 20,000 cubic feet per second water line stage on native cardinal monkey-flower (_Mimulus cardinalis_), and nonnative watercress (_Rorippa nasturtium-aquaticum_) (Spamer and Bogan 1993). The area is small, but unique to the Grand Canyon, supporting a localized community of vegetation and the only known population of the Kanab ambersnail in a wilderness setting. The vegetative community is composed of poison ivy (_Toxicodendron rydbergii_), redbud trees (_Cercis occidentalis_), coyote willow (_Salix exigua_), watercress, cardinal monkey-flower, and maidenhair fern (_Adiantum capillus-veneris_) (Stevens 1987, Spamer and Bogan 1993a). All individuals located during the May 1993 (Debra Bills, U.S. Fish and Wildlife Service, pers. comm. 1993) and subsequent surveys (David Wegner, pers. comm. 1995) were found on wet stems of dead and decaying monkey-flower and water-cress.

E. THREATS

Realized and potential threats to Kanab ambersnail stem primarily from loss and/or adverse modification of its wetland habitat. Some Kanab ambersnail individuals and associated habitat may be lost due to high flows and flood releases from Glen Canyon Dam. The Arizona population is vulnerable to uncontrolled floods and controlled high flows of the Colorado River between Glen Canyon Dam and Vasey's Paradise. The December 1994 final biological opinion on the operation of Glen Canyon Dam stated that the Service anticipates incidental take of the Kanab ambersnail due to high flow events. In addition, the species habitat receives recreational visitation from river runners because of the fresh drinking water available at the site. However, most river runners do not disturb occupied snail habitat (Robert Arnberger, National Park Service, Grand Canyon, Arizona, pers. comm. 1995). Flash flooding from the Vasey's Paradise spring-head or runoff from the canyon walls in the Grand Canyon in Arizona and in the Three Lakes Canyon drainage in Utah has caused and continues to have the potential to cause the loss of significant portions of the species known populations and has altered the species habitat through siltation and scouring.

The demographic stability of the various populations of Kanab ambersnail is not known. The smaller Utah population, located in Kanab Creek Canyon, may not be at population levels large enough to ensure the population's long-term survival, and is likely to go extinct in the near future if it has not already done so. Livestock grazing may be a threat to the survival of the species. The effect of natural factors, such as disease, parasitism, predation, and grazing of its habitat by native species, on the viability of the species population is not known (U.S. Fish and Wildlife Service 1992).

II RECOVERY

A. OBJECTIVE AND CRITERIA

The immediate objective of this recovery plan is to maintain viable populations of the Kanab ambersnail in the current range of the species. The long-term objective is to downlist and eventually delist the species. Downlisting will occur when additional populations of Kanab ambersnail exist to the degree that its inherent vulnerability will be decreased to the point that localized threats will not jeopardize the species. The recovery criteria are:

Conservation Criteria: In order to prevent the species from becoming extinct, each Kanab ambersnail population and its habitat must be protected from loss of individuals and habitat degradation through sections 7 and 9 of the Endangered Species Act.

Downlisting Criteria: The Kanab ambersnail may be considered for downlisting to threatened when the above conservation criteria have been met and when the following criteria have been attained:

1. Locate and/or establish additional populations. Maintain 10 separate populations which have been demonstrated to have population numbers large enough to allow for the long-term viability of the population. This criteria is provisional, it is probable that it will be modified as additional information is acquired concerning the species distribution, abundance, and stability of its separate populations.

2. The establishment of formal land management designations and/or implementation of land management plans which provide long-term, undisturbed habitat for the Kanab ambersnail for the above 10 populations.

It must be understood that the above objectives and criteria are subject to change as more information becomes available. Delisting criteria will not be developed until there is sufficient information to do so. The estimated date for completion of recovery is not determinable at this time.

B. STEPDOWN OUTLINE FOR RECOVERY TASKS ADDRESSING THREATS

1. Control human-caused activities that affect the Kanab ambersnail and its habitat.

1.1 Ensure human-caused activities do not adversely impact the Kanab ambersnail populations on Federal lands.

1.2 Assist willing landowners to manage occupied habitat of the Kanab ambersnail.

1.3 Monitor all populations of the Kanab ambersnail for current and potential threats.

1.4 Establish formal land management designations and/or implement land management plans for all Kanab ambersnail populations.

2. Acquire and protect all currently known occupied habitat of the Kanab ambersnail.

2.1 Acquire habitat on private lands.

2.2 Protect subsurface waters, and acquire and protect surface waters.

2.3 Establish a National Wildlife Refuge at Three Lakes.

3. Inventory all suitable habitat for the Kanab ambersnail.

3.1 Identify, delineate, and estimate size of existing populations.

3.2 Identify and survey potential habitat.

3.3 Develop detailed topographic and vegetation maps of the species habitat.

3.31 Develop habitat maps of Three Lakes Population.

3.32 Develop habitat maps of Vasey's Paradise Population.

3.33 Develop habitat maps of potential reintroduction sites.

4. Determine the biological and ecological factors which control the distribution and vitality of the Kanab ambersnail populations and the interaction of the significant biotic and abiotic elements of the Kanab ambersnail and its habitat.

4.1 Determine phenology, behavior, and life history.

4.2 Determine annual and long-term population variation and movement.

4.21 Establish a population study on the Three Lakes Canyon population.

4.22 Establish a population study on the Kanab Canyon population.

4.23 Establish a population study on the Vasey's Paradise population.

4.24 Determine viable population parameters.

4.3 Determine Kanab ambersnail density in relation to lower, middle, and upper Colorado River riparian zones at Vasey's paradise.

4.4 Determine the species synecological relationships.

4.5 Determine the species genetic relationships.

5. Establish a captive breeding population.

6. Promote and encourage improved communication and information dissemination.

6.1 Develop and distribute printed educational material.

6.2 Develop and distribute audio-visual documentary.

C. <u>NARRATIVE FOR RECOVERY TASKS ADDRESSING THREATS</u>

1. Control human-caused activities that affect the Kanab ambersnail and its habitat.

Control of human activities that adversely affect the Kanab ambersnail through alteration and degradation of its habitat is central to its preservation. The species is vulnerable to alteration and degradation of its wetland habitat. All threatened and endangered animal species are protected from harm including habitat destruction and adverse modification of designated critical habitat under the provisions of the Endangered Species Act and implementing regulations.

1.1 <u>Ensure human-caused activities do not adversely impact the Kanab ambersnail population on Federal lands</u>. A significant Kanab ambersnail population occurs at Vasey's Paradise on Federal land within Grand Canyon National Park under the jurisdiction of the National Park Service. The Bureau of Reclamation is responsible for the operation of Glen Canyon Dam on the Colorado River. The operation of that dam has the potential to directly affect the Vasey's Paradise population by causing intermittent flooding of the species habitat as a consequence of releasing high downstream flows, generally above 20,000 cfs.

