Section C

Project Description

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C PROJECT DESCRIPTION

The Grassy Mountain Coal Project (the Project) that is being proposed by Benga Mining Limited (Benga), a wholly-owned subsidiary of Riversdale Resources (Riversdale), is expected to produce approximately 4.5 million clean metric tonnes (CMT) annually of export metallurgical coking coal at full production levels. The mine life is estimated to be 24 years, including a pre-development year and excluding final closure and reclamation. The mining method will be a large scale integrated truck and excavator operation. Mine production equipment will consist of rotary blast-hole drills, hydraulic mining shovels and backhoes, front-end loaders, track dozers, large off-highway haul trucks, and typical mining support equipment. Clean coal production will increase from approximately 1.9 million CMT in the first production year to its designed nominal capacity of 4.5 million CMT annually by the fourth production year. A clean coal production level of 4.5 Mt annually will be maintained for most of the mine life with production levels averaging closer to 3.8 million CMT over the least 9 years of the mine life. Mine operations will be scheduled 24 hours/day, 360 to 365 days/year.

The following is a summary of the physical works associated with the designated project:

Mine Activities

- open pit truck and shovel mining operations area;
- waste rock disposal areas (north and south of the pit area, in addition to in-pit);
- internal haul roads; and
- topsoil storage area.

Coal Handling and Processing Plant (CHPP)

- run-of-mine (ROM) raw coal receivable bin where mine trucks dump the mined coal, which includes a feeder breaker;
- sizing station;
- ROM raw coal stackers and stockpiles;
- a coal processing plant (CPP) feed surge bin;
- a single module CPP;
- two product coal radial stackers and stockpiles;
- four product coal stockpile reclaim feeders;
- a product coal surge bin;
- overland conveyor;

- train loading bin;
- a road system that connects the main infrastructure items of the CHPP including an overland conveyor service road;
- a road system that connects the CHPP to the MIA;
- power, water and control facilities routed between the main CHPP infrastructure;
- CHPP maintenance workshop;
- CPP process flocculant, diesel, MIBC, magnetite and propane storage facilities; and
- CHPP control room and ablution facilities.

Rail Load-out Facilities

- rail track that allows trains to exit the main rail line to a siding loadout area;
- train loadout facility;
- a tie-in system to the main Canadian Pacific Rail (CPR) track network;
- an operations and controls office including portable sewage waste storage tanks;
- power supply and transmission to the train loadout area will be provided from the main mine site electrical network, or the local electrical network; and
- telecommunications provided from main mine site network.

Roads

- access road from Highway 3 to the mine infrastructure area (approximately 7 km);
- access road system from the mine infrastructure area to the mine pit operations; and
- service road system from the mine infrastructure area to the CHPP infrastructure and train loadout area.

Water Management

- water management structures including raw water wells for groundwater, CHPP reservoir, storage tanks, distribution pipe network;
- series of collection ditches and settling ponds (five release ponds);
- series of collection ditches and surge ponds (three ponds that do not release); and
- site wide drainage civil works.

Mine Infrastructure Area (MIA)

- administration office building;

- security building;
- washroom and ablution facilities;
- mine mobile equipment maintenance workshop;
- mobile equipment wash bay;
- mobile equipment fueling station;
- warehouse and storage; and
- an explosives storage and mixing facility.

Initial Site Construction Camp

- 228 room camp (expandable to 360 rooms);
- dining hall, recreation and laundry facilities;
- potable water (hauled in *via* truck and stored in tanks);
- sewage management (stored in tanks and hauled away *via* trucks);
- power; and
- HVAC (*via* propane tank).

The Project's proposed footprint is illustrated in Figure A.1.0-2. The following sections provide a more detailed description of each Project component and associated activities.

C.1 Mining Activities

Coal will be mined from three coal seam groups: Seam No. 1; Seam No. 2; and, Seam No. 4. The ROM coal will be loaded by hydraulic backhoes into large end-dump haul trucks (220 tonne) and hauled to the raw coal dump located near the southern extents of the proposed mining pit.

Mining activities will consist of the following:

- clearing, logging and grubbing;
- single lift coversoil removal and salvage;
- coal and rock drilling and blasting;
- coal and rock loading and hauling;
- rock disposal area grading;
- coal processing reject material disposal;
- haul road maintenance;
- surface water management;

- coversoil re-distribution;
- re-vegetation and reforestation; and
- general mining operations support.

All ROM coal will be crushed and transported *via* overland conveyor from the ROM truck dump to the CPP for cleaning. The clean coal leaves the CPP by overland conveyor and is sent to the clean coal stockpile facility south of the CPP facilities. The clean coal product will then be transported to the rail load-out facility *via* overland conveyor.

During the initial years of mining, rock will be transported by haul trucks to the south rock disposal area located near the southern extents of the mine (Figure A.1.0-3). As soon as pit areas have been completed, and all rock and coal material is removed, these areas will receive rock material for in-pit disposal. As mining progresses, the rock disposal area will continue to advance in height and extent. In Year 6, the north rock disposal area (NRDA) is established at the northwest of the ultimate pit extent. The north and south rock disposal areas will ultimately tie into the pit area and a single disposal area will be created. At closure, on an area basis, approximately 74% of the ultimate pit will have some level of in-pit backfill.

Coarse and fine coal processing reject material will be sent to a reject bin where it will be loaded into off-road haul trucks and transported to the active rock disposal areas for co-disposal with the rock material.

C.1.1 General Mine Planning Criteria

The general mine planning criteria applied to the project are summarized below:

- rock disposal angle of repose – 37°;
- final rock disposal area re-sloped angle – 23°;
- overburden, interburden and parting swell factor – 25%;
- coal swell factor – 30%;
- mining benches will be developed in 15 m lifts;
- rock dumps are progressively re-sloped as dump advance permits;
- pit disturbance and rock disposal area offset to Blairmore and Gold Creeks – 100 m;
- topsoil removed in advance of mining and beneath rock disposal areas one year prior to development;
- reject material swell factor – 20%;

- CPP coarse rejects are combined with the dewatered tailings rejects (which is the form of a cake) and then conveyed to the reject located just to the north of the CPP;
- reject material will be made up of approximately 60-65% coarse (+1.7 mm), 20% fines (-1.7 mm +0.25 mm) and 15-20% ultra-fines (-0.25 mm) material;
- reject material expected total moisture is between 17% and 20%; and
- reject material will be placed in cells within the interior of the active rock disposal areas.

Based on the geotechnical design criteria for the mine, the SRDA and NRDA will be constructed in lifts from the bottom up measuring 20 m to 40 m in height.

Pit highwalls will be excavated at slopes measuring between 60 to 70°, depending on the location within the pit. Catch benches measuring between 10 m to 12 m in width will be established in the highwall every 15 m to 30 m of height. Footwalls within the western and central fault blocks of the pit will generally follow the bedding plane dip angle, with 8 m catch benches established every 45 m in height where the bedding dips are greater than 35°. Eastern pit footwalls will be constructed at a 70° angle, with 8 m catch benches every 15 m of bench height where the bedding dips are greater than 35°. Endwalls are designed at 70° throughout the pit. The endwalls will be constructed to include catch benches measuring 10 m in width for every 30 m of height. The detailed geotechnical design criteria for the mine are provided in Section B.8.6.

C.1.1.1 Description of Mining

The proposed pit is approximately 6 km long and up to 1.8 km wide. The maximum pit depth is approximately 430 m at the north-central area of the pit. The proposed pit shell contains 168 million RMT of run of mine coal which will produce, after washing, 93 million CMT. This will require the removal of 854 million BCM of overburden resulting in an product strip ratio of 9.2:1 BCM/CMT. The average processing yield is expected to be 55.2%. All ROM coal will be washed. Coal processing will be processed on an individual coal seam basis (*i.e.* Seam No. 1, Seam No. 2, or Seam No. 4). Truck/shovel/excavator mining methods will be used for all primary mining operations.

C.1.1.1.1 Minimum Mineable Thickness

As discussed in Section B.7.2, the modelled coal seams were evaluated individually and in combination within overlying and underlying parting and coal seams to develop mineable coal working sections for recovery during the mining operation within the three targeted coal seams. The resultant coal seam working sections range in thickness from a minimum of 0.6 m to 9.6 m, with approximately 90% of the coal falling within the 1.5 m to 7.5 m thickness range. The number of working sections within a given coal seam varies by location and mining bench across the site. For Seam No. 1 and Seam No. 4, the number of working sections varies from one to five across the pit,

while one and three working sections are recovered within Seam No. 2. The majority of the coal in Seam No. 1 and Seam No. 2 occurs in one to two working sections per bench, while the majority of Seam No. 4 coal exists in two to three working sections per bench.

C.1.1.1.2 Dilution and Coal Loss

In general, a 15 cm loss of coal at the seam roof contact was assumed along with 15 cm out-of-seam-dilution (OSD) at the seam floor for coal seam working sections dipping greater than 35°. Where the dip of the working section is less than 35°, the roof loss and floor OSD thickness was reduced to 10 cm. The assumptions applied for loss and dilution are further detailed in Section B.7.2.

The mine plan is based on drilling through and decking within the coal seams for blasting the interburdens and partings above and below each working section. Partings and interburdens measuring less than 1.5 m in thickness will be decked with the overlying and underlying coal seam working sections. Coal will be loaded by the primary coal excavators into the coal haul trucks. A small backhoe will work in conjunction with the loading machine to clean and minimize loss and dilution. Partings or interburden less than 1.5 m will be ripped by dozers. Partings greater than 1.5 m will be blasted using the 270 mm (10 5/8″) diesel drill fleet as required. All interburden and parting material will be loaded into mine rock trucks and hauled out of pit.

C.1.2 Mine Design and Optimization

C.1.2.1 Mine Design Overview

The Grassy Mountain property is defined by steep mountainous terrain. Blairmore Creek and Gold Creek are located to the west and east of the Project. Both watercourses are considered environmentally sensitive and development will not directly impact either one. Three steeply dipping and repetitively faulted parent coal seams outcrop parallel to these creeks near the peak of the mountain. Increasing overburden depth and thinning coal seams prevent the proposed pit from continuing further to the north and south.

For pit targeting and optimization purposes during Riversdale's 2014/2015 feasibility study, external constraints were applied which limited the lateral extent of the targeting pits. These targeting constraints are summarized below:

- historical underground mining Seam No. 1 and Seam No. 2 constrained the proposed pit to the southwest due to uncertainty of the extent and status of the old underground workings; and
- a minimum 100 m offset from Blairmore Creek further constrained the pit to the west.

In consideration of these limiting factors, the primary opportunity for pit expansion as determined by the pit finding exercise was to the northwest and north central portions of the Grassy Mountain resource area.

For pit targeting and optimization, the reserve model was converted to a block model and transferred to Maptek's Vulcan software, where pit targeting was completed using the Lerchs-Grossman optimization engine. The spatial constraints noted above were applied to the block reserve model prior to pit optimization. Any reserves located within the indicated historical underground mining area were removed from the model. Potential mine rock disposal area needs were considered as part of the pit targeting exercise; however, hard limits were not added to the reserve model for this constraint.

Pit targeting unit cost input values were developed and applied to the block model. The economic targeting input parameters were derived from mine plan quantities and cost estimates developed for a preliminary mine plan for the Grassy Mountain Project in early 2015. Table C.1.2-1 summarizes the input parameter unit costs applied for pit targeting and optimization. All unit values, with the exception of revenue, are stated in second quarter 2015 Canadian dollars (CAD). Royalties were taken out of the clean coal selling price after conversion from U.S. dollars (USD) to CAD.

The economic input parameters shown in Table C.1.2-1 were applied to the block model rock volumes, ROM coal tonnages and CMT on a unit basis. Pit geometry for initial pit targeting was defined by an overall highwall slope of 45° and the coal seam bedding plane dip for the footwalls. The Lerchs-Grossman algorithm was used to generate multiple nested pits using the static input unit costs with a range of clean coal selling prices of USD$90 to USD$170.

Table C.1.2-1 Pit Optimization Unit Cost Inputs

Category	Value	Units
Topsoil Salvage	$0.06	CAD$/BCM
Mine Rock Drill & Blast Costs	$0.94	CAD$/BCM
Mine Rock Load & Haul	$2.43	CAD$/BCM
Mine Rock General Mine Expense	$0.80	CAD$/BCM
ROM Coal Load & Haul	$2.14	CAD$/ROM t
ROM Coal General Mine Expense	$0.93	CAD$/ROM t
ROM Coal Processing	$3.41	CAD$/ROM t

Table C.1.2-1 Pit Optimization Unit Cost Inputs

Category	Value	Units
Coal Refuse Disposal to ROM Stockpile	$0.60	CAD$/ROM t
Mine Rehabilitation	$0.50	CAD$/ROM t
Coal Rail Transport & Port Fees/Marketing & Testing	$40.00	CAD$/CMT
Site Administration	$5.01	CAD$/CMT
Royalty	1% of Revenue	CAD$/CMT
Revenue*	Variable	USD$/CMT

C.1.2.2 Economic Pit Results

The pit targeting analysis resulted in a series of nested pits all containing increasing coal and rock tonnages with increased coal price. Revenue values ranging from USD$90 to USD$170 per CMT were used for the initial targeting pits. These revenue factors produced pits containing 51 CMT at USD$90 and 125 million CMT at USD$170.

The varying pit extents using various price points for the coal are shown on Figure C.1.2-1. During the feasibility study the pit finding exercise demonstrated that opportunity for pit expansion would be to the north once all other constraints had been applied. The figure also shows the ultimate pit boundary, which was developed based on the $100 pit extent and limited to the north due to marginal stripping ratios.

Spatial constraints applied during the feasibility study to the pit finding exercise included the historical underground workings and environmental constraints associated with the Gold Creek and Blairmore Creek watersheds. Stripping ratio influenced the pit targeting in that there was a very limited area for mine rock disposal facilities. Watershed boundaries were used as limits for the ex-pit mine rock disposal facilities. With the increasing value pits, the available mine rock disposal within the permissible disturbance limit decreased resulting in insufficient storage options. Ultimately, the available capacities of the rock disposal areas became a primary driver, in combination with sufficient quantities of product clean coal to satisfy the targeted annual coal production level of 4 million CMT per year and 24 year mine life, for the ultimate pit extents.

The estimated coal tonnages and stripping ratios for the incremental pit analysis are shown on Figure C.1.2-2. The USD$90 pit contains an estimated 51 million CMT at an average product strip ratio of approximately 6.7 BCM/CMT. When the pit extents are expanded to incorporate coal at a USD$100 price, the estimated clean coal totals increase to approximately 83 million CMT, with a

stripping ratio of 9.0 BCM/CMT. If the coal sales price is increased from US$100 to US$110, the clean coal tonnage increases by 12 million CMT, resulting in a 0.7 BCM/CMT increase in stripping ratio (to 9.7). As the incremental coal sales price increases to USD$170, the product tonnage increases to 125 million CMT and the strip ratio increases to 12.9 BCM/CMT.

In consideration of overall project economics, it was determined that the pit should contain approximately 80 to 90 million CMT to support a 20 to 25 year mine life at an annual clean coal production level of 4.0 million CMT per year after start-up. Based on these criteria, the US$100 and USD$110 target pits were identified for further evaluation. Limitations on mine rock disposal locations and capacities further restricted the feasibility of the higher value pits.

Analysis of the USD$110 pit indicated that total volume of mine rock exceeded the estimated disposal area capacities, which ultimately led to the selection of the USD$100 pit as the basis for the detailed ultimate pit design. This USD$100 pit provided sufficient reserves and maintained an acceptable stripping ratio throughout the life of mine. Figure C.1.2-2 illustrates clean coal tonnes versus selling price (USD$).

Upon completion of the feasibility study the mine plan was subjected to a rigorous mine optimization study. A review of pit economics combined with a risk assessment determined that expanding the south-west corner of the pit into the historical underground workings could be done economically and safely. This pit expansion in the underground area increased the resource recovery by 8 million CMT.

C.1.2.3 Geotechnical Assumptions

As previously noted, the target pits were developed using a general highwall cut angle of 45°, while footwalls were designed to generally follow the dip of the coal seam floors. Due to the geological complexity of the Grassy Mountain deposit characterized by steeply dipping, severely faulted, and variable geological conditions, detailed geotechnical design criteria were developed as a result of a geotechnical analysis for the project (Section B.8.5). These geotechnical design parameters were assigned by pit region including the western, central, and eastern areas. Pit endwalls were generally oriented east-west which cuts perpendicular to the dip direction. The cross-dip orientation of the endwalls resulted in a very steep inter-ramp angle of 55.1° to be applied to all zones of the ultimate pit.

Western pit zones generally include steeply dipping beds with multiple reverse faults. Geotechnical recommendations in this area include highwall inter-ramp angles of between 45.7° and 52.6°. Footwall parameters for the western zone included 8 m catch benches every 45 m of floor height. No

undercutting of the bedding planes was permitted for footwall benching. All benching had to follow the initial bedding planes for stability purposes.

The central area of the pit has several syncline structures that require slightly different wall parameters. The western side of the central pit zone has a presence of fractured fault planes so a relatively shallow 33.8° inter-ramp angle is recommended. The western highwall also requires frequent catch benching every 15 m of height. Footwall parameters remain the same in the central zone as the western zone.

Eastern portions of the pit have nearly vertical bedding which poses risk for toppling failures. The east zone footwall is on the western side of the pit as a result of the steep bedding. Footwall design parameters for the east zone require benching due to the near vertical dip. Footwall inter-ramp angles of 48.1° have been used for this zone. In an effort to mitigate the risks of toppling failures highwall inter-ramp angles of 37.3° have been used. The combination of near angle of repose slopes with catch benches every 15 m of height should control or eliminate and localized failures to the wall.

C.1.2.4 Ultimate Pit Design

The ultimate pit design was based on the extent of the USD$100 optimized pit. The pit was modified to incorporate:

- detailed geotechnical design criteria;
- pit access roads;
- elimination of high strip ratio zones, where possible; and
- the decision during the optimization study to expand the south-west corner of the pit into the underground workings.
- a high stripping ratio portion of the pit along the north wall was also excluded from the pit to reduce the stripping ratio and mine rock contained in the ultimate pit to satisfy rock disposal area capacity limitations. A description of the ultimate pit is provided below.

Highwall slopes in the optimization generally fell a bit shallower in comparison to the geotechnical recommendations. Some higher stripping ratio material was removed from the pit by integrating the slightly steeper highwall inter-ramp angles in the detailed design. Within the ultimate pit, the western pit wall slope parameters transition from highwall to endwall as the wall orientation shifts from north-south to east-west. Steeply dipping bedding planes in the western pit zone support relatively aggressive highwall angles in the ultimate pit design. Overall pit depth varies from 50 m to 300 m in the western portions of the pit. The western highwall steepens as it transitions into the central pit zone endwall with a 55.1° inter-ramp angle.

The overall highwall height in the central pit zone is between 250 m and 350 m. The central pit highwall transitions into another endwall from the west to the east. The central pit highwall height decreases along the transition from the central zone to the relatively shallow eastern pit.

The pit optimization targeted the bottommost ply of Seam No. 4. The 4A1 floor served at the pit floor wherever the seam dip was less than 35°. The western pit zone contained very few areas of shallow dip and footwall benching was required for nearly all the pit floor. Footwalls benching required bench face angles follow the original dip to prevent undercutting the bedding planes. The syncline structure in the central pit zone required footwall benching on both the east and west sides of the pit. On the western side the footwall transitions into highwall once the pit climbs above the bedding. Bedding planes in the east pit zone are near-vertical which require frequent benching to flatten the wall out to near angle of repose.

Haulage ramps and working areas were incorporated into the ultimate pit design. Ramp widths of 33 m were chosen to safely carry two-way truck traffic. Ramps were designed into the pit walls and floor, as needed, to access the deepest levels of the pit. A 60 m width working area was built into the pit bottom to allow for efficient operation of mining equipment. To reduce ex-pit disturbance in-pit backfill was prioritized early in the mine life. The in-pit fill served a primary role in the overall pit access plan. In-pit mine rock was placed as close to the active mining phase as possible. The in-pit mine rock served as a connection point between the active mining area and the mine rock disposal facility or the ROM tip. Using the backfill to access active pit and mine rock disposal areas reduced the overall need for a comprehensive in-pit ramp network.

Pit access for the ultimate pit was approached with the phase and dump plans in mind. Mine phasing was chosen to allow lower stripping ratio portions of the pit to be extracted earlier in the mine life. With the phase locations in mind, pit access was designed to serve the smaller phased pits. Phased mining also allowed in-pit backfill to follow closer behind the mining advance which added addition options for the access plan.

C.1.2.5 Scheduled Tonnage

With the pit optimization as a guide, the detailed geotechnical and mine planning parameters were incorporated into the ultimate pit design. The overall stripping ratio and total clean product tonnes within the ultimate pit are comparable to the USD$100 target pit. The steeper highwall inter-ramp angles excluded some mine rock that was offset by pit ramps and footwall benching. Application of the detailed mine design parameters resulted in a pit containing 93 million CMT and 854 million BCM rock at a stripping ratio of 9.2 BCM/CMT. At a nominal clean coal production rate of 4.5 million CMT/year, the ultimate pit provides sufficient reserves for a 20 plus year mine life.

The ultimate pit was then broken into smaller sub-pits or phases. The pit phase sequence generally progress from lower to higher stripping ratio moving south to north within the ultimate pit. Care was taken to balance as many of the pit phasing design parameters which caused the stripping ratio to be higher in some phases. Phase 3 for example was developed early in the mine life to increase the mine rock disposal area. The pit phases were developed in consideration of the following:

- stripping ratio and pit targeting analysis of coal costs;
- sufficient working area within a phase;
- pit access requirements;
- selenium management requirements;
- in-pit backfill opportunities early in the mine life; and
- geotechnical design recommendations in relation to fault blocks and bedding plane orientation.

The resultant mine layout and sub-pit phases are identified on Figure B.7.5-1. Mine phases served as a guide for development of the detailed mine sequence. Phases 1 to 5 allow a majority of the low stripping ratio coal to be extracted in the first half of the mine life. Extraction of higher stripping ratio phases is can be deferred until later years of the mine life. A summary of both coal and mine rock quantities contained in the detailed ultimate pit broken out by seam number and phase can be seen in Table C.1.2.2.

