17 Additional Requirements for Development Properties and Production Properties (Item 25)

17.1 Hydrogeology

Powertech completed a preliminary characterization of the groundwater system at the Centennial project for mine planning and permitting purposes. In addition to descriptions of the aquifers and confining units above and below the sub-aquifers hosting the uranium mineralization, the hydraulic conductivity and transmissivity of the production aquifer will be addressed in detail, looking independently at the North and South project areas.

17.2 Regional Hydrogeology

The Centennial project is located within the South Platte River basin, the eastern part of which is composed of low relief plains with low precipitation. Due to favorable geologic conditions and readily available shallow groundwater, there has been limited development of deeper groundwater resources within the basin. Important aquifers within the region include alluvial and terrace deposits along major watercourses and streams, the Ogallala and Arikaree formations in Wyoming and northern Colorado, the White River Group, the Laramie formation, and the Fox Hills Sandstone.

In addition, the underlying Pierre shale, although considered poor quality water, has historically produced and is the deepest source of water in the region because its thickness (up to 7,000ft) limits deeper drilling for groundwater resources. This hydrogeological unit shale is characterized by a thick sequence of inter-bedded sandy shale, claystone, and massive to lenticular sandstone. There are numerous wells in the region that yield up to 30gpm from the sand deposits of the Pierre (Weist 1965). The aquifer is confined, with artesian pressures not uncommon. No hydraulic conductivity or specific capacity data for the Pierre are known in the vicinity of the Centennial Project. The extreme thickness of the unit (up to 7,000ft in the area of the project) excludes the discussion of underlying aquifers due to practical drilling depths for groundwater resources.

17.3 Project Hydrogeology

Project hydrogeologic information is based upon the results of work completed or directed by Powertech. Work completed by Powertech and their consultants includes monitor and pumping well construction, aquifer testing, groundwater sampling, and completion of a preliminary numerical groundwater model to evaluate well field hydraulics (Petrotek, 2009b).

Powertech completed two pumping tests, both within the North project area in 2007 and 2008 (R Squared, 2008), and installed wells for the completion of a third pumping test in the North project area to be completed in 2010 (Powertech, 2009a). Sixty groundwater wells have been sampled for baseline parameters within and around the Project area. In addition, core samples obtained during resource drilling activities have been analyzed for hydrogeologic parameters.

17.3.1 Project Hydrostratigraphic Units

The following describes the general characteristic of the aquifers and confining units in the vicinity of the Centennial Project. These units are shown in cross sections A-A’ and C-C’ in Figures 17-1 and 17-2 for the North and South project areas, respectively (locations of these cross sections are given in Figures 17-3 and 17-4. The hydrostratigraphic units are discussed in order of decreasing age and depth below ground surface.

Fox Hills Sandstone

Throughout the Project area, the Fox Hills Sandstone can be divided into two major units – the Upper and Lower Fox Hills Sandstones. The Upper Fox Hills is then locally sub-divided into "A" and "WE" sands, and the Lower Fox Hills into "B", "C", and "D" sands. There are four A sands, labeled A_1 through A_4, and one each of WE, B, C, and D sands. When present, local confining units adjacent to each sand sub-division are named according to the sands to which they are adjacent. In addition to these local confining units, the Upper and Lower Fox Hills are regionally divided by a thick sequence of mudstone immediately underlying the WE sand. Regionally, the entire Fox Hills Sandstone is at some point a host to uranium mineralization. However, the current targets of economic interest to Powertech are the heavily mineralized "A" and "WE" sands of the Upper Fox Hills Sandstone. These mineralized A and WE sands have been classified through petrographic thin-section analyses as generally well-sorted, fine-grained, feldspathic litharenites with an abundance of sub-angular to sub-rounded monocrystalline quartz and igneous rock fragments. The sediments are generally moderately indurated and are interpreted to be deposited in a littoral environment during Late Cretaceous time. The lithology and texture of the aforementioned sands appear to be synonymous with barrier island sequences periodically dissected by tidal inlets and storm channels. The sand sequences are typically interbedded with mudstones, siltstones, and lagoonal muds indicative of the backshore and shore face environments they are adjacent to.

In the vicinity of the project area, yields from the Fox Hills aquifer are generally less than 15gpm, however yields as high as 350gpm have been reported (Weist, 1965). The Colorado Division of Water Resources (DWR) jointly classifies the Laramie and the Fox Hills as an unconfined aquifer. However, if looked at in detail, the Fox Hills itself is a regionally confined aquifer. Although given the proximity of the project to outcrop of the formation (1 to 2mi to the west), unconfined characteristics of the Upper Fox Hills Sandstone are also evident. As such, the saturation boundary of the Upper Fox Hills aquifer projects through Centennial South, resulting in uranium mineralization in that area residing above the water table.

Laramie Formation

Throughout the Project area, the Laramie formation consists primarily of carbonaceous shales, coals, siltstones, and clay; with regionally discontinuous channel sandstones. The Laramie outcrops in the central to southern vicinity of the project, with many of the outcrops covered by remnants of the White River formation or unconsolidated soil or gravel. Where it is not truncated by the ground surface, alluvial deposits, or the White River formation, the Laramie formation conformably overlies the Fox Hills Sandstone. The contact is typically indicated by beds of lignitic shales and clays, and/or the change in sedimentation from marine to a freshwater fluvial environment. Most of the wells in the Laramie formation yield 5 to 10gpm; however, in areas of thicker sandstone deposits, reported yields have been as high as 300gpm (Weist 1965).

Alluvium and Terrace Deposits

Unconsolidated deposits in the Project area consist of beds and lenses of gravel, silt, sand, and clay. These units are associated with the larger watercourses to the south and east of the project area, and minor tributaries with thin alluvium deposits do exist within the Project area. The groundwater resources attributed to these in the Centennial project area are minimal to negligible.

17.3.2 Water Levels, Groundwater Flow and Recharge

Based on the conceptual groundwater model, completed by Petrotek (2009b), groundwater flow in the vicinity of the Centennial project is in the south-southeastern direction. However, this estimate is preliminary because water level measurements were measured in wells installed:

- With discrete sand completions; and
- Parallel to outcrop line of the Upper Fox Hills Sandstone, which is typically 1 or 2mi west of the Project area.

Location of the wells with measured water levels within the North and South project areas are shown in Figures 17-3 and 17-4, respectively, and measured water levels in production aquifers are given in Tables 17.1 (11 wells) and 17.2 (7 wells).

Table 17.1: North Area Production Aquifer Water Level Data

Well ID	Centennial Project Sub-Aquifer	Top of Casing Elevation (ft)	Elevation of Top of Uppermost Mineralized Sand (ft)	Static Water Elevation (ft)	Available Drawdown(1) (ft)
IN08-33-MM4	A2 Sand – Section 33, T10N, R67W	5614	5050	5268	218
IN08-33-PW1	A2 Sand – Section 33, T10N, R67W	5573	5072	5268	196
IN08-33-MM1	A2 Sand – Section 33, T10N, R67W	5555	5077	5267	190
IS-003T	A Sands – Section 33, T10N, R67W	5542	5077	5268	191
IN08-33-MM5	A2 Sand – Section 33, T10N, R67W	5517	5072	5265	193
IN08-3-MM1	A1 Sand – Section 3, T9N, R67W	5465	5022	5226	204
IS-005	A Sands -Section 3, T9N, R67W	5473	4996	5228	232
IS-006	A Sands -Section 9, T9N, R67W	5651	5161	5261	100
IS-009T	A Sands -Section 9, T9N, R67W	5665	5243	5264	21
IS-012	A Sands – Section 15, T9N, R67W	5526	5257	5277	20
IN08-15-MM1	A1 Sand – Section 15, T9N, R67W	5427	5184	5215	31

(1) Available drawdown is relative to the top of the target mineralized sand(s). The top of the mineral may be deeper.

Table 17.2: South Area Production Aquifer Water Level Data

Well ID	Centennial Project Sub-Aquifer	Top of Casing Elevation (ft)	Elevation of Top of Uppermost Mineralized Sand (ft)	Static Water Elevation (ft)	Available Drawdown(1) (ft)
C-003-35	A2 Sand – Section 35, T9N, R67W	5382(2)	5275	>5240	0(3)
BH-834-1AWE	WE Sand – Section 1, T8N, R67W	5359	5171	5229(4)	58
BH-843-1AWEO	WE Sand – Section 1, T8N, R67W	5359	5171	5227	56
BH-839-3BWE	WE Sand – Section 3, T8N, R67W	5347	5230	5222	0
BH-849-10AWEO	WE Sand – Section 10, T8N, R67W	5319	5259	5225	0
BH-837-11BWE	WE Sand – Section 11, T8N, R67W	5288	5222	5229	7
C-002	WE Sand – Section 11, T8N, R67W	5315	5237	5242	5

(1) Available drawdown is relative to the top of the target mineralized sand. The top of the mineral may be deeper.
(2) No as-built survey available. The elevations are estimated from a USGS topography map.
(3) Zero available drawdown indicates that the aquifer at this data point is unconfined and the water level is below at least part of the mineralization.
(4) BH-834, 839, 843, and 849 water levels are derived from measurements of RME wells in October 1981.

Comparison of water levels in the co-located wells completed in different sub-aquifers is shown in Table 17.3.