The final biological opinion for the operation of Glen Canyon Dam (U.S. Fish and Wildlife Service 1994) emphasized the need for a clear determination of the stage-discharge relationship at Vasey's Paradise. The Vasey's Paradise population should be surveyed before and after any flow greater than 25,000 cfs. Individuals are not likely to be impacted by daily flows especially during low water years, but could be impacted during uncontrolled floods or controlled flows in high water years above 25,000 cfs. The Bureau of Reclamation, with assistance from the Service and National Park Service, will ensure adequate monitoring of Kanab ambersnail populations and habitat before, during, and after Colorado River high flows.

The National Park Service is responsible to ensure that resource values (including threatened and endangered species and their habitat) on lands under its jurisdiction are conserved for current and future generations. The National Park Service has the authority, under the agency's regulations and the Grand Canyon National Park enabling legislation, to regulate and control activities within the

Park and the specific obligation under the Endangered Species Act to do so for the conservation of the Kanab ambersnail. Potential recreational activities within the Park will require the necessary permits, etc. from the National Park Service before they can take place. The National Park Service must consult with the Service under section 7 of the Endangered Species Act for any activity which may adversely affect the Kanab ambersnail, including recreation.

At present, recreational use is occurring on the Kanab ambersnail habitat at Vasey's Paradise in the Park. Recreation use, however, is near the saturation limit for use of the Colorado River corridor through the Grand Canyon. Numbers of recreationists using this area are limited and are monitored and regulated by the National Park Service. Recreational use of the Colorado River is unlikely to increase significantly. However, use of Vasey's Paradise will continue due to the area's great natural beauty and the presence of large quantities of fresh drinkable water. Poison ivy, which is common to the site, however, serves as a barrier dissuading many recreationists from degrading the species' occupied habitat.

Occupied habitat areas at Vasey's Paradise within the gorge of the Grand Canyon with populations of Kanab ambersnail should be considered as a Kanab ambersnail conservation area. The use of Vasey's Paradise should be regulated to ensure the protection of the Kanab ambersnail and its habitat. This action is necessary to protect the viable Kanab ambersnail population at this spring fed wetland area. The National Park Service will be responsible for monitoring Kanab ambersnail habitat within Grand Canyon National Park to ensure that no unauthorized use of the species' habitat area is taking place.

Potential habitat exists on Federal lands on the Colorado Plateau and the possibility exists that one or more undiscovered populations may occur. If additional populations are discovered their habitat should receive high priority protection.

1.2 <u>Assist willing landowners to manage occupied habitat of the Kanab ambersnail</u>. A significant portion of the population and the proposed critical habitat of the Kanab ambersnail occurs on private lands in Kane County, Utah. The possibility exists that additional populations may occur on private, State, and Native American lands on the Colorado Plateau. The Service will assist willing private landowners in the conservation of the Kanab ambersnail on their lands. Those activities which are or will be detrimental will be identified, and land management measures and practices that will enhance populations and habitat will be recommended.

1.3 <u>Monitor all populations of the Kanab ambersnail for current and potential threats</u>. All populations on Federal land will be monitored on an ongoing basis. If private, State and Native American landowners concur and permit, all populations of the Kanab ambersnail will be monitored on an ongoing basis for any threat which may affect the species and/or its habitat. Prompt action will be taken to remedy any identified threat.

1.4 Establish formal land management designations and/or implement land management plans for all Kanab ambersnail populations. In order to consider downlisting the Kanab ambersnail, formal land management designations or land management plans must be established/implemented for at least 10 separate Kanab ambersnail populations to continue protection of its populations and its habitat after downlisting. Such designations on Federal and State lands may include: National Parks and Monuments, Areas of Critical Environmental Concern, formal Wilderness designation, research natural areas, and formal State designated protective areas. Specific Kanab ambersnail management guidelines must be incorporated into relevant land management documents. Land management designations or management plans on private lands may be addressed through perpetual conservation agreements with willing landowners.

2. **Acquire and protect all currently known occupied habitat of the Kanab ambersnail.**

The ecosystems supporting the Kanab ambersnail are extremely localized and subject to deleterious alteration. This extremely restricted distribution makes protection of all remaining habitat of the Kanab ambersnail necessary. The largest remaining habitat area for the species is located at Three Lakes Canyon, which is within the area currently proposed as critical habitat (U.S. Fish and Wildlife Service 1991). The Nature Conservancy (Johnson 1991; and Chris Montague, The Nature Conservancy, pers. comm. 1992) has identified Three Lakes as an important area for natural ecosystem conservation on the Colorado Plateau.

Desert wetland habitats are extremely fragile and intolerant to perturbation. The effects of disturbance are likely to last for many years and altered environments are quickly occupied by nonnative plants and animals. Disturbance also initiates influences that further degrade habitat, such as changes in drainage patterns, soil compaction, and water availability. These factors combine to require special management of the proposed critical habitat area.

2.1 Acquire habitat on private lands. Three Lakes is currently under private ownership. This parcel should be purchased to avoid conflicts with potential development which may cause modification of the proposed critical habitat and adversely affect the conservation of the Kanab ambersnail. The proposed critical habitat area occupied by the Kanab ambersnail and its constituent habitat elements includes approximately 10 acres. Private lands will only be acquired from willing sellers.

2.2 Protect subsurface waters, and acquire and protect surface waters. Certified rights to ground and surface waters necessary to maintain the Three Lakes wetland ecosystem need to be acquired to ensure the continued viability of the Kanab ambersnail population and its proposed critical habitat. Acquisition will only take place if the owners are willing sellers.

2.3 Establish National Wildlife Refuge at Three Lakes. If Three Lakes is acquired, inclusion of this proposed critical habitat area within the National Wildlife Refuge system would enable the positive proactive management necessary to ensure the long-term survival of this Kanab ambersnail population and its ecosystem.

3. **Inventory all suitable habitat for the Kanab ambersnail.**

Through an inventory of all suitable habitat, additional populations may be located and essential habitat identified.

3.1 Identify, delineate, and estimate size of existing populations. Inventories will define the areas occupied by Kanab ambersnail populations. An initial total population size estimate will be made for each population. This information will provide a biological baseline necessary for determining population trends and indications of any obscure factors affecting its population. These surveys will include age class distribution, documentation of losses, and population trends. Impacts of recreation and livestock trampling, predation, disease, parasitism, etc. on each Kanab ambersnail populations will be identified. A detailed species study and monitoring plan will be developed jointly by the Service, State wildlife management agencies, and Federal land managing agencies. The field implementation of the study and monitoring plan will be the responsibility of the affected land managing agencies with technical assistance from the Service.