Table C.1.2.2 Mine Phase Reserve Summary

Mining Phase	Seam	In situ Waste Volume (bcm)	Mineable In situ Coal Tonnes	ROM Waste Volume (bcm)	ROM Coal Tonnes @ 5% Moisture	Product Coal Tonnes @ 10% Moisture	Product Strip Ratio
1	1	17,511	2,051	17,511	2,116	1,115	15.7
	2	8,387	5,740	8,387	5,791	3,245	2.6
	4	14,352	4,565	14,352	4,714	2,310	6.2
	U*	5,956	0	5,956	0	0	0.0
Sub-Total Phase1		**46,207**	**12,357**	**46,207**	**12,621**	**6,670**	**6.9**
2	1	25,193	3,118	25,193	3,253	1,593	15.8
	2	12,437	6,655	12,437	6,723	4,154	3.0

Table C.1.2.2 Mine Phase Reserve Summary

Mining Phase	Seam	In situ Waste Volume (bcm)	Mineable In situ Coal Tonnes	ROM Waste Volume (bcm)	ROM Coal Tonnes @ 5% Moisture	Product Coal Tonnes @ 10% Moisture	Product Strip Ratio
	4	6,718	4,451	6,718	4,593	2,222	3.0
	U*	10,277	0	10,277	0	0	0.0
Sub-Total Phase2		**54,624**	**14,224**	**54,624**	**14,568**	**7,970**	**6.9**
3	1	130,627	10,489	130,627	10,939	5,404	24.2
	2	52,017	28,766	52,017	29,108	17,819	2.9
	4	48,197	23,937	48,197	24,665	13,029	3.7
	U*	52,291	0	52,291	0	0	0.0
Sub-Total Phase3		**283,132**	**63,192**	**283,132**	**64,712**	**36,252**	**7.8**
4	1	3,444	92	3,444	95	46	74.7
	2	474	372	474	379	238	2.0
	4	928	308	928	315	183	5.1
	U*	396	0	396	0	0	0.0
Sub-Total Phase4		**5,242**	**772**	**5,242**	**790**	**467**	**11.2**
5	1	2,975	79	2,975	83	47	63.4
	2	1,000	538	1,000	549	336	3.0
	4	1,831	519	1,831	538	258	7.1
	U*	1,224	0	1,224	0	0	0.0
Sub-Total Phase5		**7,030**	**1,136**	**7,030**	**1,169**	**641**	**11.0**
6	1	1,788	58	1,788	61	29	62.1
	2	2,037	415	2,037	425	253	8.0
	4	1,889	855	1,889	882	409	4.6
	U*	2,845	0	2,845	0	0	0.0
Sub-Total Phase6		**8,558**	**1,328**	**8,558**	**1,368**	**691**	**12.4**
7	1	1,649	8	1,649	8	2	697.4
	2	2,015	752	2,015	771	444	4.5

Table C.1.2.2 Mine Phase Reserve Summary

Mining Phase	Seam	In situ Waste Volume (bcm)	Mineable In situ Coal Tonnes	ROM Waste Volume (bcm)	ROM Coal Tonnes @ 5% Moisture	Product Coal Tonnes @ 10% Moisture	Product Strip Ratio
	4	3,471	1,423	3,471	1,472	655	5.3
	U*	1,423	0	1,423	0	0	0.0
Sub-Total Phase7		**8,558**	**2,183**	**8,558**	**2,252**	**1,101**	**7.8**
8	1	165,924	1,153	165,924	1,206	579	286.6
	2	44,581	24,395	44,581	24,716	14,760	3.0
	4	39,982	21,292	39,982	21,876	11,390	3.5
	U*	35,812	0	35,812	0	0	0.0
Sub-Total Phase8		**286,299**	**46,840**	**286,299**	**47,799**	**26,729**	**10.7**
9	1	81,092	2,595	81,092	2,704	1,502	54.0
	2	30,167	10,489	30,167	10,631	6,182	4.9
	4	11,217	8,758	11,217	9,005	4,411	2.5
	U*	11,156	0	11,156	0	0	0.0
Sub-Total Phase9		**133,632**	**21,841**	**133,632**	**22,340**	**12,095**	**11.0**
Sub-Total Seam 1	1	430,203	19,642	430,203	20,464	10,317	41.70
Sub-Total Seam 2	2	153,114	78,124	153,114	79,094	47,432	3.23
Sub-Total Seam 4	4	128,585	66,107	128,585	68,061	34,867	3.69
Sub-Total Underburden	U*	121,380	0	121,380	0	0	0.0
Grand Total		**833,281**	**163,873**	**833,281**	**167,619**	**92,616**	**9.0**

* U indicates underburden waste which is rock mined below seam 4 required for pit development due to faulting

C.1.3 Mine Schedule

The mine is scheduled to begin pre-development activities in late 2017 and 2018 (Year - 1) once licensing is complete, with the coal processing plant commissioning scheduled to come on-line in the third quarter of 2018. First commercial coal production is scheduled to begin January, 2019.

The pit will be sequenced to extract lower ratio, lower cost coal during the initial years by mining primarily within the Phase 1 and Phase 2 sub-pits. Mining progression is also designed to accelerate the mining of all benches within Phase 1 and Phase 2 in an effort to establish in-pit rock disposal areas as early as possible. Establishment of in-pit rock disposal zones within these initial phases provides a potential for the development of saturated fill zones, which are an integral part of the selenium management strategy for the mine.

All three coal seams are generally present within each bench of each pit phase below the initial rock benches at the higher elevations of each sub-pit, with the exception of the western portions of Phases 8, 9 and 10. The coal seam dip in this section of the pit is relatively flat at the base of a synclinal structure between two north-south trending fault blocks. To allow for sufficient operating room within a phase and to provide the opportunity to mine and deliver coal from any of the three seam groups as required for product coal dispatching, multiple benches within multiple phases are actively mined in a single year.

C.1.3.1 Mine Development Phases

Pre-stripping for the mine will begin in Phase 1 during 2018. First coal is scheduled for the 1st quarter in 2019 with an annual production target of 1.9 million clean metric tonnes (CMT). Waste stripping will slowly increase from 20 million bank cubic metres (BCM) in 2019 to an average of just over 40 million BCM in 2025. Clean coal production will average 4.5 million CMT/year over the first two thirds of the mine life and reducing to less than 4 million CMT/year over the remaining third.

During operations, logging and clearing operations are scheduled to be completed a minimum of two years in advance of mining in any sub-pit. Topsoil is planned to be stripped and salvaged 6 to 12 months prior to mining advance into a new area of the pit.

Coal processing reject material will be loaded into end-dump haul trucks directly from the reject bin or by a wheel loader from a reject surge pile located in the ROM pad area. The reject material will be hauled and deposited within the active portions of the SRDA over the mine life. Once in-pit backfill is established this material will be preferentially deposited below the ultimate water level height of the saturated zones to provide a source of carbon to assist with selenium attenuation.

C.1.3.2 Mine Pre-development – Year -1 (2018)

Mine pre-development activities will consist of vegetation clearing and logging, coversoil salvage and storage, haul road construction, mine infrastructure, water management features and facilities construction (including the ROM pad, coal handling and processing facilities, rejects handling facilities, mine administration and maintenance facilities, and mine access road). Construction of the haul road and ROM pad will be completed using mine equipment and labor. All coversoil stripped

will be salvaged and stockpiled south of the mine facilities. Mine surface water management structures (ponds, ditches, pipelines and impoundments) required for the initial years of mining will also be installed at this time. Construction of the raw water pond, plant site sedimentation pond, southwest surge pond, southeast surge pond and the east sedimentation pond are all constructed during this period. The pre-development phase of the Project will begin immediately following mine licence approval, currently projected for later in 2017.

C.1.3.3 Annual Mine Production Summary

Status maps (Figures C.1.3-1 through to C.1.3-26) have been provided on an annual basis through to the end of mining. The following descriptions have been provided in order to aid in the understanding of the annual activity.

- Development through 2018 (Year 0):
  - topsoil stripping in plant areas, most of Phase 01, initial RDA, initial settling ponds, and along haul roads to Phase 02 and Phase 03;
  - construction of four initial water treatment/surge ponds;
  - construction of the CHPP;
  - construction of haul roads from the plant area to the top of Phase 02 and 03;
  - coal and waste mining operations begin with ROM coal mined of 63,000 to stockpile; and
  - construction of SRDA begins east and south of the Mini Pit and south of the existing powerline.
- 2019 (Year 1 – Figure C.1.3-1):
  - CHPP commissioned and running at nameplate capacity;
  - coal and waste mining operations continue with coal production of 1.7Mt product tonnes;
  - coal and waste mining operations begin in Phase 03 with dumping as close as possible to the digging operations;
  - first commercial coal delivery;
  - topsoil is stripped for an access road to the southern portion of Phase 03;
  - topsoil stripping to prepare Phase 04 and west settlement pond occurs; and
  - topsoil is stripped south of the SRDA to allow for its expansion.
- 2020 (Year 2 – Figure C.1.3-2):
  - regrade and revegetation activities begin on the north side of the SRDA powerline dump;
  - coal production ramps up to 3.4Mt product tonnes for the year;
  - saturated backfill commences in Phase 1 Mini-Pit;

- topsoil stripping for ramp to access Phase 04 mining area;
- new access road to lower elevations of Phase 04 developed; and
- SRDA begins southward expansion.

- 2021 (Year 3 – Figure C.1.3-3):
  - west settlement pond created to collect runoff from Phase 03 mining area;
  - topsoil stripped for access ramp to lower elevations of Phase 03 and East Sedimentation Pond;
  - topsoil stripping begins in upper elevations of Phase 03;
  - haul road to access to Phase 03 constructed;
  - coal and waste mining operations begin in Phase 03;
  - coal production rate achieves maximum value of 1.1 million product tonnes per quarter (4.5 million product tonnes per year); and
  - southern portion of Phase 01 mined out and backfilled. A dike is built across the pit for the creation of the first saturated zone up to the 1,440 m elevation (Phase 1).
- 2022 (Year 4 – Figure C.1.3-4):
  - coal and waste mining operations begin in upper elevations of Phase 03;
  - coal and waste mining operations complete in Phase 01;
  - in-pit dumping continues in the southern portion of Phase 01;
  - a second dike is built across the pit up to the 1,450 m elevation expanding the saturated zone capacity (Phase 2);
  - new ramp to the top of Phase 08 constructed;
  - road along active Phase 01/02 highwall for access to ROM coal dump hopper developed; and
  - regrade area expands along northwest side of SRDA powerline dump.
- 2023 (Year 5 – Figure C.1.3-5):
  - regrading and revegetation begin on east side of SRDA and south side of mini-pit;
  - incremental expansion of the saturated zone continues with the build-up of the Phase 2 Dike up to the 1,460 m elevation (Phase 3);
  - SRDA continues expansion to south, east, west and north; and
  - topsoil stripped to prepare Northwest settling pond.
- 2024 (Year 6 – Figure C.1.3-6):
  - SRDA expands north
  - Northwest settling pond created to collect runoff from Phase 08 and NRDA;

- Phase 4 of the 1,465 m saturated zone is complete up to the 1,460 m elevation;
- access roads from Phase 03 to NRDA established;
- waste dumping operations begin in NRDA; and
- topsoil stripping to prepare Phase 04 and 05.

- 2025 (Year 7 – Figure C.1.3-7):
  - topsoil stripping expands to southern limits of SRDA;
  - SRDA expands south; and
  - construction of the Phase 4 Dike up to the 1,465m elevation begins.
- 2026 (Year 8 – Figure C.1.3-8):
  - waste removal operations begin in Phase 08;
  - construction of Phase 4 Dike continues; and
  - in-pit dumping commences in Phase 04.
- 2027 (Year 9 – Figure C.1.3-9):
  - coal and waste mining operations complete in Phase 02;
  - the first major saturated zone (SZ1,465m) is complete. Total attenuation of 1.9 million m^3 of water is available;
  - access into Phase 04 from north end of SRDA at Elevation 1,740 m established;
  - in-pit dumping commences in Phase 05; and
  - large portion of the southern end of the SRDA is regraded and revegetated.
- 2028 (Year 10 – Figure C.1.3-10):
  - in-pit dumping operations begin in Phase 02;
  - coal removal operations begin in Phase 08;
  - topsoil stripping to prepare Phase 09 and its access road begin; and
  - regrading and revegetation begin on the northern side of the NRDA.
- 2029 (Year 11 – Figure C.1.3-11):
  - access road to Phase 09 established; and
  - coal and waste mining operations begin in Phase 09.
- 2030 (Year 12 – Figure C.1.3-12):
  - ramp established on southern face of Phase 05 to SRDA;
  - topsoil is stripped for new access from Phase 07 to NRDA;
  - topsoil is stripped in preparation for northeast settling pond; and

  - access ramp to top of SRDA direct to ROM coal dump hopper is retired as SRDA reaches its maximum limits in that area.
- 2031 (Year 13 – Figure C.1.3-13):
  - Northeast settling pond created for capture of runoff from Phases 06 and 07;
  - coal and waste mining operations complete in Phase 04 and 05;
  - SRDA reaches its maximum extents in the southern portions; and
  - in-pit dumping operations begin in Phase 04.
- 2032 (Year 14 – Figure C.1.3-14):
  - topsoil stripping begins to prepare Phases 06 for mining operations; and
  - regrading and revegetation continues on SRDA.
- 2033 (Year 15 – Figure C.1.3-15):
  - coal and waste removal operations begin in Phase 06.
- 2034 (Year 16 – Figure C.1.3-16):
  - in-pit dumping operations begin in Phase 06.
- 2035 (Year 17 – Figure C.1.3-17):
  - waste mining operations commence in Phase 07;
  - in-pit dumping operations begin in Phase 05; and
  - regrading and revegetation begins along the entire western face of the SRDA.
- 2036 (Year 18 – Figure C.1.3-18):
  - coal removal operations begin in Phase 07;
  - coal and Waste removal operations complete in Phase 07; and
  - NRDA reaches its ultimate height.
- 2037:
  - coal and waste removal operations complete in Phase 08; and
  - in-pit dumping operations begin in Phase 08.
- 2038 (Year 19 – Figure C.1.3-19):
  - SRDA and NRDA connect in northern reaches of Phase 06;
  - in-pit dumping operations begin in Phase 07; and
  - central portion of SRDA reaches its ultimate height.
- 2039 (Year 20 – Figure C.1.3-20):
  - coal and waste mining continue in Phases 08 and 09; and
  - NRDA is regraded and revegetated.

- 2040 (Year 21 – Figure C.1.3-21):
  - coal and waste mining operations complete in Phase 09;
  - in-pit dumping operations begin in Phase 09; and
  - large area in centre of SRDA regraded and revegetated.
- 2041 (Year 22 – Figure C.1.3-22):
  - completion of all coal and waste mining activities;
  - rock is hauled south into the pit bottom to bring the floor elevation up to the 1,700 m elevation and creating the final saturated zone (SZ1,700m); and
  - horizontal drainage holes are drilled from SZ1700m at the 1,700 m elevation to allow the water to decant to the west and to continue for further selenium attenuation.
- 2042 through 2044:
  - removal of non-permanent settling ponds;
  - removal of coal processing and other facilities;
  - completion of regrading and revegetation operations;
  - final end pit lake is established; and
  - horizontal drainage holes are drilled east at the 1,700 m elevation along the east wall in the end-of-mine lake area to allow the water to decant east into Gold Creek.

C.1.3.4 Mine Reclamation

After mining operations have been completed, any remaining rock disposal areas that that were not reclaimed during mining operations will be re-sloped, surfaced with coversoil and re-vegetated. The final highwall and end wall in the final mining phase (Phases 6 through 9) will be left as-mined. All rock disposal areas will be re-sloped to an overall angle of 23^0 (approximately 2.5 horizontal to 1 vertical slope). It is anticipated that reclamation of all rock disposal areas, the mining pit, and mine facilities (including coal handling and processing facilities) will be completed by the end of the third post-mining year (Year 27), with the exception of the water control structures required for on-going selenium management.

No in-pit backfill will be permitted within the drainage area of the end-of-mine lake. Based on a review of the post mining hydrology, a design elevation of 1,700 m was determined for the end-pit lake. Horizontal drainage wells may be drilled from the 1,700 m elevation to the east towards Gold Creek to enable water from the end-of-mine lake to drain east into Gold Creek.

The estimated mine reclamation status at the end of the first post-mining year (Year 24) and the end of the second post-mining year (Year 25) are shown on Figure C.1.3-25 and Figure C.1.3-26.

Additional information regarding the reclamation program and post-mine water management is provided in Section F – Reclamation Plan. Cross sections showing the pit limits, ex-pit waste dump heights and levels of in-pit backfill can be found in this section.

C.1.3.5 Mine Plan Production

The mine plan coal and stripping quantities are presented on Table C.1.3.1 annually from 2018 through to 2027 (Years -1 through Year 9). The production statistics for the remaining mine life has been tabulated as 5 year summaries. Clean coal production increases to 1.9 million CMT/year in the initial production year, and then to 4.45 million CMT/year in the fourth year.

The annual stripping requirements increase from approximately 21 million BCM (Year 1) to 37 million BCM (Year 4) when the nominal plant production capacity is reached. The stripping ratio in the first four years ranges from 6.4 to 10.9 BCM/CMT, averaging 7.5 for the period. The stripping ratios increase slightly to an average of 8.8 BCM/CMT over the next four years (Year 5 to Year 8). The next 10 years of mining sees the average strip ratio increase to 11 BCM/CMT. The average stripping ratio for the final three years decreases significantly (6.9 BCM/CMT), as the benches mined in these years are typically lower in the pit and the majority of the stripping volume is contained in the upper benches of the pit.

Over the mine life, 168 million tonnes of ROM coal is mined resulting in the production of 93 million CMT of clean product coal at an average product stripping ratio of 9.2 BCM/CMT. Approximately 833 million BCM of rock is stripped over the mine life.

Table C.1.3-1 Mine Plan Production Statistics

Description	Year -1 (2018)	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)	Year 8 (2026)	Year 9 (2027)	Years 10-14 ('28-'32)	Years 15-19 ('33-'37)	Years 20-23 ('38-'41)	Total
ROM COAL (5% TM)														
Total ROM Coal Tonnes (000s RMT)	63	3,625	6,333	7,632	8,008	8,008	8,009	8,008	8,136	8,260	39,253	34,500	27,774	167,609
Ash (%) @ 5% Moisture	33%	33%	33%	34%	33%	32%	32%	32%	33%	33%	32%	32%	32%	32%
PRODUCT COAL (10% TM)														
1-Seam Coal Tonnes (000s CMT)	22	591	639	723	1,077	822	707	644	758	757	1,848	411	1,317	**10,316**
2-Seam Coal Tonnes (000s CMT)	6	786	1,873	1,944	2,574	2,342	2,272	2,133	2,429	2,544	11,092	9,566	7,869	**47,430**
4-Seam Coal Tonnes (000s CMT)	8	534	891	1,443	801	1,339	1,455	1,648	1,347	1,405	8,882	8,921	6,191	**34,865**
Total Product Tonnes (000s CMT)	**35**	**1,911**	**3,403**	**4,111**	**4,452**	**4,503**	**4,435**	**4,425**	**4,534**	**4,706**	**21,820**	**18,899**	**15,378**	**92,612**
Air Dry Ash (%) @ 1% Moisture	9.6	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
Plant Yield (%)	56%	53%	54%	54%	56%	56%	55%	55%	56%	57%	56%	55%	55%	55%
STRIPPING VOLUME														
Prime Stripping (000s BCM)	1,319	20,237	21,263	26,228	36,592	33,568	37,010	41,416	41,278	40,321	209,722	221,597	102,903	833,454
Rehandle (000s BCM)	33	506	532	656	915	839	925	1,035	1,032	1,008	5,243	5,541	2,572	20,837
Total Effective Stripping (000s BCM)	**1,352**	**20,743**	**21,795**	**26,884**	**37,507**	**34,408**	**37,935**	**42,451**	**42,310**	**41,329**	**214,964**	**227,138**	**105,476**	**854,292**
STRIPPING RATIO														
Prime Stripping Ratio (BCM/RMT)	20.8	5.6	3.4	3.4	4.6	4.2	4.6	5.2	5.1	4.9	5.3	6.4	3.7	5.0
Effective Stripping Ratio (BCM/RMT)	21.3	5.7	3.4	3.5	4.7	4.3	4.7	5.3	5.2	5	5.5	6.6	3.8	5.1
Product Stripping Ratio (eff. BCM/CMT)	38.8	10.9	6.4	6.5	8.4	7.6	8.6	9.6	9.3	8.8	9.9	12.0	6.9	9.2

C.1.4 Mining Equipment

The mining equipment necessary to meet the annual production requirements over the life of the Grassy Mountain mine has been identified and incorporated into the mining plan. Based on the ultimate pit overall stripping and coal recovery quantities and review of deposit geology, it was determined that the Grassy Mountain reserves targeted for recovery could be effectively mined using excavator and truck fleet (truck and shovel) for stripping and coal recovery.

The selection of primary stripping and coal loading equipment is dependent on a variety of factors including annual stripping volumes, coal production levels, the number of active mining faces, pit configuration and mine operating room considerations. For costing and design purposes, specific equipment models were selected from the range of available units for a desired size-class. Model selection was based primarily on production requirements and to a lesser extent on current equipment usage at existing Alberta coal mines. Selected primary equipment models and estimated fleet sizes for the mining option evaluated are summarized in Table C.1.4.1.

Table C.1.4-1 Primary Equipment Fleet Summary

Equipment Type	Size-Class	Duty	Year 1	Year 5	Year 10	Maximum
Hydraulic Backhoe	490t (28 m^3)	Waste Removal	0	1	1	2
Hydraulic Backhoe	394 t (22 m^3)	Waste/Coal Removal	2	3	3	4
Hydraulic Backhoe	122 t (5 m^3)	Waste/Parting/Coal Removal	2	2	2	2
Wheel Loader	218 t (20 m^3)	ROM/Rejects Maintenance	1	1	1	1
Trucks - Rear Dump	220 t	Waste/Coal/Rejects Hauling	15	30	30	39
Backhoe	71 t (2.5 m^3)	Topsoil Handling	1	1	1	1
Backhoe	34 t (1.1 m^3)	Topsoil/Utility Handling	1	1	1	1
Trucks - Articulated	37 t	Topsoil Hauling	3	3	3	3
Dozer - Track	664 kW	Waste Removal/Reclamation	4	5	6	6
Dozer - Track	391 kW	Waste Removal/Reclamation	3	5	5	5
Drills - Diesel	270 mm	Waste/Parting Removal	2	3	3	4
Dozer - Rubber Tired	49t kW	Bench Maint./Op. Support	1	2	2	2
Motor Graders	7.5 m Blade	Road Maintenance	3	3	3	3

Moderate to large mining equipment was selected to facilitate the efficient mining of the Grassy Mountain property and to allow for the logical transitioning to the desired nominal production rate of 4.5 million CMT/year. The equipment fleet selection also considered: the dip and thickness variability of the coal and rock zones by phase, fault block and bench; the need to mine from multiple phases (or sub-pits) to meet coal process plant ROM feed requirements by coal seam group; pit configuration; and, fleet operating room requirements.

The primary mining fleet for the proposed plan consists of two large-class hydraulic backhoes with 28 m^3 buckets in rock, up to four 22 m^3 hydraulic backhoes in coal and rock, 664 kW and 391 kW dozers and smaller hydraulic excavators for selective mining and topsoil salvaging. The mine optimization study, which was undertaken after the feasibility study recommended that a single size truck (220 t) be utilized for both rock and coal. The mine has been scheduled to sequentially progress from south to north, mining the lower-ratio phases in the initial years of the operation. As the stripping ratio increases additional equipment is added as required.

C.1.5 Unit Operations

C.1.5.1 Clearing/Logging & Vegetation/Topsoil Removal

The Project site is classified as foothills with high rounded hills with moderate to steep sloping sides at higher elevations giving way to gentle slopes at lower elevations. The majority of the pit area is in a Subalpine Forest zone and is predominately covered in trees.

The removal of standing timber will be accomplished by a subcontractor. To minimise disturbance and insure that this operation is completed in advance, it will be necessary to coordinate logging activities with the planned mining advance in each area. For the purposes of this Application, it is assumed that logging operations will be generally completed in 5-year blocks to minimise subcontractor mobilisation and demobilisation costs to the Project well in advance of mining operations. Clearing involves the removal of small brush to enable topsoil to be removed prior to further mining disturbance. It is assumed that clearing and topsoil removal will be completed following logging operations 6 to 12 months in advance of mining.

The density of vegetation and trees across the proposed mining area varies from sparse brush to heavily wooded. It is assumed that the logging contractor will remove all timber from site. All merchantable timber will be harvested and sold to offset some of the clearing costs.

Topsoil and/or organic sub-soil thickness varies from 0 m to a maximum of 2 m depending on soil type and location across the areas to be mined. For the majority of the mine where topsoil exists, the thickness averages approximately 28 mm. All topsoil on slopes measuring less than 27° is assumed to be removed and salvaged. Initial development activities in each sub-pit area will require that topsoil

be placed into a stockpile located south of the mine facilities until such time that it can be placed over reclaimed rock disposal areas. The topsoil placed into the stockpile will be placed over final reclaim areas towards the end of the mine life to achieve final mine closure. Once topsoil removal has occurred, the area can be prepared for waste drilling and blasting operations.

C.1.5.2 Drilling and Blasting

Drilling and blasting will be necessary for the Project. Blasting will occur during day shift only with approximately four to five blasts per week. Monitoring of the size of the blast will be required to ensure that all holes can be loaded with explosives, wired, stemmed, and blasted during the daylight hours.