Table 17.3. Comparison of Water Levels in Collocated Wells

Location		Potentiometric Elevation (ft) in Sub-Aquifers			
		Laramie	A	WE	B
North	IN08-33 (MUU3,MM3,MO3)	5,429	5,267	-	5,298
	IN08-33 (MO1,PW1,MU1,MUU1,MM1)	5,379	5,268	5,274	5,298
	IN08-33 (MO2, MM2, MUU2)	5,398	5,267	-	5,305
	IS-003T	5,419	5,264	5,270	-
	IS-009T	5,429	5,274	5,250	-
South	BH-833/834	-	-	5,227	5,221
	BH-836/837	-	-	5,223	5,211
	BH-838/839	-	-	5,220	5,215

Note: All wells are located within than 200ft of each other, and having discrete completions.

Water level data, measured in nested wells in the North Project area, are different vertically and confirm confinement (at least limited hydraulic connection) between different aquifers. In the South project area, water level data are limited and differences in potentiometric elevations between WE and B aquifers is in the smaller range; from 2 to 6ft.

Aquifers in the project area appear to be primarily recharged through precipitation infiltrating at through outcrop. Additional studies to determine recharge from stream flow losses and/or minor inflow from other aquifers may be considered. The relative contribution of each component may be variable or negligible due to confinement of the mineralized sands.

17.3.3 Groundwater Chemistry

Uranium ISR permitting regulations require characterization of pre-mining groundwater chemistry data for the production aquifer, underlying aquifer, and all overlying aquifers within the Centennial project, the Laramie and the Fox Hills are jointly classified the Laramie-Fox Hills aquifer by the DWR. However, when looked at in detail specific to the Project, the Laramie formation may be separated from the Fox Hills, and may then be considered the uppermost "aquifer" if saturated Laramie channel sandstones are present. The confined A-WE sands of the Upper Fox Hills may then be labeled by Powertech as the production aquifer, and the underlying aquifer is the confined B sand of the Lower Fox Hills. In portions of the southern Project area, there may be no additional major aquifer(s), as defined by the DWR, overlying the production formation. Reasons for such occurrences were previously discussed in detail in Section 17.3.1 of this report.

Dependant on the degree and nature of truncation of overlying formations, the production aquifer may be specified as the exact sub-aquifer containing the target mineralization (example – solely the WE sand), and geologically continuous aquifer above the confining unit local to that mineralization (A/WE confining unit) may be monitored if applicable (saturated). Such cases may exist where localized alluvial deposits are the only material suitable for aquifer storage overlying the production aquifer. However, none are known to contain water and be developed within the Project area. During production, Powertech may evaluate the need for vadose zone monitoring devices to collect data (groundwater quality and water level) where non-saturated aquifer materials are present above the production formation.

As part of Powertech's background data collection, two wells (IS-003T and IS-009T) within the A_2 sands have been sampled in Centennial North, and two wells (BH-120 and C-002) within the WE sand (including thick A_4 sand in BH-120C well) were sampled in Centennial South. The groundwater data for these two areas are summarized in Table 17.4. Minimum, maximum, and mean concentrations are based upon data collected for the mine permitting process. In general, the water within the uranium ore zones of the Upper Fox Hills aquifer is characterized by high concentrations of dissolved solids, sulfates, and radionuclides. Mean concentrations of dissolved solids, sulfate, iron, manganese, selenium, uranium, and radionuclides (gross-alpha, radium-226, radon-222) exceed drinking water quality standards (EPA maximum contaminant levels (MCL), secondary MCLs, and proposed MCLs). Dissolved uranium concentrations as high as 0.401mg/L and 1.68mg/L were obtained from the A sands and WE sand respectively.

17.3.4 Hydraulic Properties of the Fox Hills Aquifer

The following section presents the hydrogeologic characterization completed to date and includes water level measurements, aquifer tests, and geotechnical laboratory test results.

North Project Area

Powertech conducted three aquifer tests within the Project area. Two were completed in Section 33, T10N, R67W from 2007 to 2008 utilizing the same wells, and one was completed in 2007 in Section 9, T9N, R67W.

The 2007 test in Section 9 consisted of pumping from the A sands of the Upper Fox Hills Sandstone for 23 hours at an average rate of 6.33gpm from a screened interval 40ft in length. The results of the pumping test yield the following data:

- Transmissivity of 61.6ft^2/d;
- Hydraulic conductivity of 1.05ft/d;
- Storage coefficient of 0.051;
- Near the end of the test, there is a suggestion of recharge influence. The pumping test monitor well in the WE sand indicated potential minor influence from pumping of the A sands;
- No influence from pumping in the Upper Fox Hills A sands was observed in the overlying Laramie formation; and
- The target-pumping rate for the test was 10gpm; however, that production rate could not be achieved.

Table 17.4: Groundwater Chemistry for the Upper Fox Hills within the Centennial Project Area

Analyte	Units	MCL or Other Advisory Value	Upper Fox Hills – A_2 Sands North Project Area			Upper Fox Hills – WE Sand South Project Area		
			Minimum	Maximum	Mean	Minimum	Maximum	Mean
Bulk Properties								
pH	pH Units	6.5 – 8.5(a)	7.47	7.64	7.56	7.31	7.91	7.67
Solids-Total Dissolved (TDS)	mg/L	500(a)	389	1,140	759	10	3,200	1,314
Cations/Anions								
Bicarbonate as HCO3	mg/L	-	278	537	356	176	634	366
Calcium-Dissolved	mg/L	-	80	212	139	62	461	165
Magnesium-Dissolved	mg/L	-	25	64	42.9	28	164	90.2
Sodium-Dissolved	mg/L	200(a)	29	68	45	9	210	71.3
Potassium-Dissolved	mg/L	-	7	18	12	2	12	6.5
Chloride	mg/L	250(a)	8	17	12.3	26	85	49.5
Sulfate	mg/L	250(a)	200	529	467	56	1,371	639
Metals – Total								
Arsenic	mg/L	0.01	0.001	0.005	0.002	0.001	0.006	0.002
Chromium	mg/L	0.1	0.01	0.01	0.01	0.01	0.07	0.02
Copper	mg/L	1.0(a); 1.3(b)	0.01	0.05	0.017	0.01	0.01	0.01
Iron	mg/L	0.3(a); 5(c)	0.06	26.6	4.32	0.03	1.98	0.32
Lead	mg/L	0.015	0.01	0.01	0.01	0.01	0.05	0.013
Manganese	mg/L	0.05(a); 0.8(c)	0.09	0.24	0.15	0.01	0.35	0.11
Mercury	mg/L	0.002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Molybdenum	mg/L	0.04(d)	0.01	0.02	0.02	0.01	0.1	0.02
Selenium	mg/L	0.05	0.001	0.003	0.001	0.024	0.425	0.18
Strontium	mg/L	4(d)	1.2	3.4	2.2	0.8	5.5	2.9
Uranium	mg/L	0.030	0.0154	0.401	0.131	0.0249	1.68	0.77
Zinc	mg/L	5(a); 2(d)	0.01	0.06	0.02	0	0.07	0.03
Radionuclides								
Gross Alpha-Dissolved	pCi/L	15	20.1	1,060	451.4	15.1	1,390	568
Radium-226-Total	pCi/L	5(e)	1.7	349	105	0	38.8	16.2
Radon-222-Total	pCi/L	300(f)	1,850	260,000	77,300	396	37,700	8,889

(a) Secondary drinking standard
(b) Action level, which if exceeded, triggers treatment
(c) Permit limit calculated by Region 8 Drinking Water Toxicologist based on human-health criteria
(d) Health advisory-lifetime
(e) MCL for Radium-226 and Radium-228 Total, Radium-228 not analyzed
(f) Proposed MCL

The 2008 test completed by Powertech in Section 33 also consisted of pumping from the A sands of the Upper Fox Hills Sandstone. The first test was 29 hours in duration at an average rate of 10.5gpm from a screened interval 30ft in length. The results of the pumping test yielded the following data:

- Transmissivity of 51.7ft^2/d;
- Hydraulic conductivity of 1.67ft/d; and
- Storage coefficient of 3.8 x 10^{-4}.

The second test was 102 hours in duration at an average rate of 37.5gpm (via airlifting) from a screened interval 30ft in length. The results of the pumping test yielded the following data:

- Transmissivity of 23.9ft^2/d;

- Hydraulic conductivity of 0.77ft/d; and
- Storage coefficient of 6.25 x 10^{-5}.

In both pumping tests conducted in Section 33, immediate drawdown was observed within the WE sand of the Upper Fox Hills Sandstone. Approximately 16ft of mudstone exists between these two sand units. Several potential causes for the communication have been presented, including pumping test well construction, exploration drillholes open at depth, secondary porosity in the intervening mudstones, and/or discontinuity of the local confining units adjacent to the A sands. After reviewing the extensive geologic and geophysical data available within the Project area, Powertech may evaluate the need for further investigations of confinement of the WE from the A sands. The WE sand is a mining designation for a sub-unit of the Upper Fox Hills, and is a mineralized target within the project area.

An additional aquifer-pumping test is planned for the A2 sand of the Upper Fox Hills Sandstone in Section 33, T10N, R67W for spring 2010. The wells to be utilized in the test were installed in 2009. The plan calls for the A2 sand to be pumped for a duration of 72 hours or longer, at a pumping rate of 8 to 15 gpm. Numerous monitor wells have been installed in the A2 and WE sands of the Upper Fox Hills, the B sand of the Lower Fox Hills, and various saturated sands of the Laramie formation. The intent is to collect sufficient data for ISR mine planning.