Survey of the Kanab Canyon population will be the Service's first priority. If the population is extant the Service will advise and work with the private landowner to protect and enhance this population. If that population has been extirpated the Service will consider the habitat site as the highest priority for the reintroduction of a viable Kanab ambersnail population. The private landowners have requested that the Service reestablish this population.

3.2 Identify and survey potential habitat. Potential habitat in spring and seep fed wetlands near the current range of the Kanab ambersnail will be surveyed for suitable habitat. It is possible that additional Kanab ambersnail populations exist and may be found. Unoccupied potential habitat may have harbored populations of the species in the past and should be considered as reintroduction sites, if necessary. Additional discovered or introduced populations of the Kanab ambersnail will increase its abundance and could contribute to maintaining the species overall viability in the event of a catastrophic loss of one or more of the existing populations.

3.3 Develop detailed topographic and vegetation maps of the species habitat. Detailed maps of the species habitat will facilitate precise management and study of the Kanab ambersnail. This task will be accomplished using high resolution aerial and ground photography, space and ground based geographic positioning systems, and traditional survey techniques.

3.31 Develop habitat maps of Three Lakes Population. Mapping the Three Lakes population will be the responsibility of the Service.

3.32 Develop habitat maps of Vasey's Paradise Population. Mapping the Vasey's Paradise population will be the responsibility of the National Park Service and the Bureau of Reclamation.

3.33 Develop habitat maps of potential reintroduction sites. Once potential reintroduction sites are identified, they will be mapped as discussed in Task 3.31 and 3.32.

4. **Determine the biological and ecological factors which control the distribution and vitality of Kanab ambersnail populations and the interaction of the significant biotic and abiotic elements of the Kanab ambersnail and its habitat.**

Recovery of the Kanab ambersnail will depend upon knowledge of the ways habitat perturbations affect the species. Understanding the relationship between its ecological requirements is prerequisite to its recovery. In depth research of the biology and ecology of the Kanab ambersnail will assist in the determination of the factors controlling the distribution and vitality of Kanab ambersnail populations and provide direction in the management of its population and habitat.

4.1 Determine phenology, behavior, and life history. The Kanab ambersnail is poorly known to science. Current assumptions concerning its life history are extrapolations from similar species within the family Succineidae. Phenological, behavioral, and life history information is critical in determining the site specific management needs of each of its populations.

4.2 Determine annual and long-term population variation and movement. Population studies will document demographic stability of Kanab ambersnail populations. If, as a consequence of these studies, other factors, natural or human-caused, are identified as having potential detrimental effects on the species population, those factors will be addressed and this recovery plan will be revised to accommodate them. Little is known concerning natural threats such as disease, parasitism, and predation by native species on the Kanab ambersnail. No known diseases have been reported in this species. Moderate to heavy domestic livestock grazing may have an impact to the Kanab ambersnail by reducing the vegetative cover necessary to protect the species from excessive predation and direct mortality from trampling. The American robin has been observed as a regular predator on the Three Lakes population in Utah (Clarke 1991). It is not known if the

5. **Establish a captive breeding population.**

The feasibility of establishing ex situ populations of the Kanab ambersnail should be investigated, including the development of reintroduction protocol. These populations could be located at academic research facilities or zoological gardens. Individuals from both extant populations should be involved, with care given to maintain the probable genetic variation of the two populations. If the extirpation of one of the existing Kanab ambersnail populations appears imminent, or if catastrophe causes an extirpation, then reintroduction into suitable habitat should be expedited.

6. **Promote and encourage improved communication and information dissemination.**

Communications between citizens, the scientific community, and government; the sharing of information; and the education of the public about the goals, methods, and benefits of the recovery program are essential for achieving the objectives of this recovery plan.

6.1 Develop and distribute printed educational material. Develop pamphlets depicting the biology and ecology of the Kanab ambersnail and recovery efforts in its behalf.

6.2 Develop and distribute audio-visual documentary. Develop an audio-visual documentary program depicting the wetland environments of the Colorado River and Plateau with emphasis on special status species including the Kanab ambersnail. This program would be directed towards local residents of the region and to tourists and recreationists visiting National Parks and other public lands on the Colorado Plateau. This program would also be available to schools and other public and private groups.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and costs for the recovery program. It is a guide for meeting the objectives elaborated under the Recovery section of this plan. This schedule indicates task priorities, task numbers, task description, duration of tasks ("ongoing" denotes a task that once begun should continue on an annual basis), the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should allow the Kanab ambersnail to be downlisted to threatened.

Priorities in column one of the following implementation schedule are assigned as follows:

1. Priority 1--An Action that must be taken to prevent extinction of, or to prevent the species from declining irreversibly in the foreseeable future.

2. Priority 2--An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

3. Priority 3--All other actions necessary to meet the recovery objective.

Key to Acronyms used in Implementation schedule

BLM - Bureau of Land Management
BR - Bureau of Reclamation
FWS - Fish and Wildlife Service
ES - Ecological Services
LE - Law Enforcement
RW - Refuges and Wildlife
NPS - National Park Service
AZ - Arizona Game and Fish Department
UT - Utah Division Wildlife Resources
NN - Navaho Nation
TNC - The Nature Conservancy

Kanab ambersnail (*Oxyloma haydeni kanabensis*) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible party			Cost			Comments
				FWS		Other				
				Region	Program		FY-01	FY-02	FY-03	
1	1.1	Ensure human-caused activities do not impact Kanab ambersnail on Federal lands	ongoing	2,6	ES, LE, RW	BLM, BR, NPS				Part of ongoing agency program
1	1.2	Assist willing land owners to manage occupied habitat of the Kanab ambersnail	ongoing	2,6	ES, LE	AZ, UT, NN, TNC				Funding for landowners to accomplish specific activities cannot be determined until the activities are identified
1	1.3	Monitor populations of the Kanab ambersnail for current and potential threats	ongoing	2,6	ES, LE, RW	BLM, BR, NPS, AZ, UT	5,000	5,000	5,000	
1	4.1	Determine phenology, behavior, and life history	5 year	2,6	ES	BR, NPS, AZ, UT	15,000	15,000	15,000	
1	4.3	Determine Kanab ambersnail density in relation to lower, middle, and upper Colorado River riparian zones at Vasey's Paradise	2 year	2	ES	BR, NPS, AZ	5,000	5,000		
1	4.4	Determine the species synecological relationships	3 year	2,6	ES	BR, NPS, AZ, UT	15,000	15,000	15,000	
1	4.5	Determine the species genetic relationships	2 year	2,6	ES	AZ, UT	15,000	15,000		
1	5	Establish a captive breeding population	ongoing	2,6	ES	AZ, UT	10,000	10,000	5,000	
2	1.4	Establish formal land management designations and/or implement land management plans for all Kanab ambersnail populations	1 year	2,6	ES, RW	NPS, BLM, AZ, UT, NN				To be determined
2	2.1	Acquire habitat on private lands	3 years	6	ES, RW	TNC	5,000	5,000	150,000	
2	2.2	Protect subsurface waters and acquire and protect surface waters	ongoing	6	RW	TNC	5,000	1,000	1,000	
2	2.3	Establish a National Wildlife Refuge at Three Lakes	ongoing	6	RW		10,000	10,000	20,000	
2	3.1	Identify, delineate, and estimate size of existing populations	3 years	2,6	ES	BR, NPS, AZ, UT	5,000	5,000	5,000	