Crawler-mounted, diesel blast-hole drills with rated pull down capacities of 334 kilonewtons (kN) capable of drilling 229 to 270 mm diameter holes were well suited for the majority of mine rock (overburden and interburden) drilling requirements. These drills are capable of multi or single pass drilling to a depth of over 20 metres, which makes them a suitable match for the 15-m truck/shovel bench heights planned for the Project. These large diesel drills were selected to provide the mobility required for the Project, while minimising costs and reducing overall manpower requirements for the drilling function. The diesel drills were assigned to drill all mine rock material greater than 2 m in thickness. All rock will be drilled and blasted in benches measuring 15 m in height.

In addition to overburden, a number of interburdens and partings between the coal seams exist and will require blasting. All mine rock material less than 2 m in thickness was assumed to be ripped by dozers. When coal is encountered in the mining bench, through-seam drilling and blasting will be completed.

Through-seam blasting has been known to show both positive and negative business effects in terms of cost savings and relieving pressures (such as drill and blast) on mine schedules in deposits displaying similar geology. The positive aspects are the reduction of drilling and blasting costs; a single shot may be sufficient to expose multiple coal seams rather than multiple, separate shots. In addition, the mining operation is greatly simplified and "hard toes" are eliminated from the wedge of mine rock that would exist at the toe of the bench below the dipping coal seam. This reduces the cost of drill clean-up, drilling, loading costs, explosives, explosive accessories, and tie up and firing delays following the extraction of each coal seam in an individual process. Through-seam blasting also allows for better characterisation of the true thicknesses of the coal seams from measurements taken on the drill rigs during the coal drilling section of the downhole cycle.

Although through-seam blasting has the potential to decrease fragmentation while increasing coal loss, coal damage, and dilution, these potential negative results can be minimised and controlled by

the drill and blast engineers through adjustment of the powder factors, explosive types, blast patterns, and by shot firers in the placement of the charge length and stemming decking through the coal seams. Significant advances have been made with electronic detonation which has improved the accuracy of through-seam blasting thus minimizing adverse effects. For these reasons, through-seam drilling and blasting will be employed for the Project.

For benches including coal, drilling will be accomplished with the same diesel blast-hole drills equipped with 270-mm bits. The loading plan will be adjusted to accommodate the reduced design powder factor and minimise the generation of coal fines. All blastholes will be decked within the coal seam working section as explosives are loaded within the hole above and below the coal. For initial phase development, where increased manoeuvrability is required, small, track-mounted drills will be utilised to develop the small upper benches. These drills will also be employed for establishing the initial drilling and blasting benches during construction of haul roads.

All drilling and blasting designs have been developed using a design average powder factor of 0.65 kg/BCM following a review of blasting experience in the respective geological formations and review of the rock strength data. The drilling and blasting parameters will be adjusted as required with operation experience to optimise coal recovery and costs.

Grassy Mountain plans to use a third-party specialist service provider for all of its blasting needs and has had discussions with several full service providers that have existing licensed explosives manufacturing facilities that will be able to deliver explosives and all related services to the mine. A bid process will be used to select the explosives contractor. The successful bidder will be responsible for all permitting, manufacturing, storage, and delivery to service the Project's mining operations.

As it is currently planned to construct a storage facility at the Project site, an application to Natural Resources Canada (NRCAN) for an *Explosives Act* licence or permit will be completed by the explosives contractor at a later date.

C.1.5.3 Excavator/Truck Rock Stripping

This unit operation consists primarily of hydraulic backhoe excavators and end-dump haul trucks. Dozers are assigned to support the waste stripping operation. The dozers are also assigned for maintenance of the waste rock disposal areas and to assist with waste excavator bench clean-up, ramp development, and maintenance.

The mine rock overburden and interburden thickness across the pit varies considerably by phase, bench, and fault zone. As such, two different size-class hydraulic excavators were selected as the primary mine rock removal machines. The larger 29 m^3 excavators are assigned to remove the majority of the thick rock (measuring greater than 5 m in working face width across the bench) after

the initial 3 years of production. All waste rock in the first 3 years of mining and the thin rock for the remainder of the mine life will be removed by the 22 m^3 hydraulic excavators. To provide needed flexibility and to more effectively allow for the removal of thinner partings, small hydraulic backhoes are also scheduled to remove lesser amounts of mine waste rock.

The rock will be loaded into 220-tonne capacity end-dump haul trucks. The rock will be hauled to the rock disposal areas, where the material will be levelled and graded by 664-kilowatt (kW) and 391-kW track dozers. Haul roads are established, as required, within the pit operating benches and the rock disposal areas at maximum 8% grades. Emergency run-out lanes will be cut into the hillside or built using the in-pit rock dump material that was placed by the mine rock truck fleet along the downhill side of the mine rock and coal haul ramps. A run-out lane will be required on all haul roads steeper than 5% grade and located every 30 m, vertically.

Once a waste bench has been drilled and blasted, the excavator/truck fleets can begin to remove the waste overlying the working section coal seam. Waste stripping includes overburden, interburden, and parting. The planned operating bench for waste removal activities is design to have a maximum thickness of 15 m. The excavators will remove the 15-m benches in a series of lifts of approximately 5 m in thickness.

The planned mining methodology is shown in Figure C.1.5-1 for standard pit conditions. Backhoes are planned for the entire waste excavation fleet. Equipment positions shown are for illustrative purposes and actual configurations may vary. Final determination of the bench and lift heights should be conducted through the use of time studies and optimisation during the initial start-up period of the mining activities.

Special consideration is to be given to working around historic underground workings. Prior to working in these areas a system will be established to appropriately control the risks associated with these activities including comprehensive surveys, geotechnical analysis, safe operating procedures and training.

Key to controlling the risks associated with working around the historic underground workings is knowing where any voids or hazardous areas are located. Prior to any activity the following activities will be carried out to define the extent and form of the workings:

- detailed surface mapping of the area to locate signs of the workings;
- review of all exploration data;
- review of historic records;
- review of methods for locating shallow voids;

- review of other operations working methods in similar situations;
- geotechnical review of overall highwall stability and local bench stability;
- hydrological model and review; and

  update of maps and plans based on findings.

An initial review of operating methods highlighted the following guidelines for safe operations:

- establishing geotechnical guidelines on vertical standoff distances above potential voids to prevent collapse;
- continuous update of historic working location based on exploration, field observation, operational drilling and survey;
- exploration using mining operation equipment;
- clear and unambiguous guidelines for crews when voids encountered;
- digging methods and procedures established for mining through voids including overhanding material on grade;
- appropriate equipment available for controlled collapse of voids (large excavator or long reach secondary breaker);
- preferentially collapse voids through drill and blast (see illustration of extended drilling);
- ROM primary screens designed to deal with tramp material of the sort expected; and
- emergency response plans to cater for risks associated with historic workings (collapse, buried equipment, water).

The planned mining method in the area of the historical underground workings is shown on Figure C.1.5-2.

Development of the production benches considered pit phase widths, highwall angles, and offsets for safety catch benches. As these benches are developed they are subset into lifts designed to accommodate equipment digging ranges. Up to three lifts per 15 m of bench height have been designed. These lifts are located perpendicular to the coal seam dip as well as along the strike length of the active mining bench. This system of mining advance also provides for ramp access between lifts.

With these development criteria and the geological structure of the deposit within the pit extents in mind, it was determined that excavators operating in backhoe configuration would provide for the most flexibility considering the variability of the waste and coal thickness.

It is envisioned that the backhoe excavator will position on top of the lift to be removed with the haul trucks either located at the base of the lift or at the level of the excavator, depending on coal seam dip and the location of the lift in the bench.

C.1.5.4 Coal Loading & Hauling

The majority of the coal will be mined by 22 m^3 (400t) excavators in backhoe configuration. These excavators are assigned to remove all of the thick coal working sections. All coal will be loaded into 220-tonne capacity end-dump haul trucks equipped with coal boxes to maximise payload. To provide needed flexibility and to more effectively allow for the removal of thinner coal seams, small hydraulic backhoes are also scheduled to remove lesser amounts of coal. The smaller excavators, however, are a poor match for the selected coal trucks; as a result, the smaller excavators will stockpile the coal on the pit floor next to the working face. This stockpiled coal will then be loaded out either by the larger excavator or the 218t wheel loader.

All coal will be hauled in 220-tonne end-dump trucks to the ROM facility. Coal will be scheduled to be mined and hauled by individual seam group and placed directly into the ROM truck hopper whenever possible. Surplus coal will be placed in ROM stockpiles. Coal from the ROM stockpiles will be rehandled by a 20 m^3 wheel loader and coal truck and placed into the ROM hopper. The coal haul roads are designed at the maximum grade of 8% and are often coincident with mine rock haul roads. During the initial years of the operation, a coal haul road is established within the Phase 01 highwall and end wall. This road is used to access the ROM facility until the Phase 01 is mined-out and backfilled. At that time, a new coal haul road is established in the slope of the SRDA, accessing the ROM pad from the east. Emergency run-out lanes will be built along the downhill side of the coal haul road using the in-pit rock dump material that was placed by the excavator and truck fleets.

C.1.5.5 Reject Material Disposal

Coarse and fine coal processing reject will be transported *via* a belt conveyor from the CPP to a reject bin located near the ROM pad. Reject will be loaded into 220-tonne end-dump coal trucks and transported to the active rock disposal areas for co-disposal with the rock excavated from the active pit.

C.1.5.6 Equipment Operating Hours

Estimated equipment operating hours are summarized in Table C.1.4.2, determined annually for the pre-development year (Year 0) and the first 10 production years (Year 1 to Year 10). They are also summarized in multi-year blocks for the remainder of the mine plan life.

Table C.1.4-2 Primary Equipment Fleet Summary of Equipment Hours

Description	-1	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-23	Total
490t – Backhoe (28 m^3)	-	-	-	1,151	5,028	5,233	4,933	5,397	5,474	5,796	6,227	44,876	55,419	10,064	149,598
394t – Backhoe (22 m^3)	415	12,900	16,020	15,989	19,058	17,918	19,468	21,096	20,968	21,132	21,248	69,159	78,000	29,953	383,349
122t – Backhoe (5 m^3)	2,155	10,267	3,715	7,681	4,959	5,609	7,022	6,676	7,180	5,572	5,192	27,003	23,857	13,815	130,702
71t – Backhoe (2.5 m^3)	1,134	1,124	516	1,624	1,313	1,720	1,267	1,126	960	626	473	3,323	1,282	-	16,489
220t – Haul Truck (rock/coal/rejects))	3,016	84,925	111,735	121,691	171,293	173,966	155,474	174,130	179,075	167,385	172,298	1,000,454	1,000,657	264,610	3,780,711
218t – Wheel Loader (20 m^3)	4	1,395	3,096	4,257	4,233	3,469	4,014	4,468	4,420	3,796	3,721	22,869	25,159	12,326	97,227
664 kW – Dozer	2,546	20,886	17,051	21,393	25,627	23,298	25,833	28,195	28,763	27,503	27,659	144,094	145,975	43,348	582,170
391 kW – Dozer	2,688	16,336	16,108	20,650	22,226	21,977	22,799	24,039	23,795	22,698	22,971	116,526	110,195	38,410	481,419
Blasthole Drill – 279mm	1,301	6,894	7,207	8,907	12,850	14,641	13,587	14,286	13,781	13,842	13,784	74,823	71,753	14,888	282,542
49t - Wheel Dozer (358 kW)	645	5,737	5,067	6,360	7,359	6,720	7,426	8,052	8,239	7,821	7,863	40,526	40,252	13,071	165,138
37t - Articulated Truck	3,546	3,516	1,613	5,077	4,107	5,378	3,963	3,521	3,002	1,958	1,478	10,392	4,010	-	51,563

C.1.6 Manpower Estimates

The estimated mine manpower requirements over the life of the mine plan are presented in Table C.1.6-1. Manpower requirements increase from 58 mine employees (58 hourly and 18 supervision and administrative employees) in the pre-production year (Year -1) to 394 in Year 4, the first year in which full production tonnage levels of 4.5 million CMT/year are achieved. For the period of Year 4 through to Year 10, mine manpower requirements remain relatively level, averaging around 400 full time employees. The workforce comprises 55 staff and an average of approximately 345 hourly employees.

Beginning in Year 11 increased waste stripping and longer coal haul distances require hourly manpower to increase as another 20 haul truck drivers are brought on for the next 10 year period. The number of operations personnel increases to 280 and maintenance personnel increases to 90. Supervision and administration employees remains at 55 individuals for a total mine workforce of approximately 425. The total manpower declines over the final 3 years commensurate with decreased production levels and lower strip ratios.

C.1.7 Haul Road Design

Mine rock and coal will be transported using end dump haul trucks. A common fleet of 220t capacity trucks have been chosen for both the rock and coal. With these trucks in mind the haul roads were designed to a maximum ramp grade of 8%. Haul roads are to be constructed with a 26 m running surface which is three times the width of the largest truck. Safety berms and ditches will be constructed, as required, along the length of the haul roads. Berms will be developed along the route at a minimum height of 1.5 m. Culverts will be installed to ensure water is appropriately conveyed. Construction materials for the road will be sourced from the pit, crushed and sized, and placed as road-course gravel. A design cross section of the road has been included in Figure C.1.7-1.

Table C.1.6-1 Estimated Workforce Requirements

Description	-1	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-23	LOM Avg.
OPERATIONS LABOUR															
Excavator & Loader Operators	8	21	19	25	27	28	30	30	31	30	29	30	30	17	26
Dozer Operators	10	27	25	32	37	39	40	41	42	41	40	41	41	21	35
Blast Crew and Drill Operators	6	15	16	15	24	19	20	19	24	20	26	28	26	13	22
Haul, Dump & Water Truck Operators	10	63	81	89	123	126	112	125	129	119	123	142	141	62	113
Grader & Utility Equipment Operators	7	13	18	22	27	27	26	27	27	28	29	29	30	21	25
Pump men	2	6	6	6	6	6	6	6	6	6	6	7	6	3	6
Laborer/Parts Runners	2	3	5	5	5	5	5	5	5	5	8	7	7	5	6
Sub-Total - Operations Labour	46	148	170	194	249	250	239	253	264	249	261	284	281	143	232
MAINTENANCE LABOUR															
Service Truck Drivers & Servicemen	3	6	13	15	20	19	20	19	20	19	20	21	20	13	18
Electricians	2	4	9	11	14	13	14	13	14	13	14	14	14	9	12
Welders	2	4	9	11	14	13	14	13	14	13	14	14	14	9	12
Heavy Duty Mechanics	2	4	9	11	14	13	14	13	14	13	14	14	14	9	12
General Mechanics & Apprentices	2	4	9	11	14	13	14	13	14	13	14	14	14	9	12
Tire men & Maintenance Helpers / Trainees	2	4	9	10	14	13	14	13	14	13	14	14	14	9	12
Sub-Total - Maintenance Labour	12	26	58	69	90	84	90	84	90	84	90	93	90	60	78
Total Hourly Labour	58	174	228	263	339	334	329	337	354	333	351	377	371	203	310

Table C.1.6-1 Estimated Workforce Requirements

Description	-1	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-23	LOM Avg.
SUPERVISION & ADMINISTRATION															
Mine Supervision & Administration	18	35	55	55	55	55	55	55	55	55	55	55	55	44	51
Total Workforce	76	209	283	318	394	389	384	392	409	388	406	432	426	247	362

C.1.8 Future Mining Potential

The Grassy Mountain Project has additional coal resources located north of the current 24 year development plan within the proposed mine permit area. These additional resources could be accessed through a northern expansion of the currently proposed mining pit, should the economics prove favorable.

Future expansion of the open pit Grassy Mountain Project could also occur within three potential metallurgical coal properties currently in the exploration opportunity phase of development to the north and east. Coal from these potential future expansion properties could be hauled or conveyed to the Grassy Mountain Project facilities locations for processing and shipment. Expansion into these areas would require a significant investment in drilling, coal quality testing, and engineering to fully understand the technical and economic aspects of the undertaking.

Any proposed expansion would be subject to a full regulatory process, similar to what has been conducted for the Grassy Mountain Project. This could include a full technical application, Environmental Impact Assessment (EIA) and additional regional, provincial, and Federal regulatory approvals along with a full consultation program with stakeholders.

There is also minor potential to develop a highwall mining operation in a few select coal seams that lie within the north end wall of the ultimate open pit. This potential is likely very limited in extent and requires a significant investment in drilling, coal quality testing, and engineering to fully understand the technical and economic aspects of the undertaking before it is deemed feasible.

C.2 Coal Handling and Processing

C.2.1 Description of Resource

The Grassy Mountain deposit is a medium volatile hard coking coal resource, with moderate in-seam ash. The Grassy Mountain lease is located in the Crowsnest Pass region of southwest Alberta, Canada, approximately 150 km south of Calgary and extends northwards from the township of Blairmore, 20 km east of the British Columbia border (Figure A.1.0-1).

Underground mining began in the area in 1913 with the start-up of the Greenhill's Mine, and subsequently a number of open cut pits operated within the Grassy Mountain area from 1956 to 1975. Since 1975, there has been no mining and no further exploration until recently.

The coal seams of the Grassy Mountain lease are medium volatile bituminous in rank, and lie within the Mist Mountain Formation of the Kootenay Group, which is Jurassic to Lower Cretaceous in age.

The coal in the past has been considered as a suitable source of coking and PCI coal for use in steelmaking, as well as for thermal use.

The main coal zones identified lie within Seams 1, 2 and 4, each of which consist of multiple plies with variable partings. The thickest seam representing approximately 50% of the resource is Seam 2. The Mist Mountain Formation in the Grassy Mountain area ranges from 66 m to 91 m thick, and contains coal within three zones or seam groups: Seam 1, Seam 2 and Seam 4.

Grassy Mountain lies within a succession of generally west-dipping thrust faults and associated folds, with broad open folds in the eastern parts of the region. Potential coal bearing areas are often contained within synclines that form topographic highs, and within large structurally continuous blocks on fold limbs. Section B.2.4 Geological structure and Figures B.2.0-1 and B.2.0-2 provide more details. The coal bearing zones in Seams 1 and 4 generally exist as multiple seams whereas the Seam 2 is usually represented as a single coal seam. The coal is generally highly sheared.

C.2.2 Coal Quality

C.2.2.1 Data Sources

The structural geology and quality models used for mine planning purposes are based on a total of 424 drill holes derived from a range of sources, but mostly an intensive drilling program conducted by CONSOL during 1973/75. A number of audit and bulk samples were also collected, including a bulk sample of 54,000 tonnes that was sent to Japan for evaluation. There doesn't appear to be any relevant data available from the bulk sample program.

In 2013/14, a large diameter core program was undertaken for plant design purposes alongside a slim-core program for mine resource and pit development purposes. Throughout the 2014 summer season, two bulk sample programs were undertaken, the first bulk sample was processed at Hazen in Denver, Colorado and the second bulk sample was processed at ACIRL in Maitland and Riverview, Australia.

C.2.2.2 Sampling and Testing Program

Seven large diameter (LD) cores (RGLD1001 through RGLD1007) were made available for plant design purposes for the Grassy Mountain project. These have been attrition tested and float/sink analyzed over four size fractions, with flotation testing of the finest material (-0.25 mm). The seven LD cores were drilled to cover the lease area from north to south as discussed earlier in the Geology section and as shown on Figure B.3.2-1.

The majority of cores intercepted seam 2 (except for RGLD1001 and RGLD1007). Seam 1 was intercepted in RGLD1001, 1003, 1004 and 1006 and Seam 4 intercepted in all except RGLD1006.

Sufficient mass was available for comprehensive attrition testing and float/sink analysis on multiple size fractions on the thicker coal intersections only. Samples from intersections less than 1.0 m or so were simply crushed and subjected to limited float/sink analysis. The thicker intersections, especially from Seam 2 which reached thicknesses up to 16 m, were separated into multiple working sections of the order of 3 to 4 m each to reflect variations in quality across the various plies.

A number of roof, floor and parting samples were also analyzed in a similar manner to allow full working sections, including allowances for coal loss and dilution reflective of actual mining practices to be considered.

This resulted in a total of 30 working sections suitable for plant design and Limn® simulation purposes. The seven cores provided good geographical coverage from the northern to the southern end of the lease, it should be noted that the suite of working sections analyzed didn't include the thinner plies, nor the near vertical limbs on the extreme eastern and western sides of the lease (Figures B.2.0-1 and B.2.0-2).

C.2.2.3 Bulk Sample Program – Hazen

The first bulk sample was approximately 1.5 to 2 tonnes of each seam, collected mid-2014, and sent to Hazen to be processed in August 2014.

Samples for all three seams were collected from existing workings, but unfortunately, despite best efforts at collecting the sample from below the surface oxidation zone, it was clear that the sample from Seam 4, the product of which registered a Free Swelling Index (FSI) of 1, was clearly a weathered sample.

A number of problems also arose during the processing of the bulk samples at Hazen, partly due to the nature and scale of the equipment, and lack of familiarity with the Grassy Mountain coal. It was clear that significant loss of fines occurred during the re-handling of the coal samples. The fines tend to be rich in the vitrinite component essential for good coking properties.

Two blends of Seams 1 and 2 were prepared and coked at the CANMET sole heated pilot coke oven, resulting in favorable Coke Strength after Reaction (CSR) values over 60, indicating a hard coking coal. A second bulk sample program was required to create an adequate product from each seam for blending. It was also decided to send the second sample to the formal pilot plant facility at ACIRL, in Maitland, Australia.

C.2.2.4 Bulk Sample Program – ACIRL

The ACIRL bulk sample program consisted of four samples, one of each seam, approximately 1 to 3 tonnes each. Seam 1 had both a pit sample and large diameter flooded reverse circulation drilling

(LDFRC) as the pit sample was potentially oxidized due to the location and exposure. These were collected late October 2014 and shipped to the ACIRL facility in Maitland in November 2014.

The ACIRL facility utilizes modern technology for coal processing, with the coarse fraction (-50 mm +2 mm) being processed by Dense Medium Cyclone (DMC), fine fraction (-2 mm +0.25 mm) being processed by both Reflux Classifier (RC) and spirals and ultrafine fraction (-0.25 mm) being processed by an internal recycle flotation column or conventional cell, depending on the amount of feed material. In particular, the pilot scale reflux classifier was used to process the fine -2.0 + 0.25 mm material, which allowed for lower cut-points more representative of the proposed flowsheet, compared with the spiral used in Hazen.

Coarse and fine coal processing was very successful, and product attained the target ash (9%) or lower. The amount of flotation material in the sample size was insufficient for the 600 mm diameter flotation column to process, so conventional cells were used. As previously found with these cells, the ash was mid-teens for most of the tests, higher than the target ash due to lack of froth washing. The FSI remained reasonably high for seam 1 and seam 4, with values of 7.5 and 8 with ashes of 15.4% and 15.8% respectively and relatively good for seam 2 with a value of 5 at an ash of 16.8%.

Table C.2.2-1 shows a summary of the proximate and carbonization properties for the combined product from each individual seam and a range of blends up to 50% Seam 2, which effectively represents 100% of production reporting to hard coking coal.

It can be seen from the carbonization data that despite Seam 2 having low fluidity and minimal dilatation, blends containing up to 50% of Seam 2 still maintained good carbonization properties. This reflects a similar proportion to the Seam 2 presence in the overall resource.

Sufficient sample was available to produce a further two blends which meant a total of five different blends were available for coke oven testing in the 400 kg pilot coke oven. Table C.2.2-2 shows the CSR and Coke Reactivity Index (CRI) results, all of which fell within the 60s and CRI values in low to mid 20s, demonstrating that hard coking coal similar to other Canadian hard coking coal products can be produced from a variety of blends from all three seam groups within the Grassy Mountain mining area.