Core samples were collected for geotechnical laboratory analysis from seven drillholes within the northern Project area. Permeability values were estimated for the sand units from 800 to 1,900mD, hydraulic conductivity – 1.8 to 176ft/d, and porosity – from 33 to 48%. Permeability of confining units was measured in the range from 12 to 152mD (or 1-2 order magnitudes lower than from productive sand units).

Powertech prepared a preliminary 3-dimensional numerical groundwater model of ISR well field hydraulics within the A2 sand of Section 33 (Petrotek 2009) that indicates a predicted drawdown in a recovery well in excess of 95 and 115ft with a net bleed rate of 0.5% and 1.0%, respectively. The predictions assume a pumping rate of 20gpm from each recovery well, totaling nearly 3,000gpm from the entire well field. The model utilized a hydraulic conductivity of 2ft/d. This value for hydraulic conductivity was based upon. Theis simulations developed to mimic the observed aquifer response to well development activities, and is consistent with conservative values derived from core analyses. Fifteen simulations were completed with an input range of 0.77ft/d to 3.08ft/d. The best fit to the data was 2.05ft/d. In addition, the Theis simulations suggest a long term pumping rate of 10gpm for the planned 2010 aquifer test (Petrotek 2009a).

South Project Area

Hydrogeologic data are available for Centennial South from previously installed wells, core analyses, and mapping of geophysical log correlations. Present water level data indicate that saturation within the mineralized sands varies throughout the southern project area. To supplement RME data, Powertech has completed two wells in this portion of the project area, and available data is being compiled from RME wells that are also discrete sand completions. To date, no aquifer tests are known to have been completed in the South Project Area.

Both the A_2 sands (Mine Units 6 and 7) and WE sands (Mine Units 8 and 9) host mineralization at various points across the southern portion of the Project area, and both vary in saturation. Water level data of the mineralized sands are available from seven wells in Centennial South (Table 17.2); location of these well is shown in Figure 17-4. The variable saturation of the WE and A2 sands limits the possibilities of aquifer pumping testing within specific areas of Centennial South.

Core samples were collected for geotechnical laboratory analysis from four drillholes within the southern Project area. Permeability values of the sand units were estimated from 850 to 3,500mD, hydraulic conductivity – 3.3 to 280ft/d, and porosity – from 26 to 43%. Permeability of confining units was measured in the range from 17 to 204mD (or 1 to 2 order magnitudes lower than from productive sand units).

17.3.5 Hydrogeological Considerations for ISR Mining Performance

This section describes the current well field design and operating parameters for the Centennial North and Centennial South project areas based upon present available data.

An important aquifer parameter to consider in the design of an ISR well field is hydraulic conductivity/transmissivity within the ore body. This parameter defines aquifer drawdown and recovery due to pumping and injection, as well as residence time for the ISR mining lixiviant. An additional aquifer parameter of great importance for ISR well field design is the amount of hydraulic head above an upper confining unit (or available drawdown). A greater hydraulic head allows for higher concentrations of dissolved oxygen within the lixiviant, more aggressive pumping and injection, and reduced risk for gas lock in the producing formation.

Hydraulic Head

Powertech estimated that a hydraulic head of 40 ft (approximately 17.3 psi water pressure) is necessary within the orebody during mining (Petrotek, 2009a). Sufficient hydraulic head is required to accommodate the drawdown from the recovery wells, as well as maintaining the dissolved oxygen in the production aquifer.

The ability to maintain dissolved oxygen injected into the production aquifer is paramount to successful oxidation and mobilization of uranium required for in situ mining of uranium roll front deposits. The inability to maintain dissolved oxygen at depth within the production formation will reduce uranium recovery. In addition, if sufficient hydraulic head cannot be maintained, oxygen bubbles will fall out of solution and may cause a gas lock condition in the formation. The gas lock can reduce well performance, damage pumps and piping, and change the flow regime in the production aquifer; all limiting resource recovery.

Powertech plans to utilize aquifer enhancement through mine unit perimeter injection well fences to provide and maintain sufficient hydraulic head in mine units 4, 5, 6, 7, 8, and 9. As presented in Tables 17.1 and 17.2 the groundwater level in the southern portion of the Centennial project is not sufficient for in situ mining techniques without artificial enhancement. If designed properly, the use of aquifer enhancement will raise the groundwater level internal to the mine unit, saturating all available uranium ore, and create hydraulic head for recovery well drawdown and maintaining dissolved oxygen injected into the production aquifer.

Development of Aquifer Enhancement

The current ISR development plan for the Centennial project includes aquifer enhancement by raising the water table through fresh water injection on the well field perimeters of six mine units. Raising the water table will promote saturation of the ore bodies and sufficient hydraulic head above the mineral to maintain the dissolved oxygen at the levels required to recover uranium. Powertech completed a preliminary assessment of the aquifer enhancement process to estimate the potential development costs associated with the approach (Petrotek 2010) for the four well fields located in Centennial South. Investigations to further hydrogeologic characterization and better define the feasibility of this process may be considered.

Once the permissions are granted, the standard well field development work may be carried out: delineation drilling, installation of monitor wells, baseline groundwater sampling, and a production aquifer test. To collect supplemental data related to parameters for aquifer enhancement, the following studies may be considered:

- Additional core sample analysis to estimate porosity and other relevant hydrogeologic parameters;
- Extended baseline sampling, with an increased number of monitor wells and sampling frequency;
- Installation of injection and monitoring wells for pilot injection testing to demonstrate feasibility of aquifer enhancement; and
- Detailed implementation of hydrogeologic and ISR models to design production, monitoring, and freshwater injection systems of the well field.

Aquifer enhancement and control of mining solutions is proposed through development of a hydraulic fence that may be operated throughout mining and restoration of the well field. Preliminary design of the proposed hydraulic fence consists of a ring of freshwater injection wells located approximately half the distance between the mining patterns and the monitor well ring. Final injection well spacing for the hydraulic fence has yet to be determined, and will likely vary based on individual well field hydrogeologic parameters; at this time a spacing of 200 ft has been chosen for the economic analysis. Well screens for the hydraulic fence will be similar to the monitor wells, with the entire production aquifer screened. Figure 17-5 presents an idealized conceptual cross section of a mine unit utilizing a hydraulic fence for aquifer enhancement.

The injection wells of the hydraulic fence will likely be supplied with Colorado-Big Thompson (CBT) water acquired through purchase. CBT water is of very good quality, and Powertech has completed a preliminary geochemical analysis that show no adverse affects of mixing CBT water with the native groundwater of the Fox Hills aquifer (Knight Piésold, 2010). No modeling has been completed by Powertech to assess the effect of the hydraulic fence on the surrounding water resources during operation.

Several additional factors will be important in the next stages of design of the Centennial project to successfully implement aquifer enhancement:

- Hydraulic conductivity of the mine unit to:
    - Estimate the area of influence of the freshwater injection wells,
    - Estimate the required available drawdown for recovery wells,
    - Estimate the height to which the water table will need to be raised,
    - Estimate the time required to flood the mineralized zone, and
    - Calculate the rate of freshwater injection on the perimeter required to maintain the increased hydraulic head within the mine unit.
- Thickness and hydrogeologic characteristics of the vadose zone; and

- Thickness and hydrogeologic characteristics of overlying confining units – if the thickness of the vadose zone is less than the height of the potentiometric surface required to create the necessary hydraulic head for ISR mining.

Further data collection and well field modeling may need to be completed to further understand the application these mining techniques to the Centennial Project.

North Project Area

The present well field plan for the Centennial North area utilizes five-spot well patterns (four injection wells, and one central recovery well), 100ft well spacing (square side length) for mine units 1, 2, and 3, with an average pumping rate of 20 gpm. Mine units 4 and 5 will be developed with 70ft well spacing and an average recovery well pumping rate of 10 gpm. The average mining thickness (screen length) in the north project area is 15ft. Of the five mine units planned in Centennial North, only units 4 and 5 will require aquifer augmentation via a hydraulic fence (Figure 17-6).

Analysis of the Upper Fox Hills sub-aquifer suggests that the anticipated recovery-well pumping rate of 20gpm is within the aquifer's potential based on aquifer test data from the Mine Unit 2 (Section 33, T10N, R67W). Data from the aquifer test located in the Mine Unit 4 (Section 9, T9N, R67W) indicate that sustainable pumping rates, without aquifer enhancement, may be lower than 10gpm. Aquifer enhancement may be required to successfully develop several planned mine units in this area based upon present available drawdown data (Table 17.5). The North project area may be an ideal candidate for initial testing of aquifer enhancement by using a hydraulic fence. The vertical distance between the present static water level and the ground surface provide ample room for operational testing and optimization of injection wells for artificially raising the water table within the A sands of the Upper Fox Hills Sandstone.