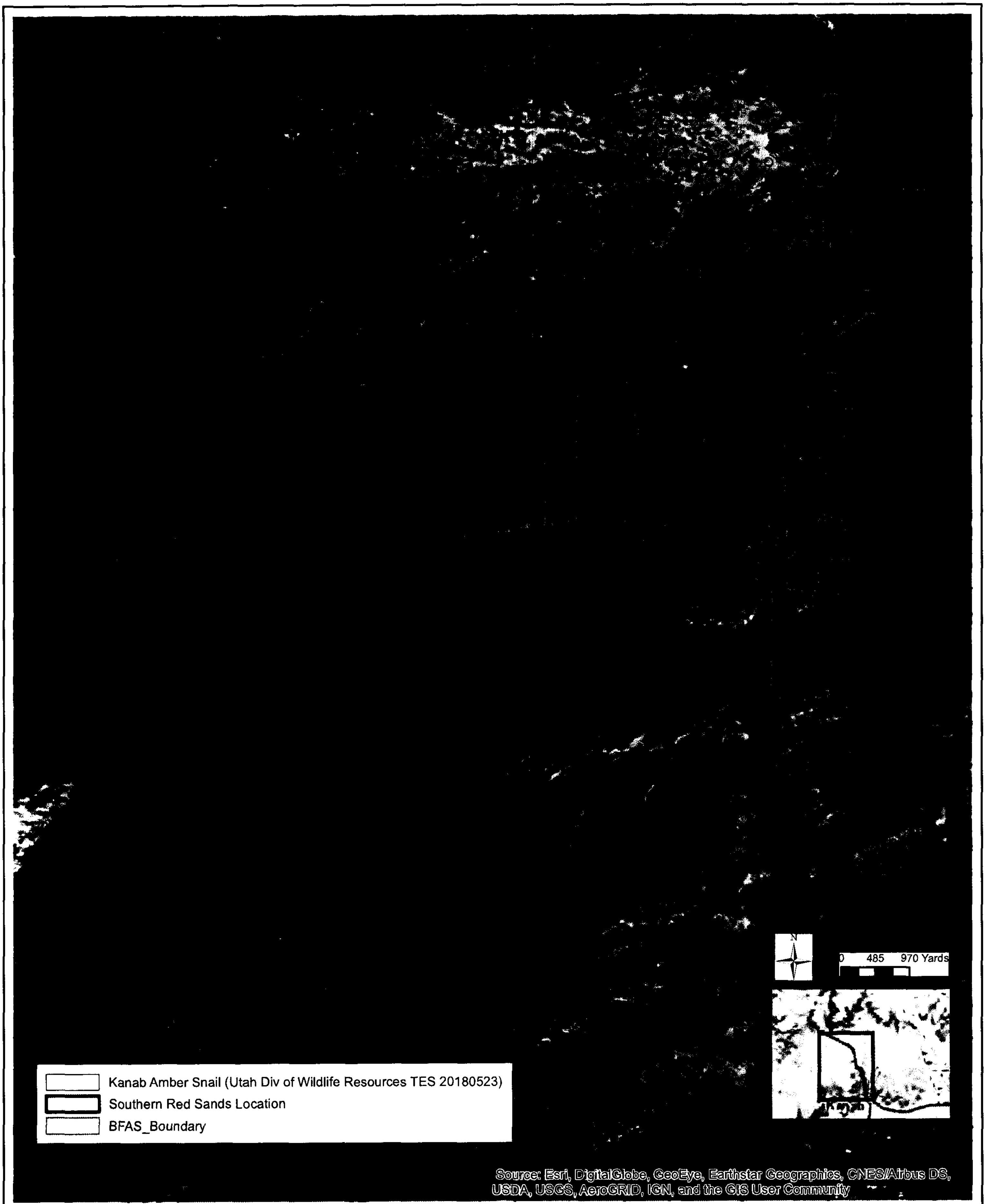
2	3.2	Identify and survey potential habitat	3 years	2,6	ES	BLM, NPS, AZ, UT, NN	20,000	20,000	20,000	
2	3.31	Develop habitat maps of Three Lakes	2 years	6	ES	UT	5,000	5,000		
2	3.32	Develop habitat maps of Vasey's Paradise	2 years	2	ES	BR, NPS, AZ	25,000	10,000		
2	3.33	Develop habitat maps of potential reintroduction sites	2 years	2,6	ES	BLM, NPS, AZ, UT, NN		5,000	5,000	If identified
2	4.21	Establish a population study at Three Lakes	10 years	6	ES, RW	UT	5,000	5,000	5,000	
2	4.22	Establish a population study at Kanab Canyon	10 years	6	ES	UT	2,000	2,000	2,000	If population still extant
2	4.23	Establish a population study at Vasey's Paradise	10 years	2	ES	BR, NPS, AZ	7,000	7,000	7,000	
2	4.24	Determine viable population parameters	10 years	2,6	ES, RW	BR, NPS, AZ, UT	10,000	10,000	10,000	
3	6.1	Develop and distribute printed educational material	ongoing	2,6	ES, RW	BLM, BR, NPS, AZ, UT, NN	5,000	5,000	1,000	
3	6.2	Develop and distribute audio visual documentary	ongoing	2,6	ES, RW	BLM, BR, NPS, AZ, UT, NN	10,000	10,000	1,000	

This recovery plan was made available to the public for comment as required by the 1988 amendments to the Endangered Species Act of 1973. The public comment period was announced in the Federal Register (59 FR 49710) on September 29, 1994, and closed on November 28, 1994.

During the public comment period, comment were received from 14 individuals. The comments provided in these letters have been considered and incorporated as appropriate. Comments addressing recovery tasks that are the responsibility of an agency other than the Fish and Wildlife Service have been sent to that agency as required by the 1988 amendments to the Endangered Species Act.

EXHIBIT 9

Southern Red Sands Location and Proximity to Amber Snail Habitat



SCANNED SD

EXHIBIT 10

WATER SERVICE AGREEMENT

THIS WATER SERVICE AGREEMENT ("**Agreement**") is entered into and made effective as of July 29, 2019 ("**Effective Date**") by and between **SOUTHERN RED SANDS, LLC,** a Utah limited liability company, ("**SRS**"), and **KANAB CITY** ("**City**"). SRS and City may also be referred to herein as the Parties or individually as a Party.