Table C.2.2-1 Proximate, Ultimate And Carbonization Properties For Individual Seam And Blends

Sample Description	Proximate Analysis				Total Sulphur	CSN	Ultimate Analysis					Dilatation		Fluidity			Phosphorus
												Max.	Max.	Max.	Max.	Plastic	
	ADM	Ash	VM	FC			C	H	N	S	O	Contraction	Dilatation	Fluidity	Fluidity	Range	
	%ad	% ad	%ad	%ad	%ad		%daf	%daf	%daf	%daf	%daf	%	%	dd/min	log10	°C	%ad
Seam 1	1.2	8.0	26.0	64.8	0.79	7.5	88.2	5.1	1.3	0.9	4.5	24	98	1,600	3.20	90	0.023
Seam 2	1.3	8.6	22.7	67.4	0.37	6	89.0	4.8	1.2	0.4	4.6	20	-14	30	1.47	60	0.004
Seam 4	1.2	9.0	23.1	66.7	0.56	6	88.7	4.8	1.3	0.6	4.6	23	14	200	2.30	75	0.009
Blend 1 (20%1: 50%2: 30%4)	1.1	8.6	23.9	66.4	0.52	7	88.5	4.9	1.3	0.6	4.8	21	10	200	2.30	75	0.012
Blend 2 (28%1: 30%:2 42%4)	1.1	8.6	24.2	66.1	0.57	6.5	88.3	4.9	1.3	0.6	4.9	23	18	300	2.48	80	0.008
Blends 3 (33%1: 17.8%2 49.4%4)	1.1	8.6	24.3	66.0	0.60	7	88.3	4.9	1.3	0.7	4.9	20	36	400	2.60	80	0.010

Table C.2.2-2 Proximate, Carbonization and CSR/CRI Results from Pilot Coke Oven Testing of Various Blends of Seams 1, 2 and 4

Blend	Seam Proportion (%)			ADM%	Ash%	VM%	TS%	CSN/FSI	Fluidity	Dilatation			Vitrinite%	Ro Max%	Ash Composition		Basicity	P%	Pilot Scale		Laboratory Scale	
	S1	S2	S4	ad	ad				Max ddm	Contract%	Dilatation %	net expansion%	db		CaO%	Fe_2O_3%	Index	in coal	CSR	CRI	CSR	CRI
1	20	50	30	1.4	8.4	23.2	0.53	7	46	19	-4	15	50	1.18	2.7	4.9	0.11	0.01	64	25	66	29
2	28	30	42	1.2	8.9	23.7	0.58	7	105	24	11	35	50	1.21	2.7	5.5	0.12	0.02	65	23	64	28
3	33	18	49	1.2	8.6	23.9	0.61	7.5	145	18	20	38	48	1.20	1.7	3	0.07	0.02	68	21	67	26
4	15	52	33	1.0	8.4	23.2	0.51	7.5	30	25	-8	17	43	1.20	2.7	5.5	0.12	0.01	62	27	60	32
5	7	50	43	1.4	8.6	22.9	0.53	7	8	12	-8	4	46	1.18	2.7	5.1	0.11	0.01	62	26	64	29
Hazen 1	50	50		1.0	9.4	23.6	0.53	7	67	16	-13	3	49	1.17	3.2	4.5	0.12	0.05	65	22		
Hazen 2	40	60		0.8	9.7	23.7	0.52	7.5	45	18	-16	2	41	1.18	3.5	5	0.13	0.06	63	25		

C.2.2.5 Dewatering Test Work

Following the bulk sample wash, ultrafine (-0.25 mm) product and reject samples were sent for testing, to determine the optimal process technologies for dewatering this fraction. Key goals of the program were to look at the moisture content of the overall product without a thermal dryer, confirm dry reject co-disposal was feasible, and ensure recovery of all product was plausible (some dewatering technologies discard some of the ultrafine fractions). Test work samples were produced from the pilot test-work at Hazen and ACIRL, so that no chemicals which wouldn't be used in the Grassy Mountain preparation plant were present to affect the results.

C.2.2.6 Product Testwork – Bokela – Germany

Ultrafine product from each seam (produced at ACIRL) was run through a pilot filter test unit varying air flow-rate, air pressure and filter time to establish the effect on product moisture content. All seams were able to produce a filter cake of between 18 and 20% residual moisture with the use of air pressure only. Nominal filter times were better than expected and air flow rates were within expectations. It is expected from these results that when the ultrafine filter cake is combined with the coarse and fine products, the total product moisture will be below 10% on all three seams. Testing also included the use of steam in addition to the air filtration, and this on average saw a further reduction in the residual moisture to 9%.

C.2.2.7 Bulk Sample Program – ACIRL

Ultrafine rejects (produced at Hazen) were put through a pilot filter test program designed to simulate the material capture, through-put rates and cake moisture of a belt-press filter in operation. This test-work also looked at different belt materials, but determined that standard equipment could be used on this material. Conclusions from the assessment show that the performance would be in line with what was expected for this coal. Belt press filters will be able to produce a cake suitable for dry co-disposal with the coarse and fines reject. Filter cake should be between 30% and 35% total moisture according to the tests performed.

C.2.2.8 Bulk Sample Summary

Table C.2.2-3 shows a summary of the bulk sample and core data used by Riversdale's design team.

Table C.2.2-3 Summary Of Sample Data For Plant Design

Bulk Sample Description	Year Drilled and Analyzed	Analysis Done	Relevant Coal Seams
Seven (7) Large Diameter Cores	Early 2014	Attrition tested and float/sink analyzed over six (4) size fractions. Flotation testing of the finest fraction.	Seam 1
			Seam 2
			Seam 4
Hazen Bulk Sample	Mid-2014	Pilot plant tested – Dense Medium Bath, Spirals, Conventional Flotation	Seam 1
			Seam 2
			Seam 4
ACIRL Bulk Sample	Late 2014	Pilot plant tested – DMC, RC and conventional flotation	Seam 1
			Seam 1 LDFRC
			Seam 2
			Seam 4

C.2.2.9 Coal Sizing Distribution

Figure C.2.2-1 shows the plant feed sizing data obtained from the laboratory analysis of LD core samples. These sizing's were obtained from material being attrition tested (drop shatter and dry tumble) as per defined coal preparation and analysis standards.

The recommended design sizing envelope for the Grassy Mountain CPP plant feed is indicated by the red lines superimposed over the test data. The three different red lines represent the finest, nominal and coarsest cases.

Figure C.2.2-2 shows the plot for the process sizing Process sizing data was obtained from the attrition tested LD cores (after wet tumbling with metal cubes, as per coal preparation standards) including dilution. Process sizing was used in conjunction with the plant feed sizing to allow for breakage and attrition within the plant circuits, and ensure that the design procedure allows for adequate capacity in all process circuits.

Table C.2.2-4 shows the expected mass split of the coal feed for the various plant circuits based on the data shown in Figure C.2.2-2.

Table C.2.2-4 Mass Percent Distribution Between Plant Circuits (%)

Circuit	Size Range	Finest	Nominal	Coarsest
DMC	-50 mm + 1.7 mm	41.5	61	79.4
RC	-1.7 mm + 0.25 mm	36.1	25.7	14.7
Flotation	-0.25 mm	22.4	13.3	5.9

C.2.2.10 Washability

Throughout the coal quality simulations and process assessment, there were a number of assumptions used to emulate the real world mining scenario. These assumptions include:

- dilution was assumed to be a 15 cm coal loss (roof loss) and 15 cm floor dilution;
- working sections of the same seam that were adjacent without significant inter-seam parting (<60 cm) were assessed as a single working section for dilution;
- any single working section less than 60 cm, or multi-ply working section (with interim parting) less than 30 cm are considered non-mineable;
- dilution washability was taken from lab data wherever possible, however in the case of RGLD1001 (all sections), RGLD1003 (seam 4 floor) and RGLD1004 (seam 4 floor) where dilution data was not available, a generic blend of dilution by seam (weighted) was used. Blended dilution data came back at 91.7% ash for Seam 1 and 84.7% ash for Seam 4. No blended dilution data was necessary for Seam 2;
- feed moisture equal to 5% total moisture (TM);
- product moisture equal to 10% TM; and
- inherent moisture (IM) of 1%.

Yield predictions were calculated using Limn® computer based modeling simulations. The Limn® simulations used the data obtained from the LD core listed in Table C.2.2-5, and the dilution assumptions as described above.

Table C.2.2-5 Indicative Yield Window (Yield% Air Dried, Diluted)				
Circuit	**Size Range**	**Finest**	**Nominal**	**Coarsest**
DMC	-50 mm + 1.4 mm	30	60	80
RC	-1.4 mm + 0.25 mm	35	70	85
Flotation	-0.25 mm	40	65	80

There are two plies out of the 30 working sections that fall outside of this yield window for the coarse yield only. Both of these plies have abnormally high raw ash values compared with the mean, and so are considered outliers which are not representative of the normal feed, and potentially the core sample selected for analysis included excessive parting material.

The intention is to campaign individual feed sources and direct feed as much coal as possible to the CPP to be blended with other feed sources for product quality on the product stockpile (refer to Section C.2.6.6). In the situation where working sections are expected to lie outside the yield window defined, or are known to be highly diluted coal due to structural or operational reasons such as pit clean-up, or when recovering coal from historical underground workings as is the case of the expanded Mini Pit, the following mitigation strategies are suggested:

- Blend any highly diluted seams on the run-of-mine (ROM) stockpiles prior to feeding the CPP.
- If necessary, highly diluted plies will need to be processed in the CPP at a reduced plant feed rate to accommodate the increased rejects production if such coal is the only feed available at the time.

C.2.3 Wash Plant Design Criteria

C.2.3.1 General Criteria

The coal handling and processing plant (CHPP) system has been designed to achieve the following objectives:

- to receive, process, and handle an ultimate 8.3 Mtpy of ROM Coal;
- to produce saleable coal with the following target specifications:
  - Coking Coal: 9% to 10% ash (air dried), 10.0% nominal total moisture (as).
- to reclaim and train load 16,416 t (153 cars x 108t) of coking coal product over an 8hr period (as specified by CPR);

- to combine coarse rejects and dewatered tailings and convey to a loading/storage bin for trucking to the nominated emplacement areas within the mine;
- to minimise coal fines and dust; and

  to optimise operator manning levels.

Additional considerations include the following:

- plant layouts designed and optimised for minimal impact on facility operation and maintainability; and
- all plant to have a nominal design[1] life of 20 years, and be fit for purpose to operate in a harsh mining environment.

Target product moisture will be achieved at discharge from the process plant, before the coal is stockpiled. To ensure optimum metallurgical coal properties are maintained, the stockpile management aim will be to turn over the stockpiles as soon as possible so coking properties are not affected by age and exposure. The stockpile base will be free draining so any moisture that drains from the coal after processing will collect in the site run off system. Experience with management of similar coals in areas of torrential rainfall, shows that final product moisture is little affected by rain as stockpile shapes tend to shed water rather than saturate the coal. Some frozen coal is expected during the winter months, so each of the reclaim feeders will be equipped with a rotary pick head to break up the frozen lumps as they are reclaimed into the feeder. This ensures reliability in the reclaim and train loading systems is maintained.

C.2.3.2 Material Properties

C.2.3.2.1 Raw Coal Characteristics

- crushed raw coal
  - load calculations 950 kg/m^3
  - volume calculations 900 kg/m^3
  - relative density 1.4 – 1.8
- moisture content (ROM coal and crushed raw coal)
  - total moisture 5% (as)
  - air dried moisture 1% (ad)
- raw coal characteristics (typical)

[1] Sedgman expects that with regular scheduled maintenance including replacement of wearing components and refurbishment of corrosion protection, the facility will have a design life exceeding 20 years.

- Hardgrove Grindability Index 70–85
- UCS (Coal) 8.8–10.4 MPa
- UCS (Dilution maximum) 150 MPa
- relative density 1.35–1.68
- angle of repose 37°(34°lateral extent)
- surcharge angle 20°
- raw coal ash 15-30%
- dilution proportion up to 10%-25%
- dilution material sandstone, siltstone, mudstone

C.2.3.2.2 Product Coal Characteristics

- relative density 1.30 to 1.60
- bulk density design values
  - load calculations 970 kg/m^3
  - volume calculations 850 kg/m^3
  - angle of repose 37°
  - surcharge angle 20°
- product coal specifications
  - total moisture 10% (as)
  - air dried moisture 1.0% (ad)
  - target ash range 9-10% (ad)
  - maximum top size 50 mm

C.2.3.2.3 Coarse Reject Properties

- bulk density design values
  - load calculations 1,300 kg/m^3
  - volume calculations 1,100 kg/m^3
- angle of repose 37°
- surcharge angle 20°

C.2.3.2.4 Tailings Properties

- by dry disposal
  - total moisture 30.0–35.0% (as)

- load calculations 1,300 kg/m^3

C.2.3.2.5 Water Properties

As water will be obtained from the water management system (surface run-off, groundwater pit inflows) it is assumed that no retreatment will be required prior to the plant for process water.

The raw water properties required for processing are typically:

- pH 6.5 - 8.0
- solids content:
  - dissolved: 1,000 ppm (mg/L)
  - suspended: 100 ppm (mg/L)
  - 100% of +250 mesh (60 µm) particles removed.
- maximum individual dissolved ions:
  - hardness (Ca+, Mg+) 200 ppm (mg/L) as $CaCO_3$
  - calcium carbonate ($CaCO_3$) 10 ppm (mg/L)
  - sulphate (SO_4-) 50 ppm (mg/L)
  - chloride (Cl-) 1,000 ppm (mg/L).

C.2.3.3 Plant Operating Hours and Capacities

C.2.3.3.1 CHPP

- nominal annual operating hours 7,500 hours
- nominal ROM coal throughput capacity 1,120 t/h (ar)
- expected capacity (product) 4.5 million CMT/year (ar)
- life of mine average CPP yield (ar) 55%
- expected yield range (ar) 45-65%
- tailings filter system design capacity (Nominal) 31 t/h
- tailings filter system design capacity (Maximum) 93 t/h

C.2.3.3.2 Raw Coal Handling

- sizing (Slotted Grizzly controlled – 1 m aperture)
- ROM maximum lump size 1,000 x 800 x 800 mm
- ROM nominal top size (d95) 500 mm

- primary sized coal nominal top size (d95) after feeder breaker 250 mm
- ash content 15– 35 %
- sizing station
  - secondary sized coal nominal top size (d95) after double roll sizer 50 mm
- raw coal CPP feed coal
  - top size (d99) 60 mm
  - nominal top size (d95) 50 mm
  - CPP module feed conveyor feed rate 1,200 t/h nominal (ar)
- raw coal handling
  - ROM truck specification 220 tonne class
  - raw coal dump hopper capacity 450 t*

*(Struck volume to top of bump stop)

C.2.3.3.3 Product Handling

- CPP washed product coal storage capacity
  - total storage capacity per stacker 2 x 25,000 or 1 x 60,000 t
  - total storage capacity all stockpiles 4 x 25,000 or 2 x 60,000 t
  - optional expansion capacity of stockpiles; 6 x 25,000 or 3 x 60,000 t
  - stockpile height 18m
  - additional pushout stockyard storage per stacker 175,000 t
  - reclaim system and overland conveyor capacity (nominal) 2,000 tph
  - overland conveyor surge bin capacity 500 t

C.2.3.3.4 Remote Train Load-out

- train loading system type flood loading
- train load-out conveyor capacity 2,500 t/h
- train load-out bin capacity 300 t

C.2.3.3.5 Coarse Rejects Handling

The coarse and fines reject handling system will be combined onto a single rejects belt with the belt press filter cake (ultrafines reject):

- reject capacity;

- maximum reject rate (minimum 40% yield) 600 t/h [nom] (ad).

- reject coal handling:
  - ROM truck specification — 220 tonne class truck
  - reject bin size — 300 t
  - reject bin overflow stockpile size — 5,000 t

C.2.4 Description of Wash Plant and Operation

C.2.4.1 Plant Location and Layout Considerations

The site location selection was influenced by the following primary factors:

- siting the plant facilities on land owned by Benga;
- the ROM facilities were to be located close to the open pit to minimize coal haul distances;
- the CHPP and MIA building locations were not to not adversely impact current land users, fish bearing waters or endangered species; and
- take advantage of previously disturbed ground as much as possible.

The layout of the coal preparation plant is shown on Figure C.2.4-1. The legal description of the plant facilities is E ½ 23, W ½ 24; Twp. 8; Rge. 4; W5M.

C.2.4.2 Coal Cleaning

Various Limn® (a widely accepted industry plant simulation tool) models were developed in order to determine the optimum plant configuration, sizing splits between circuits, and processing options. The process was developed as a traditional coarse / fines / ultrafines processing plant with a large diameter dense medium cyclone (DMC) selected for the coarse fraction, reflux classifiers for the fine fraction, and two-stage flotation selected for the ultrafine.

C.2.4.3 Dense Medium Cyclone (DMC)

A single stage DMC was selected as simulation work indicated that a two-stage DMC would not be justified from a product quality and yield point of view.

C.2.4.4 Reflux Classifiers (RCs)

Simulation work showed that RCs would result in an increased yield across the range of coal seams over spirals due to their ability to balance the cut-point of the fines circuit with the coarse DMC circuit.

C.2.4.5 Flotation Circuit

The flotation circuit was configured in a two-stage cleaner/scavenger arrangement to ensure maximum recovery of the low-ash flotation concentrate under all likely operating conditions.

In a two-stage flotation circuit, optimal froth addition can be used in the first stage to maximize flotation yield, while the second stage can be utilized to scavenge any remaining product coal from the first stage.

Air induced flotation cells with a secondary-stage tailings recycle have been selected to minimize cell volume, while maximizing froth-carrying capacity. The second stage tailings recycle will allow second stage maximum recovery, whilst also providing a constant feed sump level without adding excess water to the circuit.

Once the key unit processes were selected the Limn® model was used to compare different process configurations and variables and help determine the optimum plant configuration. A number of scenarios were run to test these key processing decision areas, with the resultant conclusions:

- The optimum size split to the DMC was selected *via* simulation of different de-sliming screen apertures. The simulations indicated the maximum yield occurred at 1.4 mm w/w however there was less than 0.2% yield difference between apertures of 1.0 mm w/w to 1.4 mm w/w. After sizing equipment, 1.2 mm w/w was selected to ensure a controlled range of feed size to the reflux classifier, while allowing some level of screen panel wear without overloading finer circuits.
- The optimum size split between reflux and flotation was determined by de-slime cyclone D50 and sieve bend aperture. Altering sieve bend aperture had very little impact on yield (sub 0.1% between 250 and 300 micron split) so that a D50 of 250 micron was selected as the optimal split for controlling loadings between the two circuits.

C.2.4.6 Product Dewatering

Dewatering of the various product streams will be accomplished by the following unit operations to minimize product coal moisture:

C.2.4.6.1 Centrifuges

Coarse coal (-50 mm +1.7 mm) will be dewatered using a conventional vibrating basket centrifuge. These are an industry proven technology which is known to perform well for minimal capital and operating costs. Fine coal (-1.7 mm +0.25 mm) RC product will be de-slimed by product thickening cyclones followed by dewatering with fine coal centrifuges.

The selected fine coal centrifuges are a scroll type centrifuge which use higher G forces than conventional vibrating basket centrifuges to dewater more efficiently. However, they have a top-size restriction. With the fine material, these machines are the most efficient choice in terms of both of capital and operating costs, for their performance in the circuits. Screenbowl centrifuges were also considered. However, as both technologies utilize mechanical dewatering, there would not be significant enough moisture benefits on this size fraction of coal, to justify the higher capital and operating cost per tonne throughputs of the screenbowl centrifuges.

C.2.4.6.2 Hyperbaric Disk Filter

Flotation product (-0.25 mm) will be concentrated using a coal thickener and then dewatered using a Hyperbaric Disc Filter (HDF).

HDF units give several advantages over other dewatering technologies; the ability to dewater to 18 - 20% moisture on the ultrafine fraction while capturing all material, additional dewatering capability if required using steam assistance, and comparable maintenance and operating costs.

Test-work on the HDF unit has shown a significant improvement in moisture over technologies such as screenbowl centrifuges, vacuum filters or horizontal belt filters. As such, the use of this equipment negates the need for a thermal dryer to get 10% surface moisture for the total final product.

C.2.4.6.3 Reject Dewatering

Current coal processing practices have several methods of rejects disposals, with industry standard being one of either co-disposal dams, or coarse reject disposal with a tailings dam for fine rejects, or rejects co-disposal.

From the outset of the project it was critically important that the water demand for the project be kept to a minimum. In the mountainous terrain of the Grassy Mountain site, providing land for both a raw water dam and a tailings dam, along with associated infrastructure would also require a significant capital cost for earth-works and would increase the project footprint. As raw water usage is one of the primary concerns at the Grassy Mountain site, it was decided to choose the most water conservative option available. This motivated the design team to dewater the entire rejects stream and to co-dispose this material in the rock disposal areas.

Dewatering of the various reject streams will be accomplished by the following unit operations to minimize reject material moisture and allow for dry co-emplacement.

C.2.4.6.4 Dewatering Screens

Coarse (-50 mm +1.7 mm) and fine (-1.7 mm +0.25 mm) reject material will be dewatered by vibrating screens as follows:

- coarse reject material dewatered by multi-slope (banana) screen with a drain and rinse section to recover maximum magnetite. This technology efficiently washes off adhering medium while dewatering coarse reject; and
- fine reject material dewatered by a high frequency screen, which is efficient in both through-put and dewatering capability.

C.2.4.6.5 Tailings Filter Press

Ultrafine (-0.25 mm) reject material will be concentrated using a tailings thickener and then dewatered by belt press filters (BPF) which utilize two belts forced together around the material to expel free water. Test work has determined that these units will be able to produce a 30 – 35% moisture cake at high throughput rates when compared to similar technology.

Material capture rates from BPF test-work was above 95% which will minimize the amount of material recycled through the tailings thickener.

C.2.4.6.6 Processing Plant Consumables

The following table lists the annual quantities of chemicals required (at the full 4.5 million CMT/year production rate) in the coal washing process.

Table C.2.4-1 Proposed Consumables Planned for Coal Cleaning Process

Plant Consumables	Consumable Application	Usage Rate	Units	Annual Consumption	Comment
Flocculant (anionic)	Thickener fine refuse settling	0.007	kg/ROM t	58,100 kg	BASF's Magnafloc 336
Flocculant (cationic)	Thickener fine refuse settling	0.003	kg/ROM t	24,900 kg	BASF's Magnafloc 1425
Flocculant (anionic)	Belt press filters	0.032	kg/ROM t	265,600 kg	BASF's Magnafloc 336
Flocculant (cationic)	Belt press filters	0.010	kg/ROM t	83,000 kg	BASF's Magnafloc 1425
Flocculant (anionic)	Coal Thickener	0.007	kg/ROM t	58,100 kg	BASF's Magnafloc 336

Table C.2.4-1 Proposed Consumables Planned for Coal Cleaning Process

Plant Consumables	Consumable Application	Usage Rate	Units	Annual Consumption	Comment
Flocculant (anionic)	Hyperbaric Filters	0.010	kg/ROM t	83,000 kg	BASF's Magnafloc 336
Flocculant (cationic)	Hyperbaric Filters	0.005	kg/ROM t	41,500 kg	BASF's Magnafloc 1425
Magnetite	Coarse coal cleaning	0.400	kg/ROM t	3,320,000 kg	
MIBC	Frother	0.121	kg/ROM t	1,004,300 kg	Methyl Isobutyl Carbinol
Diesel	Collector	0.330	L/ROM t	2,739,000 L	
TLO Anti-freeze	Prevent rail car freeze up	15	L/car	160,714 L	25% usage factor applied
TLO Dustbinder	Dust suppression on rail cars	2.7	L/car	115,714 L	

C.2.5 Process Flowsheet – Nominal Flows

C.2.5.1 Plant Water Balance

The coal handling and preparation plant has been designed with water conservation as a key priority. Unlike many western Canadian coal preparation plants, the proposed Grassy Mountain plant will not discharge fluid tailings into a storage pond. Dewatering of all the product and rejects streams inside the plant has been incorporated into the design to minimize the amount of makeup water required in the process. Some of the makeup water leaves the site in the finished washed coal product and some remains in the recombined tailings stream (dry tailings) that gets co-disposed with the mined rock in the SRDA. For the dewatering of the product, the latest technology has been incorporated combining coarse and fine dewatering with hyperbaric filters for the ultrafine product. Coarse coal centrifuges will dewater the coarse product and the effluent stream will be recycled as process water within the plant. Fine coal scrolling centrifuges will be used to dewater fine coal and the effluent stream will be used as feed into the ultrafine circuit. Ultrafine coal will be dewatered *via* hyperbaric disc filter which the effluent of the filter will report to the coal thickener and be used as process water within the plant. Dewatering of the coarse and fine reject will be done by banana screen and high frequency screen respectively. Ultrafine reject will be dewatered using belt press filters creating a conveyable and stackable reject when combined with the coarse and fine fractions. The only water to leave the plant will be the moisture difference between the raw coal and the dewatered product and rejects.