Table 17.5: Assessment of Available Drawdown, Hydraulic Conductivity & Potential for Aquifer Enhancement at Individual Mine Units in Centennial North

Mine Unit	Available Drawdown	Production Aquifer Hydraulic Conductivity Based on Pumping Test Data	Depth to Production Aquifer Static Water Level from Ground Surface	Potential Increase in Available Drawdown Through Aquifer Enhancement
1	Unknown Anticipated to be greater than 200ft	-	Unknown, probably greater than 200ft	Not Required
2	196ft based upon water level measurements from IN08-33-PW1	Aquifer testing resulted in 1.05ft/d	305ft	Not Required
3	IS-006 indicates an available drawdown of 100ft in the south of the mine unit. IN08-3-MM1 indicates 204ft of available drawdown to the north and east of the mine unit.	-	424-239ft	Not Required
4	21ft based upon water level measurements from IS-009T	Aquifer testing yielded results of 1.67ft/d and 0.77ft/d	400ft	360ft
5	IN08-15-MM1 to the northeast of the mine unit indicates 31ft of available drawdown.	-	209ft	169ft

Mine units 1, 2, and 3, will be operated for approximately 21 months based on present mine planning completed by Powertech. Utilizing the planned recovery well pump rate of 20gpm, and assuming balanced flow within a given five-spot pattern, a 150,000ft^3 mining block will have approximately 41 pore volumes circulated through the pattern during the mining period. Mine units 4 and 5 will be operated for the same 21 month duration, utilizing a recovery well pumping rate of 10 gpm. Within the 73,500ft^3 mining block of these units, approximately 43 pore volumes will be circulated. This number is higher than the 30 pore volumes utilized to obtain the 74% to 78% indicated leach efficiencies during bottle roll testing; however, bottle roll assessment does not account for unbalanced flow regimes within a well pattern that can increase the length of the mining period to achieve the same recovery. Nor do they account for the net effect of the hydraulic fence in operation at well fields 4 and 5.

South Project Area

The present well field plan for Centennial South project utilizes five-spot well patterns (four injection wells, and one central recovery well), 70ft well spacing (square side length), and an average mining thickness (screen length) of 15ft. The anticipated average pumping rate for the recovery wells is 10gpm. The project area plan outlines the development of four mine units in the South project area; all utilizing a hydraulic fence to raise the operational groundwater level (Figure 17-7).

Hydrogeologic data for Centennial South is limited to water levels, core data, and mapping of geophysical log correlations in that there has been no aquifer tests in the area to date. However, from core data, the hydraulic conductivity of the production aquifer in Centennial South appears similar to that of Centennial North, and therefore the same potential for an increased mining period over 21 months may be conservatively estimated. Within Centennial South, the uranium hosting WE sand is nearer to the surface, and in some places less than 100 ft from the surface. Successful mining of the complete resource will require a competent overlying aquitard to provide the barrier required to raise the hydraulic pressure of the aquifer for ISR mining. Laboratory analyses of the overlying confining units have been completed indicating favorable aquitard characteristics. However, aquifer and injection testing will be required to further investigate the continuity of the confining units throughout the South project area prior to construction of the mining well field.

As stated previously, Powertech performed a preliminary study of enhancing unsaturated aquifers containing uranium mineralization. Although not analyzed in concert, a brief discussion combining the results of the Centennial North groundwater model (Petrotek 2009b) and the Centennial South infiltration study to determine water requirements for aquifer enhancement (Petrotek 2010) is warranted. Utilizing the proposed spacing and pumping rate from recovery well and assuming productive sand hydraulic conductivity of 2ft/d, it was estimated by Petrotek (2009b and 2010) that the hydraulic pressure of the production formation will need to be increased to a point equal to a 40 ft of groundwater elevation above the target uranium mineralization to maintain a pumping rate of 10 gpm and dissolved oxygen in the projected concentrations required for mining based on the completed work to date. Table 17.4 provides the relative projected flood levels to the minimum ground surface within each mining unit of the South project area, although many variables in elevation exist, present data suggest that for mining to approach all mineralization in this project area, the overlying and presently unsaturated aquitard must be competent. Limited core data suggest the adequacy of this unit; definitive data will be collected prior to mining operations.

Table 17.6: Flood Level and Available Drawdown with Planned Hydraulic Fence in Centennial South

Mine Unit	Minimum Ground Surface Elevation (ft)	Projected Flood or Potentiometric Level Elevation* (ft)	Range of Available Drawdown – Height of Flood Level Above Base of Overlying Aquitard (ft)
6	5,360	5,324	35-57 (average of 46)
7	5,358	5,347	29-55 (average of 43)
8	5,310	5,262	17-44 (average of 22)
9	5,302	5,297	22-50 (average of 36)

*- Flood level as determined by Petrotek (2010)

17.3.6 Hydrogeologic Considerations for ISR Mining Impact to Groundwater System and Operational Risk

The results of the pumping test planned for spring 2010 will provide sufficient data to develop a groundwater model to assess the potential well field pumping rates, production schedule, and impact of the mining operation to the regional groundwater system for Centennial North. Additional considerations associated with the enhancement of the production aquifer through freshwater injection may include:

- Results from 2007 aquifer testing in Centennial North indicate relatively low hydraulic conductivity values for the production aquifer, but are not consistent with core data. Hydraulic conductivity in Centennial South is likely similar or greater according to core data; however, due to present groundwater conditions, future aquifer testing may be limited to specific areas where mineralization is sufficiently submerged;
- Available drawdown over much of Centennial North is sufficient for ISR development. The potentiometric surface may require enhancement at Mine Units 4 and 5 for ISR mining techniques to be efficient;
- Under present pre-mining groundwater conditions, ISR mining techniques likely cannot be applied to Centennial South without aquifer enhancement of the mineralized sands;
- There are likely limitations to increasing the hydraulic head due to relatively shallow mineralization in Centennial South. Investigations of the continuity of the overlying confining units of the shallow mineralization in Centennial South may be considered. The ability to raise the hydrostatic pressure of the mineralized aquifer is directly related to the amount of oxygen which can be dissolved in the lixiviant and can effect extraction rates.
- Further investigation of the geochemical effects of mixing injection water and groundwater in a uranium bearing aquifer may be considered.

17.4 Assessment of Centennial Project Hydrogeology

The data confidence level is typical of a uranium ISR project at this stage in development. The completion of the planned 2010 aquifer test will significantly improve hydrogeologic knowledge of the project. The overall development strategy for the Centennial Project, including aquifer enhancement, will require very detailed knowledge of hydrogeologic variability across individual mine units. Prior to the development of each individual mine unit, Powertech will complete a thorough hydrogeologic characterization program including but not limited to:

- Detailed delineation on 50-100 ft centers and mapping of the ore body;

- Installation of monitor wells;
- Baseline sampling of groundwater; and
- Aquifer testing.

Additional activities for mining the well fields where elevation of the water table is necessary include:

- Additional coring to determine porosity and other parameters relevant to the groundwater elevation process;
- Baseline sampling to include existing water within the sand unit if available, but also additional sampling of nearest down gradient water quality. Overlying and underlying sand units are to be sampled as well, with an expected higher sampling frequency than normal well fields;
- Injection tests to demonstrate the hydrogeologic feasibility; and
- Use of hydrogeologic modeling to design the systems (production, monitoring, and CBT injection) in greater detail.

The data derived from this work will utilized in the regulatory approval process for each individual mine unit.

17.5 Commercial Operating Plan (Lyntek and SRK)

Section 17.5 is a combined effort of Lyntek and SRK. SRK comments and opinions, where present, contain "SRK" in the pertinent sentences and paragraphs.

17.5.1 Uranium ISR Process Overview

In principle, in situ recovery from permeable sandstone formations is conducted by injecting a solution (lixiviant) into a mineralized section of the formation and extracting a uranium loaded production composite solution (PC) for treatment in a surface facility to recover the dissolved uranium. Typically, solution treatment produces a barren solution from which a bleed stream is disposed for control of soluble impurities. The remaining solution is reconstituted with reagents, restored with natural ground water to the desired flowrate, and re-injected.

As is the case with nearly all ISR operations, the well fields for the Centennial Project will use oxygen as the oxidant for tetravalent uranium and carbon dioxide as a complexing agent to form water-soluble uranyl dicarbonate , $[UO_2(CO_3)_2]^{-2}$, or uranyl tricarbonate, $[UO_2(CO_3)_3]^{-4}$. Although the oxygen and carbon dioxide are introduced into the lixiviant as gases, they dissolve under the static pressure produced by the hydraulic head in the injection well. The target concentrations of oxygen and carbon dioxide, respectively, will be 400mg/L and 200mg/L, yielding an anticipated PC concentration of 60mg/L U_3O_8.

17.5.2 Process Benefits

Many impacts typically associated with conventional uranium mining and milling processes are avoided by employing uranium ISR mining techniques. The ISR benefits are substantial in that no tailings are generated, surface disturbance is minimal in the well fields, and restoration, reseeding, and reclamation can begin during operations. As a particular well field is depleted, ground water restoration can begin soon after, significantly reducing both the time period of post-production restoration, and the cumulative area not restored at a point in time. The final uranium product is yellowcake (uranium oxide) that has been dried in a vacuum dryer.

At the end of the project life, all affected lands and groundwater will be restored as dictated by permit and regulatory requirements.

17.5.3 Well Field Mining Unit Concept

The well field areas are logically divided into mining units for scheduling development works, which also allows the establishment of specific baseline data, monitoring requirements, and restoration criteria. Each mining unit consists of a potentially mineable resource block ranging from 9 to 63 acres, representing an area that will be developed, produced and restored as a unit. Approximately 9 such units will be required throughout the total project area. Two to three mining units may be in production at one time with additional units in various states of development and/or restoration. Aquifer restoration of a mining unit will begin as soon as practicable after mining in the unit is complete. If a mined-out unit is adjacent to another unit being mined, restoration of a portion of the unit may be deferred to minimize interference with the operating unit.