RECITALS

A. SRS is constructing a commercial sand excavation plant near Kanab, Utah ("**Project**") and wishes to obtain water service from City as a source of water supply for the Project.

B. City is the owner of certain water rights and wishes to provide water service to the Project.

C. SRS needs to secure the right to use 1,200 acre-feet of water on a fully depletable basis (100% consumptive) for the Project on an annual basis.

D. City can provide water service to the Project in an amount up to 600 acre-feet of fully depletable water per year (100% consumptive).

E. SRS will drill one or more new groundwater well(s) at or near the Project to serve as the source of supply for the Project ("**Well**") and does not anticipate using the existing water infrastructure of City to provide water service to the Project.

F. The Parties acknowledge that use of the City's water rights or water shares from the Well will require approval of the Utah State Engineer. It is the understanding of the Parties that, upon execution of this Agreement, SRS will prepare and, with City's signature, file an Application for Permanent Change of Water with the Utah State Engineer seeking to add the Well as a point of diversion for the City's water rights, to add the Project as a place of use, and if necessary to change the nature of use to 100% consumptive municipal use ("**Change Application**"). SRS's obligations under this Agreement are contingent upon approval of the Change Application for 600 acre-feet of fully consumptive water use at the Project.

G. The Parties acknowledge that SRS may seek a separate water service agreement with the Kane County Water Conservancy District ("**District**") to obtain sufficient water service to meet its full need of 1,200 acre-feet of water for fully consumptive use.

H. This Agreement shall be considered SRS's application to City to supply water services outside of the City's municipal limits under Section 14-152 of City's municipal code.

AGREEMENT

NOW, THEREFORE, in consideration of the mutual covenants and promises described herein, the sufficiency of which is acknowledged, the Parties agree as follows:

1. **Water Service.**

a. City will charge SRS a one-time application fee of $10,000.00 for this Agreement ("**Application Fee**"). The Application Fee shall be due and payable to City within ten (10) days after the date SRS first diverts water from the Well under this Agreement.

b. City has determined that City has surplus water that it can provide to SRS for use at the Project in an amount up to 600 acre-feet of water per year during the term of this Agreement. Water service under this Agreement is exclusively for the use of SRS and its successors and assigns. SRS may not resell water diverted under the Change Application, nor allow any unrelated third party to use water diverted under the Change Application. The Parties agree that City's obligation to perform under this Agreement is subject to Section 10-8-14(2), Utah Code Ann. (2016), as may be amended and interpreted under Utah case law.

c. During the term of this Agreement, City will provide water service to the Project in an amount up to 600 acre-feet of fully depletable (100% consumptive) water per year.

d. The Well will be the source of supply for the water service provided under this Agreement. City's existing water infrastructure system will not be extended to provide water service to the Project under this Agreement. Because SRS is not developing within the City limits and will not use City's water infrastructure system, SRS has no obligation to pay impact fees to City.

e. The Parties agree that if SRS obtains a separate agreement with District for an additional 600 acre-feet of water service per year, each year that this Agreement and the District agreement are in effect fifty percent (50%) of the water SRS pumps from the Well will be considered water service from City and fifty percent (50%) of the water SRS pumps from the Well will be considered water service from District. By way of example only, if SRS obtains a separate agreement with District and in a given quarter pumps 250 acre-feet of water from the Well, 125 acre-feet of water will be considered water service from the City pursuant to this Agreement and 125 acre-feet of water will be considered water service from District subject to the separate agreement. In such case, City will be entitled to payment of a service fee for 125 acre-feet of water and District will be entitled to payment of a service fee for 125 acre-feet of water.

2. **Water Service Fee**. SRS will pay to City a water service fee of $2.00 per 1,000 gallons of water used by SRS at the Project under this Agreement.

a. On or before April 10th, July 10th, October 10th and January 10th of each year that this Agreement is in effect, SRS shall provide City a totalized meter reading showing the quantity of water SRS diverted from the Well for the Project during the preceding calendar quarter. If SRS has entered into a separate water service agreement with District, SRS shall provide payment to City for fifty percent (50%) of the actual amount of water used from the Well during the preceding calendar quarter. If SRS has not entered into a separate water service agreement with District, SRS shall pay City for the full quantity of water diverted from the Well during the preceding calendar quarter. Payment shall be due and payable to the City within thirty (30) days following the end of the calendar quarter. City may assess late fees and interest at the amount and rates established in its water utility rate schedule.

b. The water service fee may be increased every five (5) years starting from the first date SRS withdraws water from the Well under this Agreement based upon the Consumer Price Index for all Urban Consumers, U.S. City Average, (CPI-U) published by the United States Bureau of Labor Statistics. The increased price SRS shall pay for water shall be the price at the beginning of the five-year period multiplied by the cumulative CPI-U (unadjusted 12 month ended Dec.) for each of the years in the five-year period. By way of example only, if the price paid for water at the beginning of the five-year period is $2.00 per 1,000 gallons used and the unadjusted 12 month ended December, CPI-U for each of the five years were 0.5%, 0.7%, 1.1%, 1.3%, and 1.9%, the cumulative CPI-U for the five-year period would be 5.5%. The resulting water service rate would be $2.11 per 1,000 gallons ($2.00 x 1.055) of water used under this Agreement.

3. **Term of Agreement**. The initial term of this Agreement shall be twenty (20) years from the Effective Date. This Agreement shall automatically renew for up to three (3) additional ten (10) year terms unless SRS provides City written notice of its intent to terminate this Agreement at least 90 days before the end of the existing term.

4. **Change Application**. The Parties acknowledge that before water may be used from the Well the Change Application must be approved by the Utah State Engineer. SRS's obligations under this Agreement are contingent upon approval of the Change Application.

a. Upon execution of this Agreement, SRS, in consultation with the City, shall prepare and file the Change Application seeking the right to divert and beneficially use 600 acre-feet (on a fully depletable 100% consumptive basis) of the City's water rights from the Well for use at the Project. City will sign the Change Application as the owner of the underlying water rights. SRS will be solely responsible for the preparation, filing, and prosecution of the Change Application, including all costs, fees, and expenses incurred in the preparation, filing, and prosecution of the Change Application to a final non-appealable Order of the State Engineer. After approval of the Change Application, SRS will be solely responsible for filing requests for extension of time and for filing proof of beneficial use under the Change Application. City will cooperate with SRS in the preparation and filing of any extension requests or proof of beneficial use.

b. If an Order of the State Engineer limits or rejects the Change Application for any reason, SRS will have the right to decide whether to accept the limitations under the State Engineer's Order or pursue an appeal of the State Engineer's Order. If the rejection or any limitation of the Change Application that SRS determines, in its sole discretion, is unacceptable becomes final, this Agreement will terminate without further action and SRS and City will have no further obligations to one another under this Agreement.

c. City agrees that if SRS enters into a separate agreement with District to obtain water service for the Project, City will not protest or appeal any application filed by District or SRS related to water service for the Project including, without limitation, any change application filed by District pursuant to an agreement with SRS, applications for extension of time, or proof of beneficial use.