A series of wash-down hoses will be available for clean-up within the CPP, product and reject stations. CPP wash-down system is accompanied by floor-sump pumps which will pump any water and material back into the plant. Within the raw coal, product and reject stations there will be concrete floor sumps from which material and any wash-down water can be collected in a front end loader and placed onto the plant floor to be pumped back and recovered within the process.

A plant water balance flow sheet has been included as Figure C.2.5-1 and an overall CHPP Material balance has been included in Figure C.2.5-2.

C.2.5.2 Product Stream Monitoring Details

C.2.5.2.1 Coal Processing Plant Sampling Points

In order to maintain process integrity the coal processing plant will have a number of sampling points. The data collected will be used to modify the operating parameters associated with the various vessels. A detailed listing of the samples, their location and type has been included in the Table C.2.5-1.

Table C.2.5-1 CPP Sampling Points

Sample	Location	Type
DMC Feed	De-slime Screen Discharge Chute	Manual
DMC Product	Product D&R Screen Discharge Chute	Manual
DMC O/F Medium Density	Back of Product D&R Screen Drain Section	Manual
DMC Reject	Reject D&R Screen Discharge Chute	Manual
DMC U/F Medium Density	Back of Reject D&R Screen Drain Section	Manual
Coarse Coal Centrifuge Product	Front of Coarse Coal Centrifuge	Manual
Coarse Coal Centrifuge Centrate	Centrate Pipe Under Centrifuge	Manual
Deslime Cyclone Feed	Feed Pipe to De-sliming Cyclones	Spear
Deslime Cyclone O/F	De-sliming Cyclone O/F Launder Discharge pipe	Spear
Deslime Cyclone U/F	De-sliming Cyclone U/F Launder	Manual
Product Thickening Cyclone Feed	Feed pipe to product thickening cyclones	Spear
Product Thickening Cyclone O/F	Product thickening cyclone O/F launder discharge pipe	Spear
Product Thickening Cyclone U/F	Product thickening cyclone U/F launder	Manual

Table C.2.5-1 CPP Sampling Points

Sample	Location	Type
Fines Feed	Feed Pipe to Reflux Classifiers	Spear
Sieve Bend O/F	Screen O/F Discharge Chute	Manual
Sieve Bend U/F	Screen U/F Discharge Chute	Manual
Fine Coal Centrifuge Product	Front of Fine Coal Centrifuge	Manual
Fine Coal Centrifuge Effluent	Effluent pipe under Centrifuges	Manual
Fines Reject Dewatering Screen O/F	Screen Discharge Chute	Manual
Fines Reject Dewatering Screen U/F	Discharge Pipe	Spear
Primary Flotation Feed	Flotation Feed Pipe	Spear
Primary Flotation Product	Cell lip of primary flotation cell	Manual
Primary Flotation Tailings	Discharge Pipe from primary flotation cell	Spear
Secondary Flotation Feed	Secondary Flotation Feed Pipe	Spear
Secondary Flotation Product	Cell lip of secondary floatation cell	Manual
Secondary Flotation Tailings	Discharge Pipe from secondary flotation cell	Spear
Tailings Thickener Underflow	Thickener Underflow Pump Suction side	Spear
Coal Thickener Underflow/HDF Feed	Coal Thickener Underflow Pump Suction-side	Spear
Hyperbaric Product	Discharge from screw feeder	Manual
Hyperbaric Effluent	Hyperbaric Effluent Pipe	Spear
Belt Press Filter Feed	Each of the Belt Press Filter Feed pipes	Spear
Belt Press Filter Cake	Discharge Chute of each Belt Press Filter	Manual

C.2.5.2.2 Coal Handling Plant Sampling Points

As defined on the materials handling flowsheets, the following belt scales samplers and online analyzers will be installed to aid in rate control, inventory measurement and quality monitoring:

- raw coal conveyors:
  - ± 0.5% accuracy belt weigher on CV-101;
  - single stage sample system on CV-201; and
  - ± 0.5% accuracy belt weigher on CV-201.

- rejects handling conveyors:
  - ± 0.5% accuracy belt weigher on CV-702; and
  - single-stage sampler on CV-702.
- product handling conveyors:
  - two-stage sample system on CV-801;
  - ± 0.5% accuracy belt weigher on CV-801;
  - ± 0.5% accuracy belt weigher downstream of RC-801, 2, 3 and 4; and
  - two-stage sample system on CV-805.
- overland and TLO conveyors:
  - ± 0.5% accuracy belt weigher on CV-807; and
  - ± 0.5% accuracy belt weigher on CV-851± 0.5% accuracy belt weigher on CV-851.

C.2.5.3 Process Chemical Description / Use

Flotation reagents will be pumped to the appropriate delivery or injection points in the CPP to assist with the operation of the flotation cells to process the ultra-fine material. Flotation reagents will be stored in a reagent farm complete with all required dosing and transfer pumps in accordance with the current Canadian codes for storage of the selected reagents.

Flocculent will be supplied to the tailings thickener, coal thickener, belt press filters and if necessary the hyperbaric disc filter *via* containerised preparation and make-down systems located adjacent to the magnetite storage shed. The anionic flocculent will be a dry-powder system which will use 500 kg bags stored and used from an upper container which then falls directly into the make-down hopper and system to minimise spillage and wasted material. The cationic flocculent system will be a liquid system utilising 1,000 litre bulk bins and a simple water injection make-down as the preparation.

C.2.6 Equipment Flowsheets – Coal Handling

An overall equipment flowsheet has been provided on Figure C.2.6-1: Overall Material Handling Flowsheet.

C.2.6.1 Run-of-Mine (ROM) Coal Stockpile area and Sizing

The ROM coal hopper will receive ROM coal direct from rear dump mine trucks or from large front end loaders reclaiming ROM coal from stockpiles adjacent to the hopper. The use of ROM coal stockpiles will be minimized as the goal will be to direct dump as much ROM coal into the hopper as possible, reducing associated re-handling costs, and size degradation of the coal prior to processing. When ROM coal is reclaimed from the stockpile, it will be fed into the hopper by front end loader, or by front end loader and dump truck combination.

The ROM coal hopper capacity will be 1.5 – 2.0 times a mine truck payload volume to provide appropriate surge capacity.

The bin will be fitted with additional features, including (Figure C.2.6-2):

- a dust hood over the bin to contain air born dust generated during the dumping cycle;
- rock grizzly protection to exclude large dilution and break up large coal lumps; and
- an enclosed feeder breaker under the bin for feed control and primary sizing.

C.2.6.2 Raw Coal Sizing System

ROM coal will be reclaimed from the hopper by a feeder breaker (FB-101) with a nominal capacity of 1200 t/h. The Feeder breaker will size the coal to -250 mm, and will discharge it onto a 1,200 t/h nominal capacity raw coal conveyor (CV-101), for transfer to the sizing station. A weigh scale (WT-101) will be installed on this conveyor and used to control the feed rate of the feeder breaker. A tramp iron magnet (MG-101) and metal detector (MD-101) will be located along the conveyor and will remove ferrous material and stop the conveyor on detection of non-ferrous metal tramp in the coal stream (Figure C.2.6-3).

Raw coal conveyor (CV-101) will deliver primary sized coal to the sizing station (ST-101) which will be a modular construction arrangement, completely enclosed with cladding.

The sizing station will have a nominal feed capacity of 1,200 t/h. Raw coal will discharge from the raw coal conveyor on to a double deck multi slope screen (SC-101) at the top of the sizing station. The oversize from the primary screen deck will either be discharged into a double roll sizer (CR-101), or upon activation of a flop gate, it can also be discharged onto a ground rejects pile adjacent to the sizing station. This feature allows for extraction of hard rock dilution without further processing, if it is present in the feed coal, or processing of the total raw coal stream. The oversize from the screen lower deck will always discharge into the double roll sizer. The undersize of the lower screen deck will discharge onto the sizing station outgoing conveyor (CV-102), a 42" wide conveyor belt with a 1,200 t/h nominal capacity. The screen will remove the natural undersize in the primary sized feed, reducing size degradation of the finer coal and optimizing the performance of the final sizer. The double roll final sizer will provide further reduction to -50 mm top-size and will direct the remaining raw coal onto the sizing station transfer conveyor (CV-102).

A dry clean out pit will be provided adjacent to the sizing station and will be suitable for cleaning by an IT 38 loader or vacuum truck. Conveyor CV-102 will transfer the sized raw coal from the sizing station the top of the 500 t plant feed bin (BN-102) and discharge into the bin below.

C.2.6.3 CPP Feed System

Conveyor CV-102 will transfer the sized raw coal from the sizing station to the top of the 500 tonne plant feed surge bin (BN-102) and discharge into the bin below. The coal will be fed from the surge bin by a vibrating feeder (FE-201) onto the plant feed conveyor (CV-201) and elevated into the Coal Preparation Plant (CPP) at a nominal capacity of 1,120 tph. CV-201 will be fitted with a weigh scale (WT-201) to control the plant feed rate through the feeder. A single stage sampler (SA-201) will be installed on the conveyor to take incremental samples of the plant feed material (Figure C.2.6-4).

C.2.6.4 Coal Preparation Plant

The CPP building will be designed to accommodate all process equipment and will include lifting facilities and a driveway path alongside the internal structure to allow access vehicles and maintenance vehicles to enter into the building, and allow the door to be shut behind them. The CPP will be of stick-build steel design and construction and will be a fully enclosed and cladded structure.

The CPP building will house all processing equipment with an annex to house the tailings belt press filters. A general view of the CPP building is shown on Figure C.2.6-5.

The processing plant will be designed to process an ultimate 8.3 Mtpy of ROM coal. Raw coal will be washed by seam, with product blending to be controlled in the product handling section of the CHPP. Plant feed and product will have a topsize of 50 mm.

The processing plant will consist of three major circuits, defined by coal size:

- coarse (-50 mm; +1.2 mm wedge wire);
- fine (-1.2 mm wedge wire; +0.25 mm); and
- ultrafine (-0.25 mm).

Coarse coal will be treated by DMC, fine coal treated by RC and ultrafine coal processed in two-stage flotation, utilized in a cleaner scavenger formation.

Clean coal will be dried to sufficient levels so that it can be handled and meet product specifications without the use of a thermal drier. This will be achieved by drying ultra-fine clean coal using a hyperbaric disc filter. Reject materials will all be dried to a sufficient level to allow co-disposed in the rock disposal areas from the open pit therefor no continuous use tailings dam will be required. A mineable tailings cell will be provided so that any plant emergency overflows will be captured for re-handling.

Figure C.2.6-6 shows the wash plant basic flow diagram. The process flow from the incoming raw coal feed to the discharge of the clean coal conveyor feeding onto the clean coal stockpiles or the reject conveyor discharging to the reject bin is described below

C.2.6.5 Plant Feed System

The CPP will be fed from a 500 tonne surge bin containing sized raw coal (50 mm x 0 mm). This surge bin capacity will be used to smooth minor disruptions in the raw coal sizing system so it will not disrupt plant feed. The plant feed conveyor (CV-201) will transfer coal from the surge bin at a nominal feed rate of 1,120 tph to the plant.

C.2.6.5.1 De-sliming Circuit

Raw coal fed from the plant feed conveyor will be directed into a plant feed hopper, which will feed raw coal directly onto two desliming screen vibrating feeders. Each feeder will distribute the raw coal across the width of a deslime screen.

Deslime screen panels will be 1.2-mm w/w profile, separating efficiently at an approximate square particle aperture of 1.7 mm. The -1.2-mm w/w undersize fractions will collect in the desliming screen underpans and fall to the common desliming cyclone feed sump. Tramp screens in the desliming screen underpans will prevent oversize material from reporting to the desliming cyclone and fines section, in the event of screen panel wear. The -50-mm +1.2-mm w/w coal fractions discharged from the desliming screen overflows will be flushed by correct medium (controlled density medium) into the DMC feed sumps.

C.2.6.5.2 Dense Medium Circuit (Coarse Coal Circuit)

The deslime screen oversize coal fraction from each deslime screen will be processed through a dedicated dense medium circuit, *i.e.* the oversize of one deslime screen will report to one DMC feed sump which will report to one DMC and the oversize from the second deslime screen will report to the second DMC feed sump which will report to the second DMC (Figure C.2.6-7).

The process flow description below describes one of the parallel DMC circuits.

The coarse coal fraction received from the desliming screen will be sluiced with magnetite slurry (correct medium) at a controlled density into the DMC wing tank. Coal and medium slurry will be pumped at a constant pressure and flow rate into the ceramic lined 1,150-mm diameter DMC. The higher density reject material will discharge from the DMC *via* the cyclone spigot into the underflow collection box, whilst the lower density material will report to the overflow collection box *via* the cyclone vortex finder.

Higher density reject material collected from the cyclone will be directed into the reject drain and rinse feed box where it will be distributed across the width of a 2.4 m x 6.1 m, multi-slope reject screen (banana screen). The initial drain section of the screen will remove the majority of the magnetite slurry. The rinse section will collect the remaining adhering medium, utilising a series of spray bars and dams to recover the magnetite. Dewatered coarse reject material will be discharged from the end of the screen onto the rejects conveyor (CV-702).

Lower density product material collected from the cyclone will be directed into the product drain and rinse feed box where it will be distributed across the width of a 3.6 m x 6.1 m, multi-slope product screen (banana screen). The initial drain section of the screen will remove the majority of the magnetite slurry. The rinse section will collect the remaining adhering medium, utilising a series of spray bars and dams to recover the magnetite.

C.2.6.5.3 Coarse Product Dewatering

Coarse product coal from the product drain and rinse screen section will report to one centrifuge for product dewatering. The centrifuge will be a horizontal basket type and will discharge product directly onto the product conveyor, CV-801.

The centrifuge effluent from each centrifuge will drain to the respective DMC circuit dilute medium sump for recovery of any adhering magnetite.

C.2.6.5.4 Density Control and Magnetite Recovery Circuit

The correct medium sump will contain an over-dense medium slurry. Clarified water will be injected into the suction of the correct medium pump to achieve the desired separation density. The density will be measured by a nuclear density meter located on a steel spool of the correct medium pump discharge pipe, and use a feed-back loop to adjust the amount of water injected into the correct medium pump suction.

Correct medium will be pumped into the coarse discharge chute of the de-slime screen, where it will flush the coarse coal into the DMC feed sump. Medium will be returned to the circuit through the drain and rinse screen split under-pan, incorporating a “drain” section and a “rinse” section. The drain section has no water addition and medium drained in this section will report directly to the correct medium sump. The rinse section which catches a dilute medium slurry will return it to the dilute medium sump, to be pumped to magnetic separators for magnetite recovery and concentration. Concentrate from the magnetic separators returns to the correct medium sump (as over-dense media) whilst the effluent (water and fine coal particles) will be used as de-sliming screen slurry water.

Fresh magnetite slurry will be made up in a concrete magnetite storage sump located in a separate building adjacent to the plant. Raw magnetite slurry will be pumped into the correct medium sump as over-dense media. Density control and magnetite recovery circuit is shown on Figure C.2.6-8.

C.2.6.5.5 Fine Coal Circuit

Mixed fine/ultrafine particles from the de-sliming screen underflow will discharge into the de-sliming cyclone feed sump where it will be pumped into the de-sliming cyclones. De-sliming cyclones perform a size based separation resulting in two distinct size fractions; fine coal (-1.2 mm w/w +0.25 mm) and ultrafine coal (-0.25 mm). Fine coal will report to the cyclone underflow and discharge onto a pair of sieve bends, the oversize from the sieve bends will report to the fines feed sump. Ultrafine coal will report to the de-sliming cyclone overflow and the sieve bend underflow which will discharge into the primary flotation feed sump.

Fine coal slurry from the fines feed sump, will be pumped to the RC's for a density based separation. Separation density will be measured across the fluidised bed by looking at the pressure differential across two sensors of known height apart and controlled by user input into a feedback loop on the tailings valve opening, increasing or decreasing the rate of tailings removed from the unit. Cut-point density will be selected so that the incremental ash of each circuit is balanced for optimal yield.

Reflux product will flow from the top launder into a fines product sump. Fines product will be pumped into a cluster of product-thickening cyclones. Thickened underflow from the cyclones will report to four fine coal (scrolling) centrifuges, which will discharge dewatered fine product onto the product conveyor (CV-801). Thickening cyclone overflow will report to the fines effluent sump where it will be recirculated as process water to slurry the incoming plant feed.

Reflux reject material discharging from the bottom will report to four high frequency screens for dewatering. Fine dewatered rejects (high frequency screen overflow) will report to the rejects conveyor while the screen effluent (underflow) will report to the fines effluent sump.

The fine coal circuit configuration is shown on Figure C.2.6-9.

C.2.6.5.6 Flotation Circuit

Collector reagent will be added to the primary flotation feed sump along with the ultrafine coal fraction. Ultrafine material will be processed by two-stage flotation in a cleaner-scavenger set-up, with the primary flotation cell rejects being re-processed in the secondary flotation cell. Two-stage flotation will optimize recovery, while also maximizing reagent usage and operational flexibility.

Primary flotation feed will be pumped from the sump to the primary flotation cell, with frother reagent being injected into the pump discharge. Primary flotation feed sump level will be controlled

by process water addition from the coal thickener overflow, (allowing re-agent recirculation) and reject recirculation. Froth depth will be controlled by adjustment of the flotation cell tailings valve, and measured *via* differential pressure sensors. Primary flotation product will be collected in the primary flotation cell concentrate launder and discharged to the coal thickener. Primary flotation reject will be discharged into the secondary flotation feed sump.

Secondary flotation feed will have collector and frother addition to ensure maximum recovery of ultrafines, crucial to the Grassy Mountain product coal. Secondary flotation feed sump level will be completely controlled by rejects recirculation. Secondary flotation product will report into the flotation product launder and flow *via* gravity to the coal thickener. Secondary flotation reject will discharge into the tailings thickener.

The coal thickener will use two types of flocculent; an anionic powder flocculent and cationic liquid flocculent to assist in particle settling. Flocculent will be prepared in a modular plant adjacent to the CPP, and added to the coal thickener de-aeration tank and feed-well.

Flotation product will be thickened to approximately 30% to 35% solids in the coal thickener and will be controlled *via* a density reading and variable frequency drive (VFD) on the underflow pump. The underflow coal slurry from the coal thickener will be pumped to the HDF units, which will dewater product coal filter cake to approximately 18% surface moisture, and discharge the cake *via* a screw feeder onto the product conveyor CV-801.

Flotation reagents will be pumped from a nearby tank facility. The simplified flotation circuit configuration is shown on Figure C.2.6-10.

C.2.6.5.7 Tailings Thickener

The tailings thickener will be fed with ultrafine coal rejects from the flotation tailings and the fines reject effluent sump.

Flocculant will be added to the tailings thickener feed to assist settling of the tailings prior to discharging into the feed-well of the thickener. Two types of flocculant will be used in the thickener, an anionic powder flocculant and a cationic liquid flocculant. Each flocculant will have a make-down system to dilute and age the flocculant prior to injection. Flocculant will be supplied to the tailings thickener from a flocculant plant, located at the CPP.

The thickener overflow will fill the clarified water tank and will be used as process water around the CPP.

Thickened tailings will be raked to the centre well and will be pumped to and dewatered by belt press filters before discharging onto the reject transfer conveyor (CV-701).

C.2.6.5.8 Rejects and Tailings Dewatering Circuit

The simplified tailings dewatering circuit configuration is shown on Figure C.2.6-11.

Thickened tailings will be raked to the centre well of the thickener and pumped to the belt filter feed tank. The tailings material will be agitated in the belt filter feed tank and then pumped to the belt press filters. Each belt press filter will be individually pump fed from a dedicated pump. Anionic flocculant will be dosed into the discharge line of each mono pump, which will pump the filter feed slurry into an agitation or conditioning tank (agi-tank), where cationic flocculant will be added prior to feeding each belt filter.

Dewatered tailings filter cake will report to a short rejects transfer conveyor (CV-701), which will then discharge onto the reject conveyor (CV-702). The reject conveyor discharges the combined coarse and fine rejects into the rejects bin. Filtrate from the filters will be collected in the fines reject effluent sump and pumped to the tailings thickener.

C.2.6.5.9 Rejects and Tailings Disposal

Dewatered tailings filter cake will be collected on a short rejects transfer conveyor (CV-701) within the CPP building Tailings Filter annex. The transfer conveyor will have a nominal capacity of 300 tph.

The main rejects conveyor (CV-702) will first receive coarse and fines rejects from the discharge of the reject D&R and HF screens prior to receiving the tailings filter cake *via* the rejects transfer conveyor (CV-701). This helps minimise the likelihood of filter cake material adhering to the conveyor belt, and maximises handleability of the rejects through the materials handling system.

The main rejects conveyor (CV-702) will have a nominal capacity of 600 tph. The conveyor will have a weigh scale (WT-701) and a single stage sampler (SA-701) will be installed on the conveyor to take samples of the plant reject material as required. This conveyor will direct all the rejects to the rejects bin (BN-701). The section of the main rejects conveyor (CV-702) that will not be inside the CPP will be fully enclosed and insulated and will be heated.

The rejects bin (BN-701) will have a capacity of 300 tonnes, and will be designed for loading rear dump trucks up to the size of a Komatsu 930E. The reject bin discharge gate will be hydraulically operated and equipped with a drainage system to help drain water from the bin. The rejects bin will have insulated cladding on the top and underside areas of the bin and a heated cone section to help keep rejects material above freezing.

The concrete truck pad underneath the rejects bin will be electrically heated to minimise freezing of any spillage on the truck drive path, providing a safe, year-round operation (Figure C.2.6-12).

C.2.6.6 Clean Coal Storage and Reclaim

The CPP will deliver washed product coal onto a single product coal transfer conveyor (CV-801). Figure C.2.6-13 shows the simplified flowsheet of the product handling system.

The product coal transfer conveyor (CV-801) will have an 800 tph nominal capacity and will deliver washed product coal to the product stockpile system. A weigh scale (WT-801) will be located on this conveyor.

For coal quality management a two-stage sample system (SA-801) will be installed on the product coal transfer conveyor (CV-801) downstream of the CPP to take samples of washed product coal.

The product coal transfer conveyor (CV-801) runs through the enclosed and heated CPP. After it leaves the CPP building, CV-801 will be contained within fully enclosed, insulated, and heated galleries in order to keep the moist product coal from freezing prior to the stockpile.

Product Stacking

Figure C.2.6-14 shows a plan view of the product stockpile pad showing the separate stockpiles that will be able to be formed. This figure also shows room in the footprint for a future/optional third stacker. Figure C.2.6-15 shows the flowsheet arrangement of the washed coal product stacking system.

After coming from the CPP *via* the washed product coal conveyor (CV-801), the washed product coal will then be directed to a series of conveyors and stackers that will allow washed product coal to be directed to one of two stackers for separate stockpiling.

The washed product coal conveyor (CV-801) will direct the washed product coal into the transfer tower (ST-801) which will use a flop gate and bifurcating chute arrangement to direct the washed product coal onto either a stacker (SK-801), or onto a downstream transfer station (ST-802), *via* a transfer conveyor (CV-802). The stacker (SK-801) will have a nominal stacking capacity of 800 tph and the transfer conveyor (CV-802) will have a nominal capacity of 800 tph.