17.5.4 Well Field Design Concepts

Well fields will be developed based on conventional five-spot patterns. Injection and production wells within a mining unit will be completed in the mineralized interval of only one mineralized zone at a one time. Injection and production wells will be completed in a manner to isolate the screened uranium-bearing interval. Production zone monitor wells will be located in a pattern around the mining unit or units with the completion interval open to most of the production zone. Overlying and underlying monitor wells will also be completed in the aquifers immediately above and below the production zone to monitor for vertical lixiviant migration.

Well Field Pattern

The plan envisions dividing the two general production areas (Centennial North and Centennial South) into mining units for the purposes of scheduling, mining, and restoration. Each mining unit will comprise a reserve block with a surface area of 9.2 to 62.4 acres, depending on deposit configuration and topography.

The Centennial North will consist of five mining units extending over approximately 7,745,793ft^2 (177 acres). Pending future changes that will reflect a clearer understanding of site specifics such as permeability variations and well performance, there will be 1090 production wells and 1573 injection wells arranged typically in five-spot patterns averaging 7106ft^2 per pattern. Actual pattern geometry may easily vary from 70ft x 70ft to 100ft x 100ft. Powertech anticipates that there will be 778 delineation holes, assuming one hole for approximately 10,000ft^2 of active mining area.

The Centennial South will include four mining units on 5,573,210ft^2 (127.9 acres) of surface. Given the smaller pattern area noted previously for the southern well fields, there will be approximately 1149 production wells and 1730 injection wells and the five-spot patterns will average 4,850ft^2 per pattern. At a ratio of one delineation well for approximately 10,000ft^2 of active area, there will be 557 delineation wells.

Given uncertainty in average formation permeability and the methods of aquifer enhancement that have been proposed, SRK considers both well field designs to be aggressive.

Well Completion

Monitor, production, and injection wells will be drilled, logged and reamed to accommodate casing. Casing is set and cemented to isolate the completion interval from overlying aquifers. All production, injection, and monitor wells will be constructed with polyvinyl chloride following standard industry practices.

Well Casing Integrity

After a well is completed and before it is made operational, a mechanical integrity test (MIT) of the well casing will be conducted. The MIT method that will be employed is pressure testing.

If a well casing does not meet the MIT, the casing will be repaired and the well retested. If a repaired well passes the MIT, it will be employed in its intended service. Also, if the well defect occurs at depth, the well may be plugged back and recompleted for use in a shallower zone provided it passes a subsequent MIT. If an acceptable MIT cannot be obtained after repairs, the well will be plugged. A new well casing integrity test will also be conducted after well repair using a down-hole drill bit or under reaming tool.

Wells will be subject to MIT every five years of operational life.

Well Field Control

Well field flow regulation will be managed from portable well field header houses. The header house will contain the collection and distribution interfaces between the injection wells, collection wells, and process facility. A typical header house contains injection and collection manifolds, valves, and flow meters; all controlled on an individual well basis.

17.5.5 Processing Plant Design Concept

The processing plant for the Centennial Project will consist of a Central Processing Plant (CPP) and a Satellite Facility (SF). The CPP will be located at the North site and the SF will be located at the South site. Process flow diagrams for each site are presented in Appendix B.

Recovery of uranium by IX involves the following process circuits (described in detail in the following sections):

- Resin loading;
- Production bleed;
- Resin elution;
- Precipitation;
- Product washing, drying and packaging; and
- Radium removal from wastewater.

The Satellite Facility will only contain IX vessels for resin loading. The facility will be capable of processing 3,000gpm of lixiviant. The average uranium concentration for this design is 60ppm. Trucks will transfer resin between the Satellite Facility and the Central Processing Plant.

The Central Processing Plant will contain an IX process line, a precipitation circuit, and a washing, drying and packaging circuit. The IX loading vessels will be capable of processing 3,000gpm of 60ppm lixiviant. The elution, precipitation, product washing/filtering, drying and packaging circuits will be capable of processing more than 2,000lbs U_3O_8 per day (700,000lbs per year).

Resin Loading

Each resin loading circuit will consist of six pressurized vessels; each designed to contain a 500ft^3 batch of anionic ion exchange resin. These vessels will be configured in three parallel trains for two-stage down-flow loading. Booster pumps are located upstream and downstream of the trains.

As the pregnant lixiviant enters the IX circuit from the well field, the dissolved uranium in the pregnant lixiviant is chemically adsorbed onto ion exchange resin. Sand or silt entrained in the pregnant lixiviant will be trapped by the resin bed or guard column (similar to a traditional sand filter). The barren lixiviant exiting the second stage will normally contain less than 2ppm of uranium.

The lixiviant is composed of native ground water, carbon dioxide and oxygen. Carbon dioxide is to be added in the IX Facility, both upstream and downstream of the resin vessels. Oxygen is added to the barren lixiviant at the header houses prior to the injection manifold.

Elution Circuit

As resin in a first stage IX vessel becomes loaded, or saturated, and is removing very little additional uranium, the vessel is isolated from the normal process flow. The 500ft^3 batch of loaded resin is removed from the first stage vessel and replaced with stripped, or barren, resin. At the CPP, loaded resin is washed on vibrating screens to remove sand, and other trash particles. Resin is then gravity fed to the elution vessels to recover uranium and regenerate the resin.

Eluant (10% sodium chloride and 2% sodium carbonate) will be added to the elution vessels, stripping the resin of uranium and regenerating the resin for further use. Eluted, or barren, resin is then rinsed and returned to IX vessels for further loading. In some cases, it may be necessary to add an additional resin regeneration step to fully regenerate the resin. The elution process will consist of four stages: three (3) eluant stages will contact one 500ft^3 batch of resin with four bed volumes of eluant each and one (1) rinse stage will contact the batch with four bed volumes of fresh water. Uranium values (as uranyl carbonate) are then contained in the rich eluate solution.

Precipitation Circuit

Sulfuric acid is then added to the rich eluate to bring the pH down to the range of 2-3 where the uranyl carbonate breaks down, liberating carbon dioxide and free uranyl ions. In the next stage, sodium hydroxide (caustic soda) is added to raise the pH to the range of 4 to 5. After this pH adjustment, hydrogen peroxide is added (0.36lb H_2O_2/lb U_3O_8) through a batch process to form an insoluble uranyl peroxide (UO_4) compound; this precipitation takes up to 8 hours. After precipitation, the pH is raised to approximately 7 and the uranium precipitate slurry is pumped to a 30ft diameter thickener.

The precipitation cycle procedures and methods to be employed for this project have been used extensively in ISR programs and in conventional uranium milling operations and is a highly accepted and successful method of processing uranium.

Product Filtering, Drying and Packaging

After precipitation, the uranium precipitate, or yellowcake, is removed for washing, filtering, drying and product packaging in a controlled area. The yellowcake from the thickener underflow is washed to remove excess chlorides and other soluble contaminants. The slurry is then dewatered in a filter press and the filter cake is transferred in an enclosed conveyor directly to the yellowcake dryer.

The yellowcake will be dried in a low temperature (<300°F) vacuum dryer; which is totally enclosed during the drying cycle. The off-gases generated during the drying cycle will be filtered and scrubbed to remove entrained particulates. The water sealed vacuum pump will also provide ventilation while the dryer is being loaded and unloaded into drums by operators. Compared to conventional high temperature drying by multi-hearth systems, this dryer has significantly lower airborne particulate emissions.

By operating at low temperatures (<300°F), no measurable quantities of insoluble uranium solids are produced, further reducing environmental and occupational risks. This drying technology requires a high purity feed stock because operating temperatures are not sufficient to volatilize contaminates. The dried yellowcake is packaged into 55gal drums for storage before transport by truck to a conversion facility.

Radium Removal from Waste Water

Wastewater discharged from processing operations may be treated to remove radionuclides before disposal. Conventional treatment for radium is traditionally done with barium chloride ($BaCl_2$) treatment, resulting in the precipitation of a sludge that may be separated to decrease total volume for disposal. To achieve the separation of sludge from wastewater, a system of filtration tanks is employed with polymer addition, to aid in settling and filtering.

All treated and filtered water is then discharged via deep disposal well.

As one filtration tank reaches its sludge capacity, the tank will be disconnected from the system and allowed to further dewater by gravity. The remaining sludge can then be transported in the filter tank to a regulated disposal site.

The tanks are located on a curbed concrete pad to provide support and secondary containment. The concrete pad will be large enough to accommodate trucks to load/unload the filtration tanks. Due to the possibility of sustained below-freezing temperatures, the entire tank system is designed within a fully enclosed and heated building. SRK considers this processing facility design to be industry-standard.

17.5.6 Predicted Mass Balance

Powertech developed an inclusive predicted mass balance (see process flow diagrams in Appendix B). Lyntek independently spot checked key points in the process for the Centennial project using data from the Design Criteria. The predicted mass balance results for the Centennial IX circuit, Elution and Precipitation stage and Drying process are shown in Table 17.8, 17.9 and 17.10 respectively. The assigned head grade from the well field of 60ppm is based on Powertech's proprietary experience at similar plants.