5. **Ownership and Use of the Well**. SRS shall own the Well and will be responsible for the operation and maintenance of the Well including the payment of any costs, fees, utilities or taxes associated with the Well. City shall not have any ownership interest in the Well or any right to use the Well absent written consent from SRS.

6. **Continuing Consultation**. City owns and operates several wells that are believed to be within the same aquifer in which the Well will be drilled. City will monitor the water levels in its wells on a continuing basis. In the event monitoring reveals a continuous decline in the water levels of City's wells over a period of five (5) or more years, City and SRS agree to consult with each other to determine whether the decline is a result of SRS's diversions under the Change Application or other factors. If the Parties agree that diversions by SRS under the Change Application are a significant cause of the decline of the water level in the City's wells, SRS and City will jointly determine measures to be taken to mitigate the declining water level.

7. **Default**. The following events shall be deemed events of default under the Agreement:

a. SRS's failure to provide a totalized quarterly meter reading for the water diverted from the Well under this Agreement.

b. SRS's failure to pay the quarterly service fee(s) when due.

c. SRS's failure to file or reasonable prosecute the Change Application.

d. City's failure to sign the Change Application or to reasonably cooperate in the preparation and prosecution of the Change Application.

e. A Party's failure to comply with any other term, provision, or covenant of this Agreement.

8. **Remedy**. In the event of a default of this Agreement the non-defaulting Party shall provide written notice to the defaulting Party specifying the failure to comply. The defaulting Party shall have sixty (60) days after such written notice to cure the default. If the defaulting Party fails to cure within said sixty (60) days, the non-defaulting Party may enforce the provisions of the Agreement in any manner provided by law or in equity including, without limitation, termination of this Agreement.

9. **Indemnity**.

a. City shall indemnify and hold SRS, its directors, members, officers, representatives, agents, employees, and assigns harmless from any claims, demands, or causes of action that are based upon and arise from the City exercising its municipal power to enter into this Agreement or arising from negligent acts or omissions committed by City or its agents.

b. Except for claims arising from SRS's legal use of water under this Agreement, SRS shall indemnify and hold City, its directors, employees, agents, and assigns harmless from any claims, demands, or causes of action arising from SRS's operation of the Project, whether at the Project site or away from the Project site.

10. **Notices**. All notices, payments and other communications between the Parties shall be in writing and shall be addressed as follows:

To SRS:

Southern Red Sands, LLC
201 South Main Street Suite 2000
Salt Lake City, Utah 84111
Attention: Chad Staheli
E-mail: chad@srsands.com

Copy to:
Parsons Behle & Latimer
201 South Main Street, Suite 1800
Salt Lake City, Utah 84111
Attention: Wendy Crowther
Email: wcrowther@parsonsbehle.com

To City:

26 North 100 East
Kanab, Utah 84741

11. **Authority**. The Parties each represent to the other that the undersigned is authorized and has the power to execute this Agreement on its behalf.

12. **Successors and Assignment**. This Agreement and the covenants contained herein shall be binding upon and inure to the benefit of the Parties, their successors, and assigns.

13. **Attorneys' Fees**. In the event any Party commences any action to enforce any of the terms and conditions of this Agreement, the prevailing Party to that action shall be entitled to payment of its costs and expenses incurred in the action, including attorneys' fees, from the non-prevailing Party.

14. **Captions**. The paragraph headings or captions appearing in this Agreement are for convenience only, if any caption is inconsistent with the following paragraph the language of the paragraph and not the caption shall control.

15. **Further Assurances**. Each of the Parties will execute and deliver any additional papers, documents, and other assurances, and will do any and all acts and things reasonably necessary in connection with the performance of their obligations under this Agreement and to carry out the intent of the Parties.

16. **Modification or Amendment**. No amendment, change, or modification to this Agreement will be valid unless made in writing and signed by the Parties.

17. **No Obligation to Third Parties**. The execution and delivery of this Agreement will not be deemed to confer any rights upon, nor obligate either of the Parties, to any person or entity other than each other.

18. **Waiver**. The waiver of any Party of a breach to any provision of this Agreement will not be deemed a continuing waiver or waiver of any subsequent breach whether of the same or another provision of this Agreement.

19. **Applicable Law and Severability**. This Agreement shall be governed by the laws of the State of Utah. Nothing contained in this Agreement will be construed so as to require the commission of any act contrary to law, and wherever there is any conflict between any provision herein and any present or future statute, law, ordinance or regulation, the latter will prevail and the provision of this Agreement which is affected will be curtailed and limited to the extent necessary to bring it within the requirements of the law. In the event one or more provisions of this Agreement is held invalid, illegal or unenforceable, the remaining provisions of this Agreement will be unaffected, and the Agreement will be construed as if the invalid, illegal or unenforceable provisions had never been contained in this Agreement.

20. **Performance of Acts on Business Days**. In the event that the performance of any act hereunder falls on a Saturday, Sunday or holiday, that act may be performed on the next succeeding business day.

21. **Entire Agreement**. This Agreement constitutes the entire understanding and agreement of the Parties with respect to the water service to the Project and any and all prior agreements, understandings or representations are terminated and cancelled in their entirety and are of no force or effect.

22. **Counterparts**. This Agreement may be executed in any number of counterpart originals and may be delivered by electronic transmission.

IN WITNESS WHEREOF, the Parties have executed this Agreement effective as of the Effective Date set forth above.

Signature lines follow on separate page

populations of Kanab ambersnail are at population levels that will assure long-term demographic and genetic viability.

4.21 Establish a population study on the Three Lakes Canyon population. Population monitoring sites will be established strategically within the Three Lakes Canyon population. The total variation of habitat types and degree of habitat use will be represented in the monitoring sites.

4.22 Establish a population study on the Kanab Canyon population. A population study will be established in the Kanab Canyon population of the Kanab ambersnail. There is a possibility that this small population, if still extant, may not be at demographically stable levels to ensure long-term survival.

4.23 Establish a population study on the Vasey's Paradise population. Population monitoring sites will be established strategically within the Vasey's Paradise population. The total variation of habitat types and degree of habitat use will be represented in the monitoring sites.