Product coal directed into the transfer tower (ST-802) will be transferred onto the second product stacker (SK-802). The stacker (SK-802) will have a nominal stacking capacity of 800 tph.

Both product stackers, SK-801 and SK-802, will be identical in design with luffing and slewing capability. The tip of the stacker boom will be continually luffed to a position such that it is only 1 to

2 metres above the top of the coal stockpile as it is formed. This minimises the drop height of the coal and any potential dust generation.

The stockpile capacity of each radial stacker (SK-801 and SK-802) will be either a single stockpile approximately 60,000 tonnes, or two separate stockpiles approximately 25,000 tonnes each. Dozer push out will allow additional storage beyond that of the stacker's placement capacity. No heating will be installed from the product stockpile through to the TLO. Once the product material is frozen, it is better to leave it cold as it is in a competent form for rehandling.

Product Reclaim

Product coal will be reclaimed from the product stockpiles by dozer fed in pile reclaim feeders (RC-801, RC-802, RC-803, and RC-804). Each stacker stockpile arrangement will have two adjacent reclaim feeders. Each reclaim feeder will be equipped with a light duty breaker head which will break down any conglomerated lumps of frozen coal that may develop when the washed product coal is stockpiled in freezing conditions. Each reclaim feeder will have a nominal capacity of 2,000 tph.

The main drives of the reclaim feeders will be hydraulic to allow variable control of the washed product coal delivery flow onto the reclaim conveyor. The reclaim feeders will deliver washed product coal onto a reclaim transfer conveyor (CV-805), which has a 2,000 tph nominal capacity. The design of this conveyor will allow for -250-mm size frozen lumps of coal. Photograph C.1 shows the typical arrangements of reclaim feeders.



Photograph C.1 Reclaim Feeder - Typical Arrangement

Space will be made available for a future (optional) product stockpile expansion, which would include two product reclaimers (RC-805 and RC-806) and reclaim transfer conveyor (CV-805) extension. Figure C.2.6-16 shows the simplified flowsheet of reclaim transfer.

Each radial stacker has the ability to produce a pair of 25,000t nominal capacity piles. The push out capacity for one stacker, which combines the two piles, allows for a total nominal capacity of a 175,000 t/stacker. The height of the piles is 18 m.

The reclaim transfer conveyor (CV-805) will deliver washed product coal into the top of a loading bin (BN-801). The washed product coal will then be directed from the top of the bin, through the bin and directly onto the OLC (CV-807) and onto the TLO system.

A two-stage sampler (SA-802) will be installed on the reclaim transfer conveyor to allow collection of a final blended coal product prior to export. A metal detector (MD-101) will also be located along the conveyor and will stop the conveyor on detection of non-ferrous metal tramp in the product coal stream in order to protect the OLC conveyor belt.

For operations, blending of washed product coal will be achieved *via* the following:

- the operational method of simultaneous proportional reclaiming of different washed product coals from separate stockpiles onto the single reclaim transfer conveyor (CV-805); and
- a rotating chute will be installed on the top of the surge bin that feeds the OLC (BN-801). The rotating chute will deliver the coal in a circular pattern inside the bin mixing the reclaimed product coals together. It will be drawn down in a mass flow pattern through the bottom cone of the bin.

C.2.7 Overland Conveyor and Loadout Facility

A vibratory feeder (FE-801) located underneath the OLC loading bin (BN-801) will feed product coal onto the OLC (CV-807) at a nominal capacity of 2,000 tph (design capacity 2,200 tph to 2,300 tph). The OLC is designed for maximum capacity of a 1,200 mm wide belt travelling at 6.0 m/s around the proposed horizontal curve route. To increase the capacity further would require an increase in belt width and is a significant increase in capital.

The unheated OLC will transfer the product coal approximately 4.5 km and deliver it into a surge bin (BN-851) with a storage capacity of 500 tonnes. Under normal operations, the surge bin will run at around 20% to 30% capacity as its function is to provide surge capacity between the train loading system and the product stockpile. If there is a delay in the train loading operation, this also ensures the OLC doesn't stop.

A vibratory feeder (FE-851) will be located underneath the surge bin (BN-851) and will feed product coal onto the TLO bin feed conveyor (CV-851) at a nominal capacity of 2,500 tph. The TLO bin feed conveyor (CV-851) will have a nominal capacity of 2,500 tph and will deliver product coal into the TLO bin (BN-852), which has a capacity of 350 tonnes.

The TLO bin feed conveyor (CV-851) will be a fully enclosed and cladded conveyor in order to minimise visual impact and minimise noise. The TLO train loading system will be a flood loading arrangement. A hydraulic gate at the bottom of the bin will open and close using an electronic control system. The product coal will flow through the opened gate into a chute that will form the correct profile of coal into the railcars below.

Sensors installed next to the rail tracks will detect the position of the railcars and provide feedback for the opening and closing of the loading gate and to ensure the railcars will have the correct profile of coal. Weighing of the wagons will be *via* a Meridan type weigh scale system to enable the automatic loading of the train.

C.2.7.1 OLC Maintenance Provisions

The overland conveyor in this system is designed as an on demand unit and will only be used when loading trains. The surge bin capacity at the head end of the conveyor, and the train loading bin capacity only provide operational surge between the reclaim operations in the stockyard at the mine and the train loading operation (Figure C.2.7-1). Emergency storage as such will not be required and has not been provided.

The storage surge capacity for the system will be provided by push out of the nominal stockpile capacity of the plant. Mining operations and coal processing will continue uninterrupted when the conveyor is undergoing scheduled maintenance, or indeed if the conveyor fails. For 4.5 Mtpa of shipped product coal, the conveyor will be in use for nominally 4.5 Mt / 2,000tph = 2,250 hours per annum, so there is plenty of operational time available to schedule maintenance without affecting operations.

Most faults that occur with the overland can be repaired when the belt is full or empty, and it will not be necessary to completely empty the belt for repair. Installed power is sufficient to restart the belt fully loaded under all loading conditions. If the fully loaded conveyor fails through a splice failure or a ripped belt, the area to be repaired would be locally cleaned off manually and cleaned up with loader and truck, the repair carried out and the operation restored.

C.2.8 Coal Handling and Processing Plant (CHPP) Services Buildings

The CHPP service buildings will cater for the operational employees (management, operations and maintenance staff) and will be ergonomically laid out in order to efficiently conduct day to day operation of the CHPP. The facilities will be located adjacent to the CPP for easy access to the ROM, rejects and product handling areas. The CHPP control room will be integral with the office building and will provide full visibility to the ROM. These facilities will be of the demountable style suitable for local climatic conditions.

C.2.8.1 CHPP Offices

CHPP offices will comprise a common building that will include the following:

- plant control room;
- first aid room;
- ablutions and crib facilities; and
- change room and locker facility for CHPP operations personnel.

The mine dry and control room waste water will be captured in a localised tank for removal by suction truck.

C.2.8.2 CHPP Workshop

The CHPP workshop will be laid out with three bays and have nominal overall dimensions of 14 m deep x 27 m long x 6 m high.

- the first bay will hold the transportable or permanent laboratory;
- the second bay will be used as a small service bay for onsite repairs for CHPP equipment; and
- the third bay will serve as a stores area with racks to hold critical spares for servicing and maintaining the CHPP.

Minor servicing of CHPP mobile equipment will be conducted at the local CHPP workshop. Major servicing will be conducted at the mine infrastructure workshop facilities.

The CHPP workshop will adjoin the CPP office area and include a small laydown yard for storage of equipment and sample collection.

The lab area of the workshop will be fitted out with heating, ventilation, and air conditioning (HVAC) equipment to enable year-round sampling and monitoring.

C.2.8.3 Laboratory

There are two options for the arrangement and operations of the onsite lab:

- the leasing or purchasing of loose supplied lab equipment that will need to be laid out and assembled onsite; and
- purchasing or leasing a pre-fitted out transportable laboratory.

Each of the options will be suitable for installation into the first bay of the CHPP workshop.

The lab layout consists of a small office area used for management of samples and collating test work data, a building suitable for receiving collected plant sample in drums, and a small laydown yard.

C.2.8.4 Magnetite Storage

Bulk magnetite will be offloaded and stored on site within the magnetite sump. The magnetite sump will be located within the heated CPP building with truck access through a 4.2 m x 4.2 m roller door.

The magnetite sump is where magnetite will be slurried prior to being pumped into the DMC circuit. A directional water cannon will be included to help slurry magnetite into the sump.

C.2.8.5 Flocculant and Reagent Storage

C.2.8.5.1 Flocculant

Flocculant will be stored on site within a shed enclosure large enough for a minimum storage period of one month during the winter period.

Total anionic flocculant storage will allow for 50 dry powder bags weighing 500 kg each. This allows for a full delivery (36 bags), six spare bags in the storage area and eight bags in the dosage unit container ready to be moved into place.

Total cationic flocculant storage will allow for 26 liquid bulk bins each containing 1,000 L of liquid product. This will allow a full shipment (18 bulk bins), six spare bulk bins and two bulk bins loaded into the dilution system (one duty, one stand-bye). Dry powder bags will need to be kept dry and the cationic liquid needs to be kept above 0°C throughout the year.

C.2.8.5.2 Reagent (Methyl isobutyl carbinol (MIBC) and Diesel))

Reagents will be stored inside double-walled tanks inside of a concrete protection bund. Reagents include:

- diesel – used in flotation as a collector; and
- MIBC – used in flotation as a frother (surfactant).

The reagents required to operate the flotation cell (diesel and MIBC) will be provided and stored in a purpose built facility (fuel farm). The fuel farm will consist of one storage tank for collector and one storage tank for frother. Pumps and piping to transport the reagents from the storage tanks to the flotation circuit will be provided. The storage area and associated distribution networks are classified as hazardous areas and will be designed and installed in accordance with Canadian Standards.

The storage capacity for the MIBC will be 50 days at nominal usage. Diesel will have the same capacity tank as MIBC (25,000 litres) and doesn't require lengthy storage capacity due to the ability to supply *via* mine refueling trucks. A diesel tank with capacity for 14 days operation will be included in the reagents farm. Propane to supply the heating, ventilation and air conditioning (HVAC) system will also be included in this reagent farm.

The reagent pipe route from the storage tanks to the plant is *via* the thickener on a cable tray.

C.2.9 Services

C.2.9.1 Compressed Air Services

The CPP facility compressed air system will consist of compressors, air receivers, dryers and inline filters reticulated around the CPP to provide both instrument and plant air. Due to their large air flowrate requirements, the operation of the hyperbaric disc filters will each require a dedicated air compressor. Compressed air will not be reticulated outside of the CPP buildings. Mobile air compressors would be utilised during maintenance periods.

C.2.9.2 Raw/ Fire System / Washdown / Dust Suppression Systems

Raw water will be pumped from the raw water pond located adjacent to the CHPP product stockpile. A buried pipe will be placed through the dam wall and underground into the raw water pump house. Two pumps (one duty and one standby) will pump water through buried pipes, which will run adjacent to the product stockpile pad and up to the CPP area to the fire water tanks and to the CPP plant clarified water sump (SM-9101).

An alternative option to the dam wall buried pipes would be to have the pump station on a floating barge to capture clear water near the surface of the pond. The barge would be horizontally stabilized over the deepest section of the raw water pond and allowed to float vertically.

The fire water tanks provide a combined fire/wash down water distribution network for both the CHPP and MIA facilities.

The nominal water make up requirement for the CHPP is 110 litres per RMT.

The CPP will be designed to maximise re-use of various water streams to reduce the raw water demands. Gland seal water, flocculant make up and filter press sprays will be sourced preferentially from the CPP clarified water to reduce raw water demand

Fire System Design Criteria

The fire protection system for the CHPP will be designed for early fire detection, emergency warning and capability for pro-active response to an emergency fire situation. The CHPP fire protection system will be designed and installed in accordance with National Fire Protection Association (NFPA) 24 and consist of the following:

- fire water tank and pumping system (including back up diesel pump);
- maximum system operating pressure but will not be less than 1,035 kiloPascals (kPa);

- fire water pipeline servicing the CHPP and materials handling facilities, CHPP control room site offices, and workshop facilities;
- hand-activated manual alarm and fire protection activation panels located throughout structures and buildings;
- sounder and beacons located throughout structures;
- fire hose reels located throughout structures;
- 9-kg dry chemical powder portable fire extinguishers covered with polyvinyl chloride (PVC) clear cover located throughout structures;
- dry pipe sprinklers at head and tail ends of conveyors within enclosed stations and at elevated sections of conveyors higher than 12 metres;
- wet pipe sprinklers along the full length of conveyors within enclosed and heated galleries;
- sub fire alarm panels located on specific structures;
- smoke detection in the form of aspirated smoke detection systems located on specific structures;
- 5-kg CO_2 portable fire extinguishers located throughout structures;
- Class II hose station covered with foam depot boxes for hazard areas;
- fire alarm panels located on specific structures;
- point type smoke detection in the office areas;
- probe type heat/smoke detectors with alarms to stop the conveyor; and
- sub-fire indicator panels with automatic detection and alarm system for fault detection in the CHPP switchrooms (fire suppression has not been included in the CHPP switchrooms; however, it can be retrofitted in the future if required.).

Fire & Wash-down Water

Fire and washdown water will be reticulated in a common system for both the CHPP and TLO areas. The source of water for the CHPP system will come from the site CHPP raw water dam and the source of water the TLO will come from the town potable water supply.

The fire water system will be used for both fire and washdown water purposes.

An electric duty washdown water pump will operate continuously catering to washdown water / other water requirements, using the one and the same reticulation network. This washdown water pump will also act as a system pressurisation pump (jockey pump).

An electric duty fire water pump will be installed in parallel and will start only in an unforeseen event of a fire. This pump will supply the fire water demand over and above the operating washdown pump.

A diesel fire water/washdown water standby pump will be installed so that in an unforeseen event of a fire and a power outage, both the firewater and washdown water demands are met. In the event of a fire, operations should cease using washdown water.

Where the fire/wash water distribution pipe is not installed inside heated structures and enclosures, it will be buried underground in accordance with geotechnical and regulatory recommendations that will prevent the pipes from freezing. This will be achieved either by burying below the frost level, or by installing insulation and heat tracing around the buried pipes.

Each of the fire water pumping facilities for the CHPP and TLO areas will be equipped with the following:

- one 100% Duty Fire Pump Set: Horizontal Centrifugal Type - Electric Driver;
- one 100% Duty Washdown Pump Set: Horizontal Centrifugal Type - Electric Driver; and
- one standby combined fire/washdown water Pump Set: Horizontal Centrifugal Type - Diesel Driver.

Fire water pumps will comply with the requirements of NFPA 20. Each fire pump set will have a duty flow and head capable of supplying the fire water demand to the largest active fire suppression system, external, and/or internal fire hydrant demands.

Fire & Wash-down Water Storage Tanks

Separate storage tank systems are proposed for the CHPP and the TLO area. Two 300,000 L and two 220,000 L capacity tanks will be provided in the CHPP and TLO areas respectively to ensure that fire water will be available, should an area single tank be out of service for maintenance or repair. The tanks are sized for additional wash down water capacity.

Wash-down Water

Wash-down water will be provided in CHP stations, bins and in the CHPP at each floor adjacent to each set of stairs. Wash-down water will be supplied from the same system (pump & tanks) that supply the CHPP fire water system. Wash-down water will generally be provided through 25 mm hoses in the CHP stations and CHPP. Additional hose connections and ball valves will be provided at other locations as necessary.

C.2.10 Dust Management and Suppression

Conveyor hoods will be installed over the top of all the conveyor belts that are not within enclosed galleries or structures, in order to protect the belt and product coal from the prevailing weather conditions and minimise potential dust generation.

Where there is a likelihood of coal dust accumulation that could become airborne inside enclosed spaces, dust suppression or extraction systems will be included to minimize the accumulated dust and prevent explosions. Where there is a wet processing facility, or the washed product coal contains residual surface moisture, then the likelihood of airborne dust accumulation is low and dust suppression/extraction systems are not required. Dust suppression sprays will be provided at the ROM dump hopper and at appropriate transfer points in the raw coal handling system.

In all areas of the infrastructure, housekeeping procedures will be required to minimize accumulated dust levels inside enclosed spaces and thereby minimize the potential for coal dust accumulation becoming airborne.

Generally the following areas will have dust management / suppression systems installed:

- ROM bin feeder breaker area;
- sizing station; and
- transfer chutes at the top of feed bins on the raw coal system.

Both the CPP and the tailings filter buildings will have explosion vents included to meet insurance requirements. A ventilation system will also be installed inside each CPP which will provide 0.5 air changes per hour in order to keep any airborne dust levels down. Dust suppression is not provided for the following:

- product and rejects handling systems (as the conveyed material is already wet) or on the raw and product coal stockpiles where mobile plant will be operating;
- ROM pad; and
- product stockpile.

C.2.11 Heating, Ventilation and Air Conditioning (HVAC)

Due to the project's location, extreme weather conditions may be experienced particular during the winter months. HVAC will be included into the design to ensure consistent operation of the facility all year round. Each of the major areas where HVAC has been included is described below.

C.2.11.1 Raw Coal

Heating systems will be included in the ROM bin feeder breaker area and also in the sizing station of the raw coal system. Heating will be included around these areas to ensure wash down water does not freeze and cause blockages, dust suppression systems remain effective and that hydraulics and lubrication systems operate reliably.

C.2.11.2 CPP Building

The CPP building will be a fully cladded and enclosed structure that houses the process equipment. The building will be equipped with insulated cladding, with allowances for access doors, heat curtains, summer air venting, and explosion venting.

Gas heating systems will be provided inside the CPP building to keep the temperature above freezing. Heating will not be provided to ensure comfort levels, but only to keep temperatures above freezing.

A ventilation system will be installed inside the CPP, which will provide 0.5 air changes per hour to ensure adequate air quality for personnel working inside the building on a continuous basis. The ventilation system will also be used during hotter ambient temperatures to provide airflow and keep the CPP temperature down to an acceptable level.

C.2.11.3 Washed Product Coal

Washed product coal will retain a certain level of surface moisture; when exposed to the sub-zero temperatures, the coal will likely freeze into conglomerated lumps at the surface. Once frozen, the washed coal will handle easily, as long as frozen lumps are broken up and the bulk coal stays frozen.

Washed product coal will leave the CPP on the product conveyor (CV-801), which will both be fully enclosed and insulated. The transfer conveyors CV-802 and CV-805 will be open-truss-style conveyors. Conveyor hoods will be installed over the top of the conveyor belts to help protect the belt and product coal from the prevailing conditions.

The transfer towers (ST-801 and ST-802) that deliver washed product coal to the washed product stockpiles will be fully enclosed to minimise effects of severe ambient conditions; however, they will not be heated.

C.2.11.4 Reject Coal

Reject material will have high residual surface moisture, and if exposed to sub-zero temperatures, will readily freeze together and may cause blockages. To ensure the reject material handle-ability is maintained, the reject conveyor and the reject bin will be fully enclosed with insulated cladding, and

heated to keep the reject material and contact surface temperatures above freezing. Local heat pads will be installed on the reject bin lower cone section to keep the reject material and free flowing.

C.2.11.5 Product Reclaim

During winter periods the outer portion of the washed product coal stockpile is expected to freeze. The reclaim feeders on the washed product stockpiles will be equipped with breaker heads to break up any bulk frozen coal sufficient for safe conveying.

The product reclaim and transfer conveyors including the OLC will be open conveyors with hoods installed over the top of the belt to help protect the coal from the prevailing conditions.

Local electric unit heaters will be required to keep the vibrating feeder area under the OLC feed bin (BN-801) heated.

C.2.11.6 Train Loadout

The transfer conveyor that conveys product coal from the overland conveyor surge bin to the train loadout bin (CV-851) and the train loadout bin will be fully enclosed but not heated. Heat pads will be installed on the lower cone section of the train loadout bin. The heat pads ensure the rapid loading system operation is maintained in all weather conditions.

C.2.12 Minimizing Noise and Visual Impacts

The following areas have additional cladding and shed structures included in order to contain operating noise and reduce visual impacts:

- The surge bin at the end of the overland conveyor (BN-851) will have cladding on the top of the bin structure and feeder areas at the base.
- The train loadout bin feed conveyor (CV-851) will be fully enclosed with cladding.
- The train loadout bin (BN-852) will be fully enclosed with an external cladded shed structure as shown in Figure C.2.12-1.

C.3 Rail Loading Track (RLT)

C.3.1 Description of Proposed Infrastructure

The proposed infrastructure consists of a new rail track (for coal loading and transportation to markets) and supporting infrastructure including structures, earthworks, signaling/communication equipment, access roads, drainage channels/ponds and required modifications to the existing (adjacent) Highway 3.

The RLT is a new auxiliary track that will leave the Canadian Pacific Railway's (CPR) mainline at Mile 90.7. The track is approximately 6,900 m long, and is laid out in a figure 8 loop arrangement (Figure C.3.1-1). Its purpose is to allow an empty coal train to leave the CP main track and run through the loadout structure, filling each rail car (152 cars) with approximately 104 tonnes of metallurgical coal for export. Once fully loaded, the train has reversed direction and is ready to depart westward.

The area that the loading track is to be built on is north of the community of Blairmore and generally slopes upward to the north. The CPR main track runs along the valley bottom through Blairmore and is part of CPR's second crossing of the continental divide, connecting southern Alberta to the west coast of BC.

The junction switch is a #15 turnout with an allowable diverging speed of 30 miles per hour (48 km/h). The switch is adjacent to the existing CPR Chinook siding. The alignment of the auxiliary track is also designed to allow for running of trains up to 30 miles per hour (48 km/h) for the first 2,700 m of the loop.

At chainage 0+550, the loading track passes under Highway 3. Pending detailed design and further discussions with Alberta Transportation (AT), the rail will either travel in a 160 m long corrugated steel tunnel or a bridge span will be constructed to carry the highway over the track. In either case, the highway will require moderate re-profiling to allow sufficient clearance. The existing Highway 3 intersection in this area will be relocated to the west of the new rail alignment to maintain access to private and commercial residences. Construction of the highway bridge or rail tunnel will require a temporary diversion of Highway 3, which can be accommodated within the existing Highway 3 right of way. This has been discussed with AT where it has been indicated that the concept is fully compatible with AT's immediate plans based on the following:

- is feasible to construct the proposed underpass of Highway 3 while maintaining flow of traffic on Highway 3 *via* a temporary diversion;
- proposed rail spur east of the proposed tunnel, and section of loop track parallel to Highway 3 do not impact Highway 3; and
- various closures and relocations of intersections on Highway 3 are compatible with AT's Access Management policy.

Shortly after diverging from CP's right of way, the loading track begins to climb a 1.5% grade and curves around the north side of the existing golf course clubhouse. Blairmore Creek is crossed on a bridge at 1+800. Once across Blairmore Creek the track curves south toward the highway. The track crosses the lower part of the Crowsnest Pass Golf Course on an embankment before curving north

and then west, entering a cut in the hillside at approximately 3+100. The embankment is up to 12 m high along the alignment of the current #17 and #18 fairways.

Towards the east side of the rail loop at chainage 2+800 the curvature of the track tightens to minimize the size of the cut into the hillside. This dictates a reduction in design speed from 30 miles per hour down to 10 miles per hour for the majority of the loop track. The loop continues through the 1,200 m long cut in the area of the #3 and #4 fairways at a depth of up to 26 m.

Geotechnical investigation of the underlying rock formation will determine the optimum slope angles for the sides of the cut section, and therefore the overall width of the cut. Allowance will also be made for sufficient ditches along the track to carry off track drainage and overland flows. Total volume of earthworks is estimated to be in excess of 1 million m^3.

After curving through a reverse loop north of the existing golf course clubhouse, the track passes under the loadout building near the center of the figure 8 loop. A 200 m long siding is adjacent to the loadout building so that railcars needing repairs or maintenance can be set out for CPR mechanical crews to work on.