Table 17.8: Predicted Mass Balance for Centennial Project IX Circuit

Item	Units	North Central	Satellite South
Head grade from well field to IX	lb/h U_3O_8	84.0	84.0
IX feed flow rate	Gpm	2,800	2,800
Head grade from well field to IX	g/L	0.060	0.060
Barren resin grade	lb/h U_3O_8	1.4	1.4
Barren resin mass flow	lb/h total	664	664
U_3O_8 on barren resin	lb/t	4.6	4.6
% Loading on barren resin		0.2%	0.2%
Loaded resin grade	lb/h U_3O_8	86.0	86.0
Loaded resin mass flow	lb/h total	748	748
U_3O_8 on loaded resin	lb/t	253.5	253.5
% Loading on loaded resin		11.5%	11.5%
Barren solution grade	lb/h U_3O_8	2.8	2.8
Barren solution flow rate	gpm	2,800	2,800
Barren solution grade	g/L	0.002	0.002
Total Recovery in IX Columns		97%	97%

Table 17.9: Predicted Mass Balance for Centennial Project Elution

Item	Units	Central North
Loaded resin grade	lb/h U_3O_8	86.0
Loaded resin mass flow	lb/h total	748
U_3O_8 on loaded resin	lb/t	253.5
% Loading on loaded resin		11.5%
1st stage elution recovery		87%
Recovered U_3O_8 in 1st stage	lb/h	74.8
U_3O_8 remaining on resin	lb/h	11.2
2nd stage elution recovery		70%
Recovered U_3O_8 in 2nd stage	lb/h	7.8
U_3O_8 remaining on resin	lb/h	3.4
3rd stage elution recovery		40%
Recovered U_3O_8 in 3rd stage	lb/h	1.3
U_3O_8 remaining on resin	lb/h	2.0
% Loading on barren resin		0.1%
Barren resin grade	lb/h U_3O_8	1.4
Barren resin mass flow	lb/h total	662
Total recovered U_3O_8	lb/h	84.0
Total recovery in Elution		**98%**

Table 17.10: Predicted Mass Balance for Centennial Project Precipitation and Drying

Item	Units	Central North
Feed head grade to precipitation	lb/h U_3O_8	84.0
Feed flow rate	gpm	7
Feed head grade to precipitation	g/L	23.624
Solid U_3O_8 precipitate recovered	lb/h U_3O_8	84.0
Slurry discharge flow rate	gpm	8
Total slurry mass flow	lb/h	4,020
Slurry % solids		2.1%
Thickener underflow	lb/h	870
Thickener underflow % solids		9.7%
Recovery in precipitation		100%
Feed flow to filter press	lb/h	870
Feed % solids		9.7%
Filter cake mass flow	lb/h	206
Filter cake % solids		40.8%
Dried yellowcake mass flow	lb/h	85
Dried yellowcake % solids		98.8%
Daily yellowcake production	lb/day	2,016

17.5.7 Predicted Water Balance

Uranium ISR is typically a water-intensive process; therefore, a significant amount of water is recycled through the system to reduce the water usage. The brine disposal system design is also dependent on the amount and quality of the wastewater produced. The wastewater disposal option investigated for the Centennial project was deep well disposal.

The Centennial project will have two sources of process water: local aquifers in the project area and fresh water (Colorado Big Thompson) from the North Weld County Water District (NWCWD). Water usage is grouped into the following categories:

- Production well field;
- Restoration well field;
- Pre-mining of areas which require water mounding;
- Hydraulic fencing of mounded areas;
- Central Processing Plant and Satellite Facility; and
- Drilling, road maintenance and other activities.

The production well field is estimated to operate at 0.5% to 1% bleed in order to maintain favorable hydraulic conditions; however, the disposal system has been designed to allow for a capacity for well field bleeds to operate at 3%. As Table 17.8 shows, a production flow rate of 2,800gpm (i.e., barren solution flow rate) is required to achieve the desired annual yellowcake production.

The water balance is divided into three stages; Stage 1 is production and restoration of mining units that do not require aquifer enhance, Stage 2 introduces the pre-mining of units requiring aquifer enhancement and Stage 3 is production and restoration of aquifer enhanced units after pre-mining is complete. The water balance will also vary between these three stages due to multiple situations occurring simultaneously.

Table 17.11 summarizes the predicted water balance for the Centennial project during the mine life. The water balance is divided into three stages:

- Stage 1 - production and restoration of mining units that do not require aquifer enhancement;
- Stage 2 - pre-mining of units requiring aquifer enhancement; and
- Stage 3 - production and restoration of aquifer enhanced units after pre-mining is complete.

The water balance will also vary between these three stages due to multiple situations occurring simultaneously.

Table 17.11: Predicted Water Balance for Centennial Project

	Water Balance (gpm)		
Stage	**1**	**2**	**3**
Production Wellfield			
Total CBT feed	28	28	500
CBT to hydraulic fencing outflow	-	-	472
CBT feed to production	28	28	28
Recycle	2772	2772	2772
feed to IX	2800	2800	2800
% bleed	1%	1%	1%
Restoration Wellfield			
Total CBT feed	150	500	395
CBT to hydraulic fencing outflow	-	-	245
CBT feed to restoration	150	500	150
Recycle	350	0	350
feed to IX	500	500	500
% bleed	30%	100%	30%
IX product split to pre-mining	-	100%	-
IX product split to pre-mining	-	500	-
CBT to pre-mining hydraulic fence	-	250	-
Ra Removal Tank System			
feed to Ra removal tanks	187	37	187
CPP & Site Facilities			
local aquifer water feed	12	12	12
feed to brine accumulation pond	9	9	9
evaporation	1	1	1
septic system	2	2	2
Drilling, Roads, etc.			
local aquifer water feed	37	37	37
Total from local aquifer	49	49	49
Total from CBT	178	778	895
Total to Deep Disposal Well	187	37	187

17.5.8 Design and Selection of Major Equipment

Some major equipment was sized so that the selected unit was appropriate for its duty. These sizes were then reviewed against the Powertech equipment selection and quotes were used in the capital cost estimate.

17.5.9 IX Vessels

The IX Vessels were sized using a fixed diameter of 12ft and a resin volume of 500ft^3 and the results are shown in Table 17.12. Quotes were obtained from manufacturers for 12ft-diameter x 8ft-height IX Vessels which were suitable for this duty and these quotes were used in the capital cost estimate.

Table 17.12: IX Vessel sizing for Centennial

Item	Units	IX Vessels
Vessel height TT	ft	10
Vessel internal diameter	ft	12
Vessel volume	ft^3	1131
Vessel volume	gallons	8,460
Resin in each vessel	ft^3	500
Resin av. bulk density	lb/ft^3	42
Number vessels		10
Resin bed height	ft	4.4
Est. % resin swelling	%	80%
Required Vessel Height	**ft**	**8**

17.5.10 Yellowcake Thickener

A 30ft diameter thickener was selected for this Project, as additional storage capacity of yellowcake slurry was required by Powertech. This size thickener is more than adequate for this operation and is typical in industry for this size operation.

17.5.11 Filter Press

The filter presses were sized based on the required yellowcake production in lb/day and the results are shown in Table 17.13. Quotes were obtained for 50ft^3 sized filter presses and these are included in the capital cost estimate.

Table 17.13: Filter Press sizing for Centennial

Item	Units	Centennial
Daily U_3O_8 production required	lb/day	2,000
$UO_4.2H_2O$	U_3O_8	1.20
Filter cake $UO_4.2H_2O$	lb $UO_4.2H_2O$	2,408
Discharge from Press	% solids	50%
Free H_2O	lb H_2O	2,408
Density of $UO_4.2H_2O$	g/cc	5.2
Density of $UO_4.2H_2O$	lb/ft^3	324.63
Volume of $UO_4.2H_2O$	ft^3	7.42
Volume free H_2O	ft^3	38.57
Total Discharge Volume	**ft^3**	**46**

17.5.12 Yellowcake Dryer

The industry standard type of dryer for yellowcake produced in both ISR and modern conventional uranium recovery plants is a vacuum paddle dryer. This is an indirectly heated dryer consisting of a cylindrical shell with the axis horizontal and a heating jacket. A paddle system, based on a horizontal shaft, agitates the contents of the dryer. A vacuum is drawn on the dryer to cause the water in the product to evaporate at lower temperatures than atmospheric pressure. These dryers are widely used in the pharmaceutical industry.

In uranium production, these dryers have several advantages, primarily in control of the process and also in controlling yellowcake dust emissions. The vapor and air are drawn from the drying chamber then flow through a filter system, then into a condenser and liquid ring vacuum pump. Yellowcake dust that might pass through the filters will be collected in the condenser or seal water for the vacuum pump and then will return to the process.

These are batch dryers and typically take 16 hours to process a batch in uranium applications. A batch will be one day of production of yellowcake. The dryer volume chosen will be twice that of the batch of yellowcake slurry that will be fed to the dryer. For instance, production of 700,000lb/y of U_3O_8 will require drying of approximately 2,310lb/d of uranium peroxide ($UO_4 \cdot 2H_2O$) product. At a typical feed slurry mix of 35% solids by weight, this will occupy 98 ft^3. The vacuum paddle dryer volume required will therefore be 196 ft^3. Vacuum paddle dryers are available in a wide range of sizes, with units that can produce 2,000,000lb/y of U_3O_8 readily available.

17.5.13 Radium Filter Tank System

The design of the radium removal system assumes a feed rate of 250gpm of wastewater. Including the addition of barium chloride and flocculant, the total sludge removed is expected to be approximately 1676ft^3/y. The sludge is classified as an 11e.(2) hazardous waste and two to three loaded filter tanks will be taken for disposal each year. After the sludge has been unloaded at a licensed disposal site, the filter tank will be returned to the mine site for further use.