4.24 Determine viable population parameters. Population studies will be established to determine population numbers, age-class distribution of the populations, spacial distributions of each of the populations, and the periodic variation of both numbers and spacial distributions of each of the populations.

4.3 Determine Kanab ambersnail density in relation to lower, middle, and upper Colorado River riparian zones at Vasey's paradise. This information is critical for the effective management and protection of the Kanab ambersnail in relation to variations in the regulated flow of the Colorado River below Glen Canyon Dam.

4.4 Determine the species synecological relationships. Knowledge is needed concerning the species ecological interaction with its environment. Studies will include Kanab ambersnail dietary studies, predator interactions, and other biotic and abiotic factors affecting the viability of the species populations.

4.5 Determine the species genetic relationships. A determination of the genetic variability for O. h. kanabensis populations in Arizona and Utah and O. h. haydeni populations in western North America is needed to determine uniqueness of the population and infra-specific relationships of the species. This information is critical in evaluating the species various populations for potential reintroductions into unoccupied suitable habitats. Cytological and biochemical investigations with traditional anatomical and morphological investigations may demonstrate the need for a nomenclatural re-evaluation of the O. haydeni complex.

SRS:

SOUTHERN RED SANDS, LLC,
a Utah limited liability company

By: ______________________
M. Chad Staheli - CEO

City:

KANAB CITY,

____
Robert D. Houston, Mayor

____
Joseph Decker, Attest

____
Jeff Stott, City Attorney

____
Rick Hafen, Attorney

4822-6596-9289v1

SCANNED SD

EXHIBIT 11

6. In the event of collection, to pay a reasonable attorney's fees and costs of court.

DATED this______ day of_________ , 20_____.

____

Applicant

Section 14-113.4 Application for Water Service Outside Kanab City Limits

Any person who desires or is required to secure water service when such service is available from the municipal water system, to property located outside the Kanab City limits, shall file with the water department a written application and agreement for the service which shall be in substantially the following form:

KANAB, UTAH

APPLICATION FOR WATER SERVICE

OUTSIDE KANAB CITY LIMITS

The undersigned hereby applies for water service from the municipality of Kanab, Utah, for premises located at______________________________ and hereby agrees:

1. To pay charges for such water service as are fixed from time to time by the governing body until such time as I shall direct such service to be discontinued.

2. In the event of a failure to pay water charges within the due dates fixed by the governing body or of a failure of the occupant of the premises to conform to the ordinances and regulations established by the governing body regulating the use of the water system, that the municipality shall have the right to discontinue the water system service at its election, pursuant to five days written notice of the municipality's intention mailed to the address of service, until all delinquencies and any

re-connection fees imposed are paid in full or until any failure to conform to this ordinance or regulations issued thereunder is eliminated.

3. To be bound by the rules, regulations, resolutions, or ordinances enacted or adopted by the governing body applicable to the municipality's water system.

4. Applicant does hereby deposit $____________________ with the municipality on the filing of this application for water service, and it is agreed and understood that the municipality may, but need not, apply the deposit upon bills due for prior service and that the right of the municipality to shut off service as above provided shall exist even though the deposit has not been applied to the payment of past due bills for services. On final settlement of applicant's account, any unused balance of the deposit will be refunded to applicant upon return of the security deposit receipt issued by the municipality at the time the deposit was made.

5. The deposit shall not be considered as an advance payment for any service. Charges and unpaid accounts shall be considered delinquent notwithstanding the existence of the deposit, and the applicant or user of water service shall not have the right to compel the municipality to apply the deposit to any account to avoid delinquency.

6. In the event of collection, to pay a reasonable attorney's fees and costs of court.

7. It is understood and agreed that this agreement is for the supply of surplus water only as determined available by the City Council and this agreement shall at all times be subject to obligations of the City to supply its inhabitants with water as required by Article XI, Section 6 of the Constitution of Utah, and the provision of Utah Code Ann. 10-8-14. In the event of shortages, absence of surplus, or circumstances requiring the use of the City's surplus waters within the corporate limits of the City the delivery of waters by the City under this agreement may be restricted or terminated, either temporarily or permanently, without liability to the City. In the event of termination of less than 30 days duration or restriction of any duration, the City shall give reasonable notice thereof

to the user. In the event of permanent termination, the City shall give the user sixty (60) days written notice thereof.

8. It is understood and agreed that user may be receiving its water supply through lines, mains or systems not owned by Kanab City and that the City assumes no liability or responsibility for said lines, mains, or systems.

DATED ________ this _________day of __________, 20________.

Section 14-113.5 Severability

If any clause, section or paragraph of this ordinance is held to be unconstitutional or void for any reason, such holding shall not affect the remaining provisions.

Section 14-114 Application for Water Connection by Sub-divider

Whenever a sub-divider or developer desires or is required to install water connections and extensions for a subdivision or development, the sub-divider or developer shall enter into a written extension agreement which shall constitute an application for permission to make the extensions and connections and an agreement specifying the terms and conditions under which the water extensions and connections shall be made and the payments that shall be required.

Section 14-117 Rates and Connection Fees

The rates, penalty fee for delinquency in payment, connection fee, reservoir fee, inspection fee and other charges incidental to connection and services from the municipal water system shall be fixed from time to time by resolution enacted by the governing body. The governing body may from time to time promulgate rules for levying, billing, guaranteeing and collecting charges for water services and all other rules necessary for the management and control of the water system. Rates for services furnished

EXHIBIT 12

40 Year Projected Water Usage Report

KANAB CITY

July 2014

ALPHA

Table of Contents

Part I. Introduction

Kanab City currently serves approximately 2,000 culinary water connections. Due to recent changes in the law a 40 year plan must be prepared to show that existing water rights currently being held in reserve by the City will be required for future growth and development. The existing culinary water system is being fed from 23 springs and 18 Wells that are rotated during the winter and summer based on demand.

Part II. Existing Water Usage

The estimated equivalent residential units ERU's for the community were estimated as follows:

TABLE 1 – KANAB CITY EQUIVALENT RESIDENTIAL UNITS (2013)

Land Use	Units	No[1]	Demand[2]	ERUs	
				Multiplier	Total
Residential	Dwelling	1,760	800	1	1,760
Multiunit	Dwelling	94	800	1	94
High School	Person	245	15	0.0188	5
Middle School	Person	118	15	0.0188	2
Elementary School	Person	455	15	0.0188	9
Hotel	Room	912	150	0.1875	171
Service Station	Pump	67	250	0.3125	21
Restaurant	Seat	1296	35	0.0438	57
RV Park	Vehicle	94	100	0.125	12
Church	Seat	1,733	5	0.0063	11
Nursing Home	Bed	15	200	0.5	8
Doctor's Office	Patient	100	10	0.0125	1
	Staff	15	35	0.0438	1

Land Use	Units	No[1]	Demand[2]	ERUs	
				Multiplier	Total
Hospital	Patient	30	10	0.0125	0.38
	Beds	10	200	0.5	5
	Staff	70	35	0.0438	3
Fire Station (volunteer)	Person	25	5	0.0063	0
Commercial	Building	91	1,600	2	182
Industrial	Building	1	3,200	4	4
Total Equivalent Residential Connections					2,349.4

1 Number of units are estimates

2 Assumed Peak Day Demand per Unit in gallons for the purpose of calculating ERUs only

Using the total flow for the year ending in December 2013, the *average yearly demand per ERU* is 224,669 gallons (527,748,280 gallons/2,349 ERUs). The peak day demand for indoor use is estimated to be 219 gpd/ERU. This was derived by taking the total usage during the months of December of 15,934,114 gallons and dividing it by 31 days and 2,349 ERU's.