Past the loadout, the loading track continues east and then curves around parallel to the inbound loop until chainage 6+967 where it connects to the inbound track with a #9 turnout, completing the reversing loop. A switch point derail will be installed near the entrance to the loop track to prevent any unintentional train or railcar movements from leaving the loading facility and reaching the CPR main track.

In addition to the track and bridges already described, several internal roads will be constructed to provide access to the turnouts, loadout building, conveyor system, set-out track, and locomotive crew change-out points. Overall impact on the current golf course infrastructure will include full or partial obstruction of Fairways #1, #2, #3, #14, #15, #16, #17 and #18, as well as the club house, car park and maintenance buildings. All affected golf course infrastructures will be re-located to the west of the existing golf course. Detailed design of the new golf course will continue to be established between Benga and Crowsnest Pass Golf and Country Club.

The current access road into the Grassy Mountain mine site at chainage 2+950 will be cut-off by the rail embankment. The project is proposing to use and upgrade this approach which will require the access road to be relocated just to the east of the rail loop. This access road will be aligned to avoid a number of heritage buildings located east of the existing Blairmore Golf Course. A traffic impact assessment [TIA] has been prepared to identify modifications to the Highway 3 intersection required to handle additional traffic generated by traffic travelling to/from the mine site and rail load-out area.

Additional discussions are ongoing with Alberta Transportation to establish the effect of the proposed rail alignment on future plans to upgrade Highway 3 to 4 lane freeway status. Appropriate mitigations will be determined by undertaking functional planning on the future Highway 3 alignment, subject to future discussions and agreement with Alberta Transportation.

The location of the RLT facility has been the subject of considerable discussion with the community through a number of open houses and individual meetings. The golf course option has been selected as many of the local stakeholders including the municipality of Crowsnest Pass have indicated they prefer this option, of a number that were evaluated. Figure C.3.1-1 shows the location of the RLT and has some renderings that show the facility from different visual vantage points in the community.

C.3.2 Rail Loading Track – Operations, Maintenance and Decommissioning

C.3.2.1 Description of a Typical Train Load

An empty unit coal train with 152 cars, approximately 2,550 m in length, arrives from the west with a CPR crew operating the train. The switch at Mile 90.7 is aligned to direct the train onto the Benga Rail Loading Track. The train proceeds under Highway 3 and into the loop track. A switch point derail is aligned for through movement. Once the rear end of the train passes the derail, it is aligned back to derailing position to prevent any unintentional train or railcar movements from leaving the loading facility and reaching the CPR main track.

When the head end of the train reaches the loadout building, the CPR crew turns the train over to Benga to handle the loading. During loading, the train passes under the loadout chute at a slow steady speed of about 350 m/hr while the loadout fills each car with approximately 104 CMT of cleaned metallurgical coal. The loadout also sprays a latex binder solution over the top of the coal load to minimize release of dust as the train travels to port. The loading of the train can take up to eight hours.

When the train has been fully loaded and is ready to depart, a CPR crew returns to take control. Once clearance and proper authority have been obtained from CPR's rail traffic controller, the switch point derail is aligned to allow the train to depart from the loading track. The switch at Mile 90.7 is also aligned and the train proceeds onto the mainline. The derail and the switch are automatically realigned to their normal positions once the train has cleared them.

On occasion, one or more railcars which require service or maintenance may be switched out on a short set out track near the loadout building. CPR mechanical crews would access these cars from an adjacent road and effect necessary repairs. CPR may also use the access roads to bring fuel trucks up to the locomotives to top up their diesel tanks if required.

C.3.2.2 Maintenance

Routine inspection and maintenance of the rail infrastructure is required to ensure continued safe operations. Inspections by qualified personnel will be done according to Canadian Pacific Railway's Standard Practice Circulars and Red Book of Track Requirements at intervals specified for industrial private sidings.

Maintenance may be done by Benga personnel or by rail contractors specializing in such activities. Maintenance typically entails tightening bolts, lifting low spots in the track where settlement has occurred, welding and grinding turnout components, and replacing worn out rail if required. Treated wood track ties typically have an average service life of 25 years or greater so some tie replacements may be needed in future years.

The high degree of curvature in the rail loading track requires application of specialized biodegradable lubricating grease to the rail to reduce friction, noise, and wear. Automated lubricators will be installed on the track to dispense the grease. These lubricators require periodic filling, inspection and adjustments. The automated or remotely controlled switches and derail require inspection, adjustment, and maintenance by CPR's signals and communications personnel.

C.3.2.3 Decommissioning

Once the Project has been completed and the loading track is no longer required, the track will be removed. Used track materials have high value in the market place and may be sold for reuse. Some of the treated wood track ties may be suitable for reuse but those which cannot be reused will be disposed of through approved facilities such as co-generation power plants, or licenced landfills.

Bridges and other major structures may be salvaged for reuse or scrap, or may be left in place for pedestrian trails or general access if desired.

C.4 Roads

C.4.1 Mine Access Corridor

The mine access road will start form an upgraded intersection on Highway 3 and follow the overland conveyor up to the MIA area. The road alignment is shown on Figure C.4.1-1. The vertical alignment is controlled by the tie in levels at Highway 3, the MIA platform and the tee-off to the CHPP product stockpile area. Cross-sectional elements of the mine access road are:

- 7 m wide with a 2% cross-fall;
- 200 mm gravel surface layer;

- 1V:2H cut and fill battered slopes, pending the results of the detailed geotechnical investigation;
- maximum grade 8%;
- 50 km/h speed limit;
- two 3.5 m wide traffic lanes;
- two 1.5 m shoulders; and
- one right of way (ROW) for the overland conveyor.

The mine access road is designed to accommodate normal road truck axel loads and incorporates:

- a single culvert near the future product blending area; and
- multiple wildlife crossings.

A cross-section view of the access road and conveyor corridor is shown on Figure C.4.1-2.

C.4.2 Train Loadout Access Road

Access to the Train Load-Out (TLO) area will be *via* tee intersection off the mine access road. The TLO areas access road will incorporate a bridge to cross the rail system. The road alignment is shown on Figure C.3.1-1. Cross-sectional elements of the access road are:

- 6 m wide with a 2% cross-fall;
- 200 mm gravel surface layer;
- maximum grade 6%;
- 50 km/h speed limit;
- no shoulders; and
- 200 mm selected layer thickness

Access into the TLO area will be *via* a single lane, 6 m wide bridge structure installed across the rail line. Location of the TLO access point took the following into account:

- overall rail earthworks requirements;
- full time accessibility into TLO bin area when a train was present in the loop; and
- easy interconnection into the mine access road.

C.4.3 General Site Access Roads

The general site access roads will be mostly located around the CHPP and MIA to provide access to the local facilities. It will also allow for movement of mobile equipment for maintenance and shutdown works. The cross-sectional elements of the roads are:

- 6 m wide with a 2% cross-fall;
- 200 mm gravel surface layer;
- maximum grade 6%;
- 50 km/h speed limit;
- no shoulders; and
- 200 mm selected layer thickness.

C.4.3.1 Road Lengths

Based on the site arrangement and railway alignment, the lengths of road that will have to be constructed are shown in Table C.4.3-1.

Table C.4.3-1 Site Road Lengths

Road	Length
Mine access road from Highway 3 intersection to intersection into TLO area	0.89 km
TLO access road	0.26 km
Mine access road from TLO intersection to MI area	4.90 km
CHPP and MI area general site roads (inc. raw coal, rejects and product coal)	2.80 km

C.4.4 Traffic Impact Assessment

C.4.4.1 Overview

Benga conducted a Traffic Impact Assessment (TIA) as per Alberta Transportation's *Traffic Impact Assessment Guideline* (www.transportation.alberta.ca/613.htm), which is provided in full in Appendix 8.

The study area composed of three unsignalized intersections located within a 1.7 km section of Highway 3 in the vicinity of the community of Blairmore. The proposed access to the Project is an existing gravel access located approximately 1 km to the east of 107th Street and 700 m west of 129th Street. A total of 54 vehicle trips will be generated by the proposed coal mine development:

32 inbound trips and 22 outbound trips. During the PM peak hour, a total of 44 vehicle trips will be generated: 22 inbound and 22 outbound from the site. During the off-peak hours approximately eight vehicles trips will be generated: four inbound to the mine and four outbound from the mine.

Historically traffic on Highway 3 has been growing at an average rate of approximately 2.5 – 3% per annum. This analysis has found that the existing intersection is operating at a good level of service. By the 2021 horizon, the existing roadway and intersection geometry is sufficient to accommodate projected traffic volumes. The intersection of 107th Street and Highway 3 has been approved for the installation of a traffic signal; this installation has been incorporated into the analysis and, in conjunction with other related improvements including provision of separate eastbound and westbound left turn lanes on the highway, will improve operations at this intersection for the 2021 horizon and beyond. After the full build out of the mine and the addition of the site-generated traffic, the road network can continue to operate satisfactorily and does not require further improvement.

Continued growth post 2021 to a 2041 planning horizon will require additional improvements to accommodate just background (without site) traffic volumes. These improvements should include extension of the left turn lane storage at major intersections and the signalization of the 129th Street intersection should also be considered when volume warrants are met. The addition of site related traffic will increase highway volumes by approximately 2% and would not cause significant deterioration of the operation of nearby intersections.

The gravel access road intersection with Highway 3 that will serve as the mine access road can accommodate existing and future 2021 and 2041 background traffic volumes without the need for additional turning lanes; however, with the development of the mine, a separate eastbound Type IV left turn lane will be required by the time the mine is anticipated to commence operations (*i.e.*, 2018). A separate eastbound Type IV left turn lane, including a 210 m taper length and 85 m parallel lane will be required. Provision of partial illumination of the intersection is not warranted.

C.4.4.2 Regulatory Liaison

As part of the TIA, as well as part of the rail alignment process, Benga consulted with AT on a number of occasions. The following provides a synopsis of this liaison:

- **October 2014** – Benga established initial contact with AT South Region Team *via* email and telephone. Outline sketches were supplied to AT showing the proposed rail spur crossing and running parallel to Highway 3 to form a loop partly on Blairmore Golf & Country Club land. AT advised that a Roadside Development Permit Application would ultimately be required for the rail spur and upgrade of main mine access road.

- **November 2014** – A meeting was held between Benga and AT's South Region and AT's Engineering department. The plans for the rail loop, potential highway crossing of the rail spur, and upgrades to the mine access road were described Benga. AT provided some details of various functional planning studies that had previously been completed for future upgrades to Highway 3 (detailed functional plans for some, but not all, of the potential upgrades to Highway 3 had previously been prepared by AT's consultants between the 1960s and 2009). It was apparent that there were conflicts between some of the potential upgrades to Highway 3 and the proposed rail spur, although no timeframe for any upgrade had been established. It was agreed that Benga would progress the design of the rail spur to a higher level of detail and undertake a traffic impact analysis on the proposed access from Highway 3. A single point of contact was established for all project correspondence to AT.
- **January-April 2015** – Benga prepared a traffic impact analysis on the proposed upgrade to the existing mine access road. Various technical correspondences were made with AT during preparation of this document.
- **June 2015** – Benga and AT attended a meeting with Crowsnest Pass Municipal Council. At the meeting, Benga presented the latest feasibility study designs for the project, including more detailed designs of the rail underpass of Highway 3, the impact on a future interchange of Highway 3 on the west side of Blairmore, and additional design of the rail loop and access road. It was at this point that the re-location of the mine access road was presented to the Council and AT, from its existing location on Highway 3 to the existing Cemetery Road intersection to the east. It was determined that AT would support the technical analysis of the proposed rail loop design if the Council passed a motion to support the design. It was also proposed that Riversdale should undertake additional functional planning of Highway 3 to show that any potential upgrades to the highway can be accommodated with the proposed rail underpass and spur line.
- **July 2015 to present** – Additional meetings were held between Benga, AT, local stakeholders and the Crowsnest Pass Municipal Council to discuss the Project. The Council approved a motion in support of the preferred design on July 21st 2015. Benga has since commenced the preparation of a functional plan of future highway upgrades in support of the Project. Various technical correspondences were undertaken between Benga and AT to determine the scope of this consultation. Additional consultation was made between Benga and AT to establish technical requirements for the road realignments required for construction of the Highway 3 rail underpass. The functional planning study and update to the Mine Access Road TIA are currently ongoing.

C.5 Water Management

The Grassy Mountain Coal Project has developed a water management strategy that facilitates both the management and use of water from the Project. There will be interaction with both surface water and groundwater resources during the construction, operation and reclamation of the Project. The Project has been designed to manage the surface water and groundwater efficiently and to minimize the impact on the environment.

The following three documents were prepared by SRK Consulting and form the basis for the water management program for the Project:

- Appendix 10A – Grassy Mountain Project – Geochemical Characterization;
- Appendix 10B – Grassy Mountain Project – Water and Load Balance Model; and
- Appendix 10C – Grassy Mountain Project – Water Quality Management.

In addition to these reports, surface hydrology (CR #4) and surface water quality (CR #5) provide details of the water management program.

Water is needed to operate the mine, including the coal wash plant which is the major user of water, dust control for roads and wash water. It has been estimated that approximately 960,000 m^3 of water will be required annually to operate the mine. A portion of this volume will require licencing to allow use of the water. Benga has considered various sources of surface water and groundwater to supply the Project's water needs.

A key component of mine development is the surface water management program. This program is primarily focused on capture, treatment and release of all surface run-off and water pumped out of the pit (which also includes a groundwater component) for the removal of suspended sediment. The Project has also identified a geochemical component that requires additional management beyond the typical sediment removal.

This section of the report will deal with the water supply and use, licencing options and requirements, water treatment and water balance and management.

C.5.1 Water Supply and Source

C.5.1.1 Volume Required

The Coal Handling and Preparation Plant (CHPP) requires approximately 110 litres (0.11 m^3) of water to wash each metric tonne of raw coal that is processed. The plant has been designed to produce a nominal 4.5 million clean metric tonnes (CMT) of coal per year. Approximately 900,000 m^3 of make-up water is required for the coal wash plant each year.

Additional water is also required for peripheral activities such as watering roads (for dust suppression) and washing vehicles. The volume of water required for these activities has been estimated at 60,000 m^3 annually. The total annual volume of process water required for the Project operations is 960,000 m^3. The CHPP water balance is shown on Figure C.2.5-1. This will not be potable water.

Some potable water is required for use at the office/shop/maintenance facilities. It has been estimated that a total volume of 15,500 m^3 of potable water will be required. A water well will be drilled in the vicinity of the office to supply water.

C.5.1.2 Water Source

The two main sources of water that were considered for the Project were from surface water and groundwater sources. Considerable effort to identify a viable groundwater supply for the Project was undertaken. While no surface water allocations are being issued in this basin, groundwater licences can be issued.

After Benga completed the site wide water balance, it was apparent that a considerable volume of surface water would be collected on site, some of which could be treated and released, and some that had to be collected and managed for geochemistry concerns (may contain elevated levels of selenium). The estimated volume of water requiring further management would be enough to supply all the Project water needs. It was determined to be usable in the coal wash plant and operations of the Project.

The entire Project non-potable water requirements (~960,000 m^3) will be provided from surface water collected on site. This is all surface water that may require a surface water licence/allocation. Benga has engaged numerous existing water licence holders to identify possible water licence transfer opportunities. If there are times of water supply shortage, as a backup, Benga will look at alternative groundwater sources which may include new wells or investigate the legacy underground mines which are known to store considerable volumes of water.

The potable water required for the Project will be groundwater and will be licenced as groundwater, separate from the surface water requirements.

C.5.2 Water Licencing

Since all of the Project's process water needs will be supplied from the Project's surface water management program, it is likely that surface allocations would need to be acquired from existing licence holders. Benga is primarily considering existing water licences for potential transfer opportunities. There is some volume of new surface water allocation available from the unallocated

crown reserve for industrial and commercial purposes, which Benga will also apply for. The Project has a requirement for both consumptive and non-consumptive uses, so a balance between these types of water transfers is required.

C.5.2.1 Consumptive Water Use

Consumptive use of water is defined as water that is used in the process and is eventually lost from the system. The raw coal that is brought to the coal wash plant from the pits has a moisture content of 5%. Once the coal has been processed and washed, it will have a moisture content of approximately 10%. This cleaned coal product will be loaded onto rail cars and shipped to market. The additional 5% moisture that the clean coal contains will be lost to the system and is considered consumptive use. This has been calculated to be approximately 237,000 m^3 per year. There is additional water needed to road watering that is estimated to be 60,000 m^3 per year, which will also be considered consumptive use. The total consumptive use is estimated to be 297,000 m^3 per year.

C.5.2.2 Non-consumptive Water Use

The non-consumptive use of water is defined as water that is used in the process and is not lost, but will remain in the local hydrology of the area. As the raw coal is washed, most of the water is recovered *via* the use of mechanical dewatering and is available for re-use in the system. For each raw tonne of coal that is processed, approximately 55% is recovered as clean coal and the remaining 45% is reject material. The reject material contains both coarse and fine reject from the plant and contains approximately a combined 18% moisture content. This material is hauled back to the pit/disposal areas where it is disposed of. The water contained in the reject material remains in the hydrologic system and is considered non-consumptive use.

The total volume of non-consumptive water has been calculated at 662,000 m^3 per year.

C.5.2.3 Licencing Approach

Benga has identified that the Project will at times, result in reduced flows in the Crowsnest River as a result of the Project activities. Given the highly variable water flow patterns that will occur at the boundaries of the proposed mine site, due to changes to runoff as the topography is altered, Benga proposes that the *Water Act* requirements for the Project be administered by identifying the total reduction in water runoff from the site. The most downstream point where the rest of the basin will be affected is the Crowsnest River at the mouth of Gold Creek. This is similar to the "fence-line approval" system used for other large area surface impact projects.

Blairmore Creek and Gold Creek, where they are affected by mine operations, will be assured of meeting IFN values for fisheries and all other water user's needs (stock water) at all times. At many times, and at mine closure, Blairmore Creek will have the same or slightly more flow than pre-mining

conditions; however, Benga will apply for allocations for the shortfall periods. The reach of the Crowsnest River between Blairmore and Gold Creeks will be assured of meeting pre-mining operation flows at all times with a portion of the transferred allocation from the upstream former Devon licence. Benga is proposing to use this most downstream point (NW 30-7-3-W5M) as a "water allocation accounting point". The Grassy Mountain hydrology assessment predicts a flow reduction at this point of 430,000 m^3 per year (349 acre feet), as a result of the Project related activities. This land is privately owned and since no works are needed or planned for this location, landowner consents have not been requested or provided. The *Water Act* Licence information is provided in Appendix 1E.

C.5.2.4 Licencing and Water Transfer Options

Benga will require existing licence holders to transfer portions or all of their existing licences to secure the required volumes of water rights. Initially over 30 surface water licences in the Crowsnest River watershed were considered. This lengthy list was pared down to several main options that are listed in Table C.5.2-1.

The process to transfer water from one user to another requires consideration of the following items:

- is the licence in good standing;
- what was the historical water use;
- what was the potential of water use based on the approved plan; and
- how much of the licence may be transferable.

With the issuance of a new licence or any transfer, two key items to be evaluated include:

- are there adverse effects to the environment; and
- are there adverse effects to other users.

Benga is assessing and considering all of these items in pursuit of obtaining water rights for the Project. It is likely that numerous transactions from multiple licensees will be required. Benga is also aware that the transfers may need to be moved from one drainage basin to another and the purposes of the water use may also need to be changed, all of which may add complexity to the process.

Table C.5.2-1 Potential Options for Transfer of Water Licences

Licence No. & Point of Diversion	Licensee	Gross Diversion (m^3 annually)	Gross Diversion (acre-feet)	Consumptive Use (acre-feet)	Rate of Diversion (ft^3/sec)	Rate of Diversion (m^3/sec)	Comments
00039493-00-00 (Crowsnest River - Devon) NE-02-008-05-W5M	Devon Canada Corporation	123,350	100	100 (losses)	?	?	Benga and Devon has worked out an arrangement to have this licence transferred to Benga. The request for this transfer is provided in the *Water Act* Licence for this application for a total of 123,350 m^3 (100 acre-feet).
Unallocated Crown Reserve (industrial)	GoA	184,000	150	150	TBD	TBD	Benga will seek the full volume of this Crown Reserve if necessary (184,000 m^3 (150 acre-feet)) (consumptive)
00045980-00-00 (Gold Creek) NE-31-007-03-W5M (*Cancelled by AEP March 4, 2016*)	Margetak	250,400	203	not described	0.28	0.008	Benga has requested a temporary transfer of 250,400 m^3 (203 acre-feet) from Gold Creek, all of which would be for consumptive use by Riversdale. This licence has been cancelled and this decision is currently being appealed.
Unallocated Crown Reserve (commercial)	GoA	6,167,500	5,000	5,000	TBD	TBD	Benga will seek the remaining volume of through the Commercial Crown Reserve

Table C.5.2-1 Potential Options for Transfer of Water Licences

Licence No. & Point of Diversion	Licensee	Gross Diversion (m^3 annually)	Gross Diversion (acre-feet)	Consumptive Use (acre-feet)	Rate of Diversion (ft^3/sec)	Rate of Diversion (m^3/sec)	Comments
00045625-00-00 (Drum Creek) NE-18-007-03-W5M (*Cancelled by AEP March 4, 2016*)	MD of Crowsnest Pass	254,100	206	206	0.65		There have been discussions with the Municipality about the transfer of the licenced diversion of 254,100 m^3 (206 acre-feet) (consumptive) from Drum Creek, but no actions have been taken.
00045849-00-00 (coulee to Crowsnest River) NE-29-007-03-W5M (*Cancelled by AEP March 4, 2016*)	MD of Crowsnest Pass	339,200	275	112	0.9	0.025, 0.007	There have been discussions with the Municipality about the transfer of the licenced diversion of 339,200 m^3 (275 acre-feet) (approx. 40% consumptive) from Drum Creek, but no actions have been taken.
Piikani Nation Water Rights, Oldman River Basin	AEP	43,172,500	35,000				Piikani have up to 10,300 acre-feet of off-Reserve surface water rights as well, with potential for allocation/transfer.
00032258-00-00 (Allison Creek) SE-27-008-05-W5M	AEP	5,083,170	4121	1	5.61	0.159	The hatchery may have some excess surface water allocation as most of the current water requirements are being supplied by groundwater allocations. Benga has requested a potential transfer of water from AEP.

C.5.3 Water Treatment

Water management is required for all components of the Grassy Mountain Project from the initial site disturbance through to final reclamation. Water management is a priority consideration throughout the mine planning and development. Minimizing surface disturbance and completing timely reclamation are essential considerations that can affect water management. The water management strategy aims to minimize water diverted from streams, maximize the separation of clean and contact water, and pump water with high selenium and nitrate concentrations to saturated zones for attenuation. The planned water management infrastructure is shown in Figure C.5.3-5.

Water collected in the pits during mining will be pumped to sedimentation ponds for treatment and discharge. Water seeping from waste rock (placed in-pit or ex-pit) will either percolate naturally or be actively managed to pass through the saturated zones.

Benga is applying for a "fence-line" approval under the *Water Act* to conduct these water management activities. This information is provided in Appendix 1D.

C.5.3.1 Selenium Treatment Approach

Selenium can be removed from water by making the water anoxic (free of oxygen) and electrochemically reducing. Under reducing conditions, selenium can precipitate or adsorb to mineral particles. The saturated backfill areas planned for the Grassy Mountain Mine can be managed as reducing zones and used for removal of selenium from mine contact water. Nitrate is removed from the mine water by a similar process.

Removal of selenium in saturated backfill zones has been observed to occur naturally in backfilled pits at active or closed mines. The removal process is well understood. The majority of active selenium water treatment plants rely on the same process.

Uncertainty around passive selenium removal in saturated backfills can to an extent be mitigated by actively managing and operating the backfill zones. Full-scale treatment campaigns and pilot trials have demonstrated that mine water can quickly be electrochemically reduced by adding nutrients and sources of easily degradable carbon, such as methanol, to the water. The nutrients and carbon source feed microorganisms that scavenge oxygen and generate reducing conditions.

The operation of the saturated backfill consists of a system for injecting a carbon source and nutrients to contact water that is pumped to, or flowing through, the saturated backfills. Reducing conditions in the backfill can be monitored with a network of monitoring wells where the oxidation-reduction potential (ORP) of water within the backfill can be measured. The saturated zones will be engineered and constructed to facilitate removal of the selenium, and operated as an effective semi-passive

"bioreactor". Examples of where saturated zones are being used to attenuate selenium are provided in Appendix 10C – Water Quality Management (Section 3.3.2).

C.5.3.2 Grassy Mountain Surface Drainage, Diversion and Water Management

The collection of surface runoff water and the management of pit water are required for the removal of total suspended solids (TSS). Management and mitigation of the selenium content of water precipitating through the excavated rock placed in the ex-pit rock disposal areas is also of primary concern. The main objective is to control selenium and TSS levels to meet wastewater guidelines and objectives.

Pit dewatering operations involve the disposal of surface water (from rainfall and snow melt) and groundwater that enters the pits. The groundwater level is typically at greater depths in the mining area. As mining operations drop below the natural groundwater levels, continual dewatering of pit areas will be required. Pit dewatering is conducted by directing all water to containment sumps established within the active benches of the pit and using pumps to transfer the water to a settling pond for treatment and release.

A series of collection ditches, sumps, pumps and settling ponds will be established to manage all surface water on the mine site. Surface runoff from mining areas and haul roads is collected and directed to settling ponds for treatment or will be pumped to the raw water pond for storage and use in the coal cleaning process. Water collected at the toes of disposal areas is expected to contain elevated levels of selenium. This water will be directed initially to surge ponds before being directed to saturated zones for selenium attenuation. Benga will control all surface runoff from disturbed areas.

Activities that result in the removal of surface vegetation have the potential to cause erosion and sedimentation. Soil erosion is reduced by minimizing the time that disturbed surfaces are left without vegetation. Temporary measures to control erosion before a vegetation cover is established include:

- diversion ditches;
- drainage control;
- check dams;
- sediment ponds;
- sumps; and
- mulch.

Construction activities related to the major stream crossings are carried out during periods of lowest potential impact, typically during the winter months. A 100 m undisturbed buffer zone, maintaining

existing vegetation, will be retained between development activities and Blairmore Creek to the west and Gold Creek to the east. Construction techniques will be employed that protect the integrity of the streams as well as the quality of water.

Five figures have been prepared that show the progress of the mining development and the water management activities for five key years of the Project. These include:

- Figure C.5.3-1 – EOY – Year 4;
- Figure C.5.3-2 – EOY – Year 9;
- Figure C.5.3-3 – EOY – Year 14;
- Figure C.5.3-4 – EOY – Year 20; and
- Figure C.5.3-5 – EOM.

C.5.3.3 Capture and Release (Sedimentation Ponds)

The source of the water directed to the sedimentation ponds will be from surface runoff and groundwater interception from the pit and will not be exposed to selenium enrichment, so they do not require selenium management efforts. This water may contain suspended solids that will require removal prior to release to the environment. The six settling/release ponds will treat and release water back into the environment. These ponds are shown on Figures C.5.3-1 to C.5.3-5 and are listed below:

- Plant Site Sediment Pond (PSSP) (Year 0) - water from the plant and shop area will be directed to this pond for TSS treatment and released to Blairmore Creek;
- Loadout Sediment Pond (LSP) (Year 0) - water from the rail loadout and rail loop area will be directed to this pond for TSS treatment and released to Blairmore Creek (Figure C.3.1-1);
- South West Surge Pond (SWSP) (Year 1) - water collected at the mining face during the initial years of mining will be directed here before transfer to the West Sediment Pond and release to Blairmore Creek;
- West Sediment Pond (WSP) (Year 2) - water collected at the mining face along the western pit extents will be directed here before release to Blairmore Creek;
- East Sediment Pond (ESP) (Year 6) - water collected at the mining face along the eastern pit limit will be directed here before release to Gold Creek; and
- Northeast Sediment Pond (NESP) (Year 14) - water collected in the final area of mining in the northeast will be directed here before release to Gold Creek.

Surface runoff from the railroad and loadout areas will be captured and sent to a settling pond along the western edge of the rail loop. This water will be treated and released into Blairmore Creek.

Water from the sedimentation ponds is intended to be captured, treated and released. If the quality does not meet the release criteria it can be directed towards the saturated backfill zones as needed.

C.5.3.4 Capture and Management

C.5.3.4.1 Surge Ponds

Based on the results of kinetic testing (Appendix 10A – Geochemistry Characterization) it is expected that selenium concentrations will increase in the water that percolates through the rock dumps. This water will be directed to the selenium management surge ponds which have been strategically located to accept water that will impacted by the external rock disposal areas. These surge ponds will not release water and will require additional management that includes storage and transfer of water. These ponds are also shown on Figures C.5.3-1 to C.5.3-5 and are listed below:

- Raw Water Pond (RWP) (Year 0) – This pond accepts the majority of the SRDA affected water and will be the source of the plant process water;
- South East Surge Pond (SESP) (Year 0) – This pond is also in place to accept water that has been impacted by the SRDA. It will be connected to the RWP; and
- Northwest Surge Pond (NWSP) (Year 6) – This pond accepts water from the NRDA.

C.5.3.4.2 Saturated Zones for Selenium Attenuation

Selenium impacted water will be directed to a number of selenium attenuation zones located within mined out and backfilled portions of the open pit. Three saturated rock zones will be developed during the mine life (SZ1, SZ2, and SZ3). SZ1 will be engineered and constructed to function as a semi-passive bioreactor for selenium attenuation. Saturated zones are assumed to attenuate 99% of selenium loading. As discussed in Section C.5.3.1, in the absence of oxygen these zones will cause the selenium to drop out of solution. Examples of existing mining operations where selenium attenuation has been (and is) successful are provided in Appendix 10C – SRK Water Quality Management, Section 3.3.2.

To establish the first selenium attenuation zone the northern end of the first in-pit disposal area will be compacted (essentially an in-pit dike) to maintain containment and prevent the pore water from flowing north towards the active mining area. As mining and backfilling progresses north additional capacity is added through the construction of additional dikes. Eventually there will be three saturated zones created within backfilled portions of the open pit. These are:

- SZ1465 (Figure C.5.3-2):
  - this zone is made up of a number of in-pit dikes built over the first 9 years of mining;

  - a dewatering well will be drilled into the southern end of the saturated zone to decant the treated water and to return it to either Blairmore or Gold Creeks.
  - the zone is limited to the 1,465m elevation as mining will intersect the underground workings. Water from the legacy underground workings is currently seeping out a mine portal at the 1,468 m elevation.
- SZ1636 (Figure C.5.3-4):
  - the zone is created simply through the backfilling the open pit in the north-west corner. Once the saturated zone reaches the 1,636 m elevation the water will spill south towards SZ1465 for further attenuation. No in-pit dikes are required to be constructed.
- SZ1700 (Figure C.5.3-5):
  - once mining has been completed a third zone is created in the backfill on the eastern side of the pit. Horizontal dewatering wells will be drilled from the 1,700 m elevation to the west to allow the water from SZ1700 to make it to SZ1465.

The compacted areas of the in-pit disposal areas (in-pit dikes) have been nominally designed at a downstream slope of 1.5:1 (angle of repose). Detailed designs will be submitted as part of future dam safety applications. Figure C.5.3-5 shows a plan view of the saturated zones along with a trace of the underground workings. A cross section (A-A') showing the build-up of SZ1465 has been included in Figure C.5.3-6.

C.5.3.4.3 Seepage Capture

In order for the selenium treatment plan to be effective short circuiting of seepage flowing from the toes of the waste rock storage areas needs to be prevented. Seepage water will be collected in ditches and directed to surge ponds. Supplementary collection ditches may be required in additional areas downslope where seepage daylights at surface. A capture efficiency rate of 95% was assumed in the assessment. Monitoring of the groundwater along the base of the ex-pit rock disposal areas will be done to confirm the capture efficiency is being achieved. Monitoring of the surface waters will also be done to confirm that selenium levels are within guidelines. If guidelines are being exceeded additional ditching may be required along with the installation of seepage capture wells.

C.5.3.5 Metals Treatment Plant

The GoldSim water model developed for the Grassy Mountain project has indicated the potential for some metals, such as cobalt, zinc and cadmium, to be found in the discharge of the saturated zones at levels above the water quality guidelines. Direct discharge of this water may cause constituent concentrations in the receiving creeks to exceed provincial and federal guidelines. Monitoring of the discharge will confirm if water treatment is required and the timing of such treatment.

The proposed method for removal of metals and nitrite is conventional lime treatment, also known as a high density sludge (HDS) process. Selenium is not removed in an HDS process. In the process, the process water is mixed with lime, which increases the pH to between 9 and 10. In this pH range, metals precipitate as solid metal hydroxide. Precipitated metals are collected as sludge in a clarifier. HDS water treatment is the most common type of treatment method for removal of metals from mine water. The proposed treatment plant location is shown on Figure C.5.3-1.

C.5.3.6 End-of-Mine Lake

Final mining will occur in the north-east corner of the Grassy Mountain open pit and no in-pit backfilling is available. The remaining excavation will fill with water forming a lake. Benga will avoid any in-pit backfill inside the lake's drainage area in order to minimize the amount of selenium affected water from entering the lake. Horizontal drainage holes would be drilled at the 1,700 m elevation in the lake area to the east to allow the lake water to decant and report east into Gold Creek at final closure.

Figure C.5.3-7 is a cross section (B-B') showing the locations of the 1,700 m saturated zone (SZ1700) and the 1,700 m end-of-mine lake. An unmined portion of rock in the pit floor separates the saturated zone from the lake. Transfer of water between the two is expected to be minimal as both zones will be limited to decant at the same elevation.

C.5.4 Water Balance and Management

This section provides the overall concept and timelines for water balance and management for the Project. An overall schematic of the water balance has been included in Figure C.5.4-1.

The results of the long term kinetic testing reveal that selenium leaching can be expected from the overburden rock found at Grassy Mountain. An assumption has been made that the selenium can be expected to materialize approximately one year after rock placement. As discussed in Section C.5.3, all potentially selenium affected water from the rock disposal areas will be directed to the three surge ponds. From here the water will be directed to the various saturated zones for treatment. The details of the selenium management plan are provided in Section C.8 – Geochemistry and Selenium Management.

In general, the mine progression begins at the southern limit of the Grassy Mountain resource and progresses north into higher elevations. Backfilling the previously mined out pit begins as soon as is practicable and follows the mine progression. This backfilling sequence allows for the creation of an ever expanding backfill zone by constructing a series of east-west dikes across the northern limit of the in-pit backfill. These dikes will hold the water occupying the void space in the backfill back to the

south to keep it from impacting the active working face to the north. Selenium attenuated water will be pumped from the saturated zone by a dewatering well located at the very south end of SZ1465.

Figures C.5.3-1 to C.5.3-5 shows the locations of the saturated fill zones and the timelines when they will be available for selenium attenuation. The saturated fill zones include the following:

- 1,465 m Saturated Zone (SZ1465) – Initial attenuation volume by end of Year 3;
- 1,636 m Saturated Zone (SZ1636) – Year 20; and
- 1,700 m Saturated Zone (SZ1700) – EOM.

SZ1465 is constructed in five phases. As mining progresses north the pit is backfilled creating opportunities for an ever expanding attenuation zone. Phase 1 involves constructing a dike across the southern pit extent and creating a zone up to the 1,440 m elevation. The Phase 2 dike is built 150 m north of the Phase 1 dike up to the 1,450 m elevation. The Phase 3 zone is created by extending the Phase 2 dike upwards to the 1,460 m elevation. The final Phase 4 dike is built 350 m north of Phase 3 up to an elevation of 1,465 m. Once the pit has been mined and completely backfilled, Phase 5 will fill to the 1,465 m elevation increasing the total volume available to 4,390,000 m^3. The 1,465 m elevation was chosen as the open pit is expected to intersect the legacy underground workings. A review of the as-built underground maps, coal geology and field sampling of hillside seepages has indicated that the surface interaction of the legacy workings occurs at an access portal located at the 1,468 m elevation. A dewatering well will be drilled into the Phase 1 zone in order to keep the attenuation zone below this elevation to prevent the early escape of selenium affected water. A plan view of the SZ1465 attenuated zone along with the legacy underground workings and field sampling seepage locations has been included on Figure C.5.3-5. A cross section showing the five phases of SZ1465 has been included on Figure C.5.3-6. A description and timeline of the water balance and attenuation plan has been provided below and summarized in Table C.5.4-1. The timing of the various saturated zone structures has been included below.

Years -1 to Year 1 - Pre-development activities and the initial mining area are not expected to generate selenium impacted water. All water is sent to the sediment ponds, treated for TSS and released to the environment.

Years 2-3 - Water from the south rock disposal area now has the potential to contain selenium. No discharge from the RWP or SESP directly back to the environment will be allowed. The PSSP will treat and discharge water back to the Blairmore creek during this time period. Mining has progressed far enough in the very south west corner of the pit by year 3 to allow the construction of Phase 1of the saturated zone. This zone will be created by constructing a dike across the north end of the pit up to the 1,440 m elevation (Phase 1 - SZ1440 – 170,000 m^3). This dike (compacted fill) will prevent water

from heading north toward the active mining face and will create a saturated zone to the south. Selenium affected water from the RWP and SESP (*via* the RWP) will be sent to this zone for attenuation.

Year 4 – Phase 2 of SZ1465 is created by building a second dyke across the northern limit of the in-pit backfill up to the 1,450 m elevation (Phase 2 - SZ1445 – 300,000 m^3). Excess water from the RWP continues to be pumped to the saturated zone for attenuation. Attenuated water is pumped from the southern end of the saturated zone and returned to either Blairmore or Gold Creeks.

Year 5 – Phase 3 builds up the Phase 2 dyke up to the 1,460 m elevation (Phase 3 - SZ1460 – 180,000 m^3). RWP water continues to be pumped here for attenuation. Attenuated water is pumped from the southern end of the saturated zone and returned to either Blairmore or Gold Creeks.

Year 7 – Phase 4 completes SZ1465 by building a dike up to the 1465 m elevation (Phase 4 - SZ1465 – 900,000 m^3). The overall zone is now capable of treating 1.6 million m^3 of water annually. Attenuated water continues to be pumped from the southern end of the saturated zone and returned to either Blairmore or Gold Creeks.

Year 12 - 14 – Phase 5 is now mined out and backfilled and the water elevation can rise up to the back of the Phase 4 dike up to the 1,465 m elevation (Phase 5 - SZ1465 – 2,840,000 m^3). Attenuated water continues to be pumped from the southern end of the saturated zone and returned to either Blairmore or Gold Creeks.

Year 20 – Once mining is completed in the northeast corner of the pit a second zone is created in the pit bottom. Water will rise within the backfill (SZ1636) up to the 1,636 m elevation before it follows the pit bottom toward the south.

End of Mining and Completion of Reclamation – Final mining occurs in the very northeast corner of the pit. In order to create an end-of-mine (EOM) lake which will be largely free from the effects of selenium, all waste will be placed south into the pit bottom outside of the lake's drainage area. A rise in the pit floor at the 1,700 m elevation creates an in-situ high point between the northern EOM lake and the 1,700 m saturated zone located to the south. To prevent mixing of the water in SZ1700 with the water in the EOM lake, the water elevation will be limited to the 1,700 m elevation with the use of horizontal drainage holes. On the saturated backfill side (south side), the horizontal drainage holes will be drilled towards the west so that the selenium affected water can makes its way towards the SZ1465 zone. Horizontal drainage holes will also be drilled from the EOM lake east towards Gold Creek. This will allow water that accumulates in the EOM lake to augment flows in Gold Creek after closure. Figure C.5.3-7 provides a cross section showing the undisturbed rock separating the 1,700 m saturated zone (SZ1700) with the 1,700 m end-of-mine lake.

The three saturated zones will eventually discharge into Blairmore Creek. Water from the EOM lake will discharge into Gold Creek. All three disposal area surge ponds (NWSP, RWP, SESP) will remain in service after closure as it has been assumed that selenium will continue to leach out of the rock for a time period that extends beyond completion of reclamation. These three ponds will continue to pump water into the saturated zones until selenium levels reach acceptable limits. The remainder of the ponds will be pulled from service and reclaimed.

Table C.5.4-1 Summary of Water Management Plan

Water Management Feature	Year of Operation	Comments
Blairmore Creek Drainage – Release Ponds		
Plant Site Sediment Pond (PSSP) 20,000 m^3 capacity	Year 1 to Year 27	Surface water collected around the site infrastructure (coal wash plant, office buildings, maintenance shop) is directed here. All water discharges to Blairmore Creek all the time.
Loadout Sediment Pond (LSP) 6,350 m^3 capacity	Year 1 to Year 27	Surface water collected around the coal loadout, rail loop and infrastructure is directed here. All water discharges to Blairmore Creek all the time.
West Sediment Pond (WSP) 109,000 m^3 capacity	Year 2 to Year 27	Water collected at the western active mine faces is directed here and discharges to Blairmore Creek (includes water being forwarded from SWSP)
Blairmore Creek Drainage – Surge Ponds requiring Management		
Southwest Surge Pond (SWSP) 34,000 m^3 capacity	Year 1 to Year 27	Water collected at the active mine faces in the south western portion of the pit will be directed to this pond. Water will be directed to RWP if required in the CHPP or else directed north to WSP for treatment/release into Blairmore Creek.
Northwest Surge Pond (NWSP) 35,300 m^3 capacity	Year 1 to Year 5	Pond does not exist, natural flows only to Blairmore Creek
	Year 6	This pond is constructed in advance of rock placement in the North Rock Disposal Area (NRDA). Water is not expected to contain selenium from the NRDA during its first year and is released to Blairmore Creek.
	Year 7 to 23	Water from the NRDA is expected to contain selenium and therefore there will be no discharge directly to Blairmore Creek. All water is instead pumped to the nearest saturated zone for selenium attenuation.
	EOM to Closure	Water will continue to have the potential for elevated

Table C.5.4-1 Summary of Water Management Plan

Water Management Feature	Year of Operation	Comments
		levels of selenium beyond the end of mining. Water will be pumped into SZ1636 saturated zone for as long as selenium levels in the pond dictate. Once levels subside to acceptable levels then this pond will be removed from service and water will be allowed to flow directly to Blairmore Creek.
Raw Water Pond (RWP) 1,200,000 m^3 capacity	Year -1 to Year 2	This pond collects water from the South Rock Disposal Area (SRDA) and is constructed in the year prior to plant production. This pond is used to supply the coal wash plant. Water collected during the first couple of years from the SRDA is not expected to contain elevated levels of selenium and therefore is discharged to Blairmore Creek.
	Year 3 to 23	Water is collected directly from the SRDA and also transferred from the Southeast Surge Pond (SESP). Plant process water is sourced from this pond. Excess water is pumped to the saturated zones for selenium attenuation and then released.
	EOM to Closure	Water will continue to be pumped into the saturated zones for as long as selenium levels in the pond require attenuation. Once levels subside to acceptable levels then this pond will be removed from service and water will be allowed to flow directly to Blairmore Creek.
Blairmore Creek Drainage – Saturated Backfill Zones		
Saturated Backfill Zone 1,465m (SZ1465) 4,390,000 m^3 capacity	Year 1 to Year 2	Mining activity is occurring in the southern limit of the open pit which will be backfilled to create the first saturated backfill (Phase 1) zone for selenium attenuation.
	Year 3 – Phase 1 +170,000 m^3	The Phase 1 dike is built across the open pit up to the 1,440 m elevation which allows for water to be directed into the backfill located to the south of the dike. Excess water from the RWP is directed here in Year 3. Treatment capacity of 170,000 m^3 is created.
	Year 4 – Phase 2 +300,000 m^3	The Phase 2 dike is built to the north up to the 1,450m elevation. Total zone capacity is increased to 470,000 m^3. Excess water from the RWP is pumped here for selenium attenuation.

Table C.5.4-1 Summary of Water Management Plan

Water Management Feature	Year of Operation	Comments
	Years 5 and 6 – Phase 3 +180,000 m^3	The Phase 2 dike is extended vertically upward to the 1,460 m elevation (Phase 3). This increases the saturated zone capacity to 650,000 m^3.
	Years 7 through 9 – Phase 4 +900,000 m^3	The Phase 4 dike is built to the north which increases the total saturated zone capacity to 1,550,000 m^3.
	Years 12 – 23 – Phase 5 +2,840,000 m^3	Once mining has progressed far enough north the water will be allowed to rise up the north side of the Phase 4 Dike (inside the in-pit backfill). This will result in a total saturated zone capacity of 4,390,000 m^3. This zone is large enough to treat all the expected selenium affected water for the remainder of the mine life and also past closure.
	Years 23 +	Water will continue to be directed to this zone for as long as the water percolating through the external disposal areas shows elevated levels of selenium.
	Post Closure	Pumping from the dewatering well cease and water levels inside the zone will be allowed to rise to 1,468m where the water will discharge out the underground mine portal as is currently the case.
Saturated Backfill Zone 1,636m (SZ1636) 2,600,000 m^3 capacity	Year 20 to Closure	Once in-pit backfilling has been completed in the northwest corner a second saturated zone is created in the pit bottom. Water from the NWSP will be re-routed here. Once the zone reaches the 1,636m elevation the water will naturally spill south towards SZ1465.
Saturated Backfill Zone 1,700m (SZ1700) 3,220,000 m^3 capacity	Year 1 to Year 23	Not available
	EOM to Closure	At the end of mining the remainder of the in-pit backfill creates an extremely large selenium attenuation zone. Horizontal drainage wells will be drilled at the 1,700m elevation towards the west to direct the water from the east side of the open pit into the west side and into SZ1465. This water will eventually discharge into Blairmore Creek.
Gold Creek Drainage – Release Ponds		
Northeast Sediment Pond (NESP) 115,000 m^3 capacity	Year 1 to Year 13	Pond does not exist. Natural drainage occurs to Gold Creek
	Year 14 to Year 23	Water collected at the mine face (surface runoff and gw)

Table C.5.4-1 Summary of Water Management Plan		
Water Management Feature	**Year of Operation**	**Comments**
		is directed to this pond prior to release to Gold Creek.
East Sediment Pond (ESP) 125,000 m³ capacity	Year 6 to Year 23	Water collected at the mine face (surface runoff and gw) is directed to this pond prior to release to Gold Creek
Gold Creek Drainage – Surge Ponds requiring Management		
Southeast Surge Pond (SESP) 280,000 m³ capacity	Year 1 to Year 2	Water is collected from the SRDA dump and is discharged directly to Gold Creek during this initial period.
	Year 3 to 23	Water is collected from the SRDA and then pumped across the SRDA powerline corridor split to the RWP. This pond will not discharge to Gold Creek during this period.
	EOM to Closure	This pond will pump the collected water into the end-of-mine saturated zone for as long as selenium levels dictate. Once the quality of the water in the pond is acceptable this pond will be removed from service and the water will flow directly to Gold Creek.

C.5.5 Water Management Structure Design Specifications

C.5.5.1 Sedimentation Ponds

Three sedimentation ponds (WSP, ESP, NESP) (Figure C.5.3-5) will be located downstream of the active mining areas during the operating life of the mine to receive and treat dewatering flows for suspended solids prior to release into Blairmore and Gold Creeks. A fourth sedimentation pond (PSSP) (Figure C.5.3-5) will be located in the vicinity of the plant areas to manage storm water runoff from access roads, the clean coal stockpile, the CPP, the Mine Infrastructure Area (MIA) and the ROM pad. A fifth sedimentation pond (LSP) (Figure C.3.1-1) will be located near the rail loadout and rail loop facilities to manage storm water runoff from these areas and will discharge into Blairmore Creek. Water from the sedimentation ponds is intended to be captured, treated and released. If the quality does not meet the release criteria it can be directed towards the saturated backfill zones as needed.

Geotechnical foundation drilling has also been completed in support of future Dam Safety