17.5.14 Major Buildings

The following design assumptions were made for the CPP and satellite plant:

- ISR daily yield, 9t resin;
- Assume design to be a fully loaded 25t, tandem axle, dual wheel truck based on Powertech design;
- Expected project life span based on current reserve studies – 6 years and 15 years;
- Design loads based on AASHTO design Tandem Load Vehicle with 25 kip load on each axle, which is conservative; and
- Soil conditions are unknown, but are likely clays and dense sand. The assumed sub-grade modulus, k = 250 psi/in (average value).

Based on Lyntek's design assumptions, the main floor slab in the Centennial Project's Central Processing Plant is appropriately designed at 12in thick with double steel reinforcing. This design is sufficient for the proposed activities of the building.

17.5.15 Product Handling and Storage

The yellowcake drying and packaging stations will be segregated within the processing plant for worker safety. Dust abatement and filtration equipment will be deployed in this area of the facility. Storage of yellowcake drums will be in a dedicated and secured storage room while they await transport.

17.5.16 Transport

Following standard industry protocols, yellowcake will be transported in 55gal steel drums. The shipment method will be via specifically licensed trucking contractor. Approximately 240 shipments of 40 drums each are estimated from the Centennial Project of the life of the mine based upon the present resource estimate.

17.5.17 Mobile Equipment

Major required mobile equipment will include resin haul tractors and trailers to deliver loaded resin from the satellite facility to the central processing plant, pump hoists, cementers, forklifts, pickups, logging trucks, and generators. In addition, several pieces of heavy equipment will be on site for excavation of mud pits, road maintenance, and reclamation activities.

17.5.18 Equipment Maintenance and Facilities

Dedicated maintenance facilities will be constructed along with the central processing plant. In addition to maintenance of mobile equipment, the most commonly overhauled equipment will be the submersible pumps utilized on the recovery wells.

17.5.19 Liquid Waste Disposal

Powertech retained Petrotek to prepare the preliminary conceptual design and cost estimate for a deep disposal well at the Centennial Project. It was estimated that an injection well depth of 11,000ft would be suitable for the disposal of wastewater produced during the life of mine. Powertech intends to construct two deep disposal wells at the Centennial Project.

Powertech is also investigating the use of land application of treated water as a method of disposal. For the purposes of this Preliminary Assessment, only deep well injection was considered in the economic analysis.

17.5.20 Solid Waste Disposal

Solid wastes at an ISR facility include, but are not limited to, spent resin, empty packaging, tank sediments and filtration products, motor vehicle maintenance waste, office waste, and clothing. All waste materials will be reviewed and entered into waste stream classifications on site.

Waste classified as non-contaminated (non-hazardous, non-radiological) will be disposed of in the nearest permitted sanitary waste disposal facility. Waste classified as hazardous (non-radiological) will be segregated and disposed of at the nearest permitting hazardous waste facility. Radiologically contaminated solid wastes, that cannot be decontaminated, are classified as 11e. (2) byproduct material. This waste will packaged and stored on site temporarily, and periodically shipped to a licensed 11e. (2) byproduct waste facility or a licensed mill tailings facility.

17.6 Personnel

The present work force estimates for the Centennial Project during full operation of the Central Processing Facility, Satellite Facility, and all associated well fields is 53 full time staff. In general the work force can be segregated into the following groups: administration (7 staff), radiation safety (3 staff), geology (3 staff), construction/drilling (5 staff), and production (35 staff). Staff schedules will vary based upon duty; some will work a typical 8 hr day, 40 hrs per week, while others will work a shift schedule to cover 24hr operations of the facility. Additionally, a significant number of contracted persons are expected to work at the project on a full time basis to perform drilling and construction activities.

17.7 Markets

The uranium commodity markets are volatile, and have ranged from a high of USD138/lb of U_3O_8 in June of 2007, to a present day spot price of USD41.75/lb on July 19, 2010 (The Ux Consulting Company, LLC). Due to the increased focus on nuclear energy, and the potential for uranium supply issues related to expansion of the industry, long-term contract prices are higher than the spot price. Long-term contact prices as of July 2010 are at approximately USD60/lb U_3O_8, with each contract having some variance due to individual pricing terms and potential for adjustment over the sales period. Given the high variability of uranium sales price, and potential for large swings, the sales price is a concern of the economic analysis.

17.8 Contracts

Powertech has no contracts presently in place for production from the Centennial project. This includes sales contracts, tolling agreements, or other financial arrangements with other parties associated with the purchase or price of final uranium product.

17.9 Environmental Considerations

17.9.1 Aquifer Restoration

After economic recovery in a well field has ceased, aquifer restoration will commence as soon as practical. Aquifer restoration will require the circulation of native groundwater and extraction of mobilized ions through reverse osmosis treatment. The intent of aquifer restoration is to return the groundwater quality parameters to that reported during the baseline studies.

17.9.2 Reclamation

Following completion of economic recovery from a mine unit, aquifer restoration will commence as soon as operationally practical. The restoration of some mine units may be postponed in whole, or in part, so as to limit interference with adjacent mine units. Once aquifer restoration is completed, and the regulatory objectives have been met, pumps and injection lines will be removed from the wells. Wells will be abandoned with a bentonite or cement based grout following the requirements of the DRMS. Final requirements for reclamation will be dependent on the outcome of rule-making under House Bill 2008-1161, as discussed in Section 2.5.

Simultaneous with well abandonment operations, pipelines will be removed from the mine unit, tested for radiological contamination, and segregated for appropriate disposal. Header houses will be removed to other mine units, or radiologically surveyed, demolished, and appropriately disposed of. Other facilities, including the process plant, offices, warehouses, laboratory, and maintenance buildings will be radiologically surveyed, dismantled and/or demolished, and disposed of according to individual waste profiles.

Following well field abandonment and site dismantling and demolition, the site will be regraded to approximate the pre-existing topography. Topsoil stockpiled at the start of development will be placed across the site and disturbed areas will be re-seeded.

17.9.3 Closure Costs

Total closure costs are based upon 2010 dollars and material volumes developed in conjunction with this Preliminary Assessment. Closure costs are included in the well field restoration costs, and are represented in the model as operating costs.

17.10 Taxes and Royalties

17.10.1 Production Taxes

Production taxes in Colorado include property tax, sales and use tax and severance tax. SRK applied the property tax and severance tax estimates prepared by Lyntek in the Technical Economic Model described in Section 17.11.

Lyntek prepared the following property tax description for the Project. The Office of the Weld County Assessor provides a description of how property tax is calculated for business and industry in Colorado using an assessment rate of 29%. The general equation is:

Assessed Value = Assessment rate (29%) x Actual Value

Property Taxes = Assessed Value x Tax Rate.

In 2008, the average Tax Rate for Weld County was $71.333/$1000 (i.e., 7.13%).

According to the Colorado State Assessor Guidelines and Office of the Weld County Assessor, there are three approaches to calculating the Actual Value:

- Market Approach – actual value of the subject property is based on an analysis of arms length sales of similar properties;
- Cost Approach – actual value of the subject property is based on an estimate of the cost to replace the property with a substitute that is equivalent in function and utility. Accumulated depreciation is subtracted from the new replacement cost to arrive at the conclusion of value;
- Income Approach – the annual net income of the subject property is capitalized to account for a typical investor’s financial return on the investment.

The County Assessor will determine which approach is appropriate. For the purpose of this PA, although the regulatory language is not completely transparent, Lyntek recommends that the income approach be used because this method is common in determining value and the taxes are based upon real, financial figures that the mining company reports publicly and that are checked by audits. Based on the income approach, the total property tax per pound of U production is $0.50.

SRK notes that purchases of equipment and supplies are subject to sales and use tax. The State imposes a tax ranging from 2.9% to over 8.0% depending on local options. Project economics presented in this report have sales and use tax included in the operating cost estimate.

Lyntek prepared the following description of applicable severance taxes for the Project:

"For taxable years commencing prior to July 1, 1999, the Colorado Severance Tax is defined as follows (Session Laws of Colorado, 1999):

Colorado Severance Tax Rate

Amount of Gross Income	Percentage Tax on Gross Income
First $19,000,000	None
Amount exceeding $19,000,000	2.25%

Lyntek further quotes:

"According to the Session Laws of Colorado, 1999:

'There shall be allowed, as a credit against the tax computed in accordance with subsection (1) of this section, an amount equal to all ad valorem taxes assessed during the taxable year in the case of accrual basis taxpayers or paid during the taxable year in the case of cash basis taxpayers on producing mines valued for assessment pursuant to 39-6-106. Such credit shall not exceed fifty percent of the tax computed in accordance with subsection (1) of this section.' "

Finally, Lyntek concludes:

Severance Tax = [(Gross Revenue - $19,000,000) * 2.25%] – Property Tax with a maximum of 50% of severance tax without deduction.

17.10.2 Income Taxes

Federal Income Tax

In general, corporate Federal income tax is determined by computing and paying the higher of a regular tax or a tentative minimum tax (TMT). If the TMT exceeds the regular tax, the difference is the alternative minimum tax (AMT).

Regular tax is determined by subtracting all allowable operating expenses, overhead, depreciation, amortization, and depletion allowance from total current-year revenues to arrive at taxable income. Deductions for exploration and development are either expensed or amortized. The tax rate is determined from a progressive rate schedule outlined by the Internal Revenue Service.