Assuming the peak day demand for outdoor and indoor water use is equal to the average daily flow of 2,551,413 gallons (76,542,400/30 days) in June of 2013, the *peak day demand for indoor and outdoor use* is 1,086 gpd/ERU. The *peak day demand for outdoor use* is 867 gpd/ERU (1,086 gpd – 219 gpd).

The results of the daily demands are summarized below.

- Peak day demand for indoor use: 219 gpd/ERU
- Peak day demand for outdoor use: 867 gpd/ERU
- Total peak day demand: 1,086 gpd/ERU
- Total average yearly demand: 224,669 gallons/ERU (0.690 acre feet/ERU)

Part III. Projected Population

The growth rate in Kanab has varied greatly in the last 20 years depending on when the projections are taken but for the purposes of this report are estimated at 3.25%. Based on a 3.25% growth rate the projected population ERU's in 40 years would be 8,443. With this number of ERU's the peak flow requirement would be 6,367 gpm.

An estimate of the Kanab City population at build-out (when all vacant land within the city limits has been developed) has also been prepared. The calculations along with the estimated build-out population for Kanab City are summarized in following table taken from the Capital Facilities Plan.

TABLE 2 – KANAB CITY ESTIMATED BUILDOUT POPULATION

Type of Use[1]	Acres	Units/ Acre	Units at Build-out	Build-out Population[3]
West of Kanab Creek				
Very low density[2]	535	0.4	214	505
Very low density	1,209	1	1,209	2,853
Low density[2]	124	2	248	585
Low density	384	3.5	1,344	3,172
Medium density[2]	557	1.5	836	1,972
Total	2,809		3,851	9,087
East of Kanab Creek				
Very low density	2,242	1	2,242	5,291
Low density[2]	514	2	1028	2,426
Low density[2]	130	2.64	343.2	810
Low density	1,771	3.5	6198.5	14,628
Medium density	45	1.5	67.5	159
Medium density	133	7	931	2,197
Planned unit development	422	15	6330	14,939
Total	5,257		17,140	40,451
Combined Total	8,066		20,991	49,538

1 Table includes only zones where dwellings are allowed.

2 Modified to show actual densities where development has occurred.

3 Persons per household assumed to be 2.36 based on culinary water account data supplied by the city of Kanab

Based on 2.36 persons per household the buildout ERU's will be approximately 20,990. The water rights required to provide for this population would be a peak flow of approximately 15,830 gpm and a total diversion of 14,473 acre feet.

Part IV. Existing Water Rights

The following table is a summary of existing water rights owned by Kanab City with their current status.

TABLE 3 – KANAB CITY EXISTING WATER RIGHTS

Water Right	Priority	Diversion Points	Flow (cfs)	Flow (gpm)	Acre-feet	Status
85-28	1956	Wells	0.448	201	324.56	Certificated
85-39	1956	Well (Highway 89 Well)	0.885	397	641.15	Certificated
85-55	1963	Well #11	1	449	724.46	Certificated
85-59	1964	Wells	1.81	812	1,311.28	Certificated
85-112	1864	Springs: Trough, Big, Cave 1&2, Cold, Iron 1&2, Little, Robinson, Slab, Slide, South, Twin, Weeping, Willow, Boiling, Head 1&2, Spring 1&2	0.5	224	362.23	Diligence Claim
85-703	1896	City Chicken Spring	0.033	15	23.91	Diligence Claim
85-736	1962	Wells	0.93	417	673.75	Certificated
85-772	1977	Wells	3.48	1562	2,521.13	Certificated
85-946	1975	Wells	3.02	1355	2,187.88	Application
85-956	1962	Well #14	1.5	673	1,086.69	Certificated
Totals			13.606	6,106.79	9,857.04	

Part V. Conclusion

With their current water rights, Kanab City can deliver a peak day demand 6,106 gpm with all of their rights being used. This is close to the projected peak day demand of 6,367 gpm based on a 3.25% growth rate over the next 40 years. It is anticipated that to service a build-out population of 49,538 residents with a peak day demand of 15,830 gpm and an annual flow of 14,473 acre feet that Kanab City will need to continue actively acquiring water rights to serve the future needs of its citizens. This includes both surface and subsurface rights.

	Jun-13	Dec-13	2013	
Cave Lakes Spring Area	10.7	11.8	134.6	
Cave Lakes Well No.5	0	0	0	
Chicken Canyon Well No.4	0	0	16.9	
City Spring (Chicken Sp)	0	0	0	
Hinckley Well No.13	55.6	0	313.6	
Mace Well No.2	0	9.5	68.1	
School Well No.11	0	19.7	100.8	
Three Lakes Well No.12	50.2	0	95.3	
Well No. 15	0	7.9	31.5	
Well No.1 (#9)	0	0	0	
Well No.14	45.1	0	293.8	
West Fork Well #1	0.9	0	191.2	
West Fork Well #2	6.4	0	65.9	
West Fork Well #3	5.1	0	39.4	
West Fork Well #4	60.9	0	268.5	
West Fork Well #5	0	0	0	
Totals	234.9	48.9	1619.6	Acre-feet
Totals	76,542,399.90	15,934,113.90	527,748,279.60	Gallons

waterrights DNR <waterrights@utah.gov>

Best Friends Animal Society Protest - Corrected

1 message

Janelle Bauer <JBauer@joneswaldo.com> Wed, Oct 2, 2019 at 1:22 PM
To: "waterrights@utah.gov" <waterrights@utah.gov>

The protest fee was paid online, I have attached a corrected copy of the BFAS protest and exhibits. In the original filing part of Exhibit 3 was mistakenly attached to Exhibit 5.

Thanks,

Janelle

JONES WALDO
Attorneys Est. 1875

JANELLE BAUER | ATTORNEY
170 S. Main Street, Suite 1500 Salt Lake City, UT 84101-1644
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JBauer@joneswaldo.com | bio | joneswaldo.com

BFAS-Final.pdf
5911K