The second Federal corporate tax, the AMT, is determined in three steps. First, regular taxable income is adjusted by recalculating certain regular tax deductions, based on AMT laws, to arrive at AMT income (AMTI). Secondly, the AMTI is then multiplied by 20% to determine the TMT. Finally, if the TMT exceeds the regular tax, the excess is the AMT amount, payable at year-end, in addition to the regular tax liability. The AMT tax paid can be used to offset regular tax payable in succeeding years in which the regular tax is greater than the TMT.

An estimate of federal income tax for Powertech is not included in the technical economic model.

State Income Tax

The Colorado corporate income tax rate is 4.63% applied to net income. Colorado income is apportioned by a two or three factor formula. A deduction is allowed for depletion, but not for federal income taxes paid.

An estimate of Colorado income tax for Powertech is not included in the technical economic model.

17.10.3 Royalties

The project is subject to a 2% surface and a 5% mineral royalty. Each royalty is assessed on gross proceeds.

17.11 Technical Economics

All costs presented in this report were provided to SRK for review and evaluation. Powertech provided access to an internal engineering economic assessment and Lyntek's report titled "Preliminary Economic Assessment, Centennial ISR Project", with an effective date of March 1, 2010. To meet the needs of a Preliminary Assessment, costs must be presented at ±35 to 40%. Powertech compiled a number of vendor quotes for capital expenditures, and therefore some costs provided are defined to a pre-feasibility level.

17.11.1 Capital Costs

Life of Mine (LoM) capital costs excluding mine closure will total USD129.3million as summarized in Table 17.14. Pre-production capital costs are USD71.1million. Ongoing capital, totaling USD58.2million accounts for the remaining mine life. Capital cost estimates are in Q1 2010 US constant dollar terms.

Capital-related labor costs and owner costs were estimated separately and are therefore shown as specific line items. Replacement capital represents the provision for mobile equipment used throughout the Project.

Table 17.14: Capital Cost Summary ($000s)

Description	Initial Cost	Sustaining Cost	LoM Cost
CPP/Gen Facilities	$43,874	$11,223	$55,097
Well Fields	$5,359	$8,849	$14,208
Capital Labor	$852	$823	$1,675
G&A	$9,142	$4,463	$13,605
Replacement Capital	$0	$12,568	$12,568
subtotal	**$59,227**	**$37,926**	**$97,153**
Contingency	$11,845	$7,585	$19,547
Mine Closure	$0	$12,584	$12,584
Total	**$71,073**	**$58,213**	**$129,286**

CPP (Central Processing Plant)) and generating capital details are shown in Table 17.15. Initial capital costs of USD43.9million are for the general construction and equipment to bring the project online. Sustaining costs of about USD11.2million are associated with well restoration and reclamation activities for the operation.

Table 17.15: CPP & Generation Facilities ($000s)

Description	Initial Cost	Sustaining Cost	LoM Cost
CPP	$21,625	$0	$21,625
Satellite Plant	$0	$7,195	$7,195
Electrical Infra	$1,047	$0	$1,047
Surface Impound	$1,170	$0	$1,170
CPP/SF Pipelines	$1,705	$0	$1,705
Deep Disposal Wells	$4,329	$0	$4,329
H2O Supply	$9,024	-$580	$8,445
Restoration Equip	$0	$4,608	$4,608
Mobile Equipment	$4,974	$0	$4,974
Total	**$43,874**	**$11,223**	**$55,097**

Capital costs associated with the well fields are shown in Table 17.16. Development is relatively uniform over the LoM with delineation drilling required only during the pre-production year.

Table 17.16: Well Field Capital ($000s)

Description	Initial Cost	Sustaining Cost	LoM Cost
Delineation Drilling	$934	$0	$934
Well Construction	$3,062	$6,124	$9,185
Surface Construction	$1,061	$2,123	$3,184
Pipelines	$302	$603	$905
Total	**$5,359**	**$8,849**	**$14,208**

Working Capital

SRK estimates working capital as 20% of production costs.

17.11.2 Operating Costs

LoM operating unit costs are estimated to total USD332.8million as shown in Table 17.17. This results in an operating unit cost estimate of USD34.95/lb U_3O_8. Operating costs account for USD279.6million (USD29.36/lb U_3O_8) of the total. A contingency of 20% is applied to all operating costs.

Production taxes of USD53.2million (USD5.59/lb U_3O_8) make up the difference. Cost estimates are in Q1 2010 US constant dollar terms.

Table 17.17: LoM Operating Costs

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Central Plant/Ponds	$61,919	$6.502
Satellite/Well Field	$135,862	$14.267
Restoration	$9,404	$0.988
Decommissioning	$4,466	$0.469
Site Management	$21,339	$2.241
Contingency	$46,598	$4.893
Production Taxes	$53,231	$5.590
Total	**$332,819**	**$34.950**

Operating cost details are shown in Tables 17.18 to 17.22.

Table 17.18: Central Plant and Ponds Operating Costs

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Labor	$18,180	$1.909
Electricity	$24,112	$2.532
Chemical	$5,755	$0.604
Hardware Maintenance/Replacement	$8,151	$0.856
Laboratory	$412	$0.043
Materials/Consume	$4,478	$0.470
Byproduct Disposal	$762	$0.080
Monitoring	$68	$0.007
Total	**$61,919**	**$6.502**

Table 17.19: Site/Well Field Operating Costs

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Delineation Drilling	$2,493	$0.262
Well Construction	$47,335	$4.971
Surface Construction	$22,516	$2.364
Pipelines	$4,347	$0.457
Development Labor	$7,687	$0.807
Operating Labor	$11,706	$1.229
Electricity	$4,524	$0.475
Chemical	$23,147	$2.431
Maintenance	$1,924	$0.202
Laboratory	$0	$0.000
Materials/Consume	$44	$0.005
Water Rights Usage	$9,120	$0.958
Byproduct Disposal	$608	$0.064
Monitoring	$412	$0.043
Total	**$135,862**	**$14.267**

Table 17.20: Restoration Operating Costs

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Labor	$616	$0.065
Electricity	$2,393	$0.251
Chemical	$158	$0.017
Maintenance	$5,904	$0.620
Byproduct Disposal	$263	$0.028
Monitoring	$70	$0.007
Total	**$9,404**	**$0.988**

Table 17.21: Decommissioning Operating Costs

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Well Closure	**$4,466**	**$0.469**

Table 17.22: Site Management Operating Costs

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Labor	$14,311	$1.503
U3O8 Transport Costs	$1,428	$0.150
Corporate Overhead	$5,600	$0.588
Total	**$21,339**	**$2.241**

Production taxes, as described in Section 17-10 are shown in Table 17.23.

Table 17.23: Production Taxes

Description	LoM Cost ($000s)	Unit Cost ($/lb U_3O_8)
Severance Tax	$4,928	$0.518
Surface Royalty	$12,380	$1.300
Mineral Royalty	$30,949	$3.250
Property Tax	$4,974	$0.522
Total	**$53,231**	**$5.590**

17.11.3 Economic Analysis

The technical-economic results of this report are based upon work performed by Powertech's consultants and have been prepared on an annual basis. All costs are in Q1 2010 US constant dollars.

Model Inputs

The technical-economic model, shown in Exhibit 17.1, is presented on an unleveraged, pre-tax basis. Assumptions used are discussed in detail throughout this report and are summarized in Table 17.24.

Table 17.24: Technical-Economic Model Parameters

Model Parameter	Technical Input
General Assumptions	
Pre-Production Period	1 Year
Mine Life	14 years
Operating Days per year	365 days/yr
Market	
Discount Rate	8%
U_3O_8 Price	$65.00/lb
Transportation to market	$0.15/lb

A 12-month pre-production rate is used in the analysis implicitly assuming that permitting, detailed engineering, and due diligence/financing are well under way. The Project will have an estimated life of 14 years given the mineable resource described in this report.

Revenue from U_3O_8 sales are based upon a market price of USD65.00/lb. Freight charges are assumed to be USD0.15/lb.

Technical-Economic Results

The base case economic analysis results, shown in Table 17.25, indicate a pre-tax NPV of USD51.8million at an 8% discount rate with an IRR of 18%.

Table 17.25: Technical-Economic Results ($000s)

		units	Value
Net Revenue			
U3O8 Price ($/lb)		$/lb-U3O8	$65.00
Prod.		klbs	9,523
	Gross Revenue	**$000s**	**618,983**
Transportation		$000s	(1,428)
Severance Tax		$000s	(4,928)
Surface Royalty		$000s	(12,380)
Mineral Royalty		$000s	(30,949)
Property Tax		$000s	(4,974)
	Net Revenue	**$000s**	**564,324**
Production Costs			
Central Plant/Ponds		$000s	61,919
Satellite/Well Field		$000s	135,862
Restoration		$000s	9,404
Decommissioning		$000s	4,466
G&A Labor		$000s	14,311
Corporate Overhead		$000s	5,600
Contingency		$000s	46,598
	Production Costs	**$000s**	**278,160**
	Gross Margin	**$000s**	**286,164**
Project Capital (Equity)		$000s	(129,286)
Income Tax		$000s	0
	Free Cash Flow	**$000s**	**156,878**
	IRR	**-**	**18%**
	Present Value	**-**	**51,774**

Sensitivity

Table 17.26: Price Sensitivity of the Technical Economic Model

Item	Units				
U_3O_8 Price	$/lb	$42	$60	$65	$80
Free Cash Flow	$000s	(38,916)	$112,159	156,878	$285,356
IRR	$000s	-7%	13%	18%	32%
$PV_{8\%}$	$000s	(56,334)	$27,076	51,774	$122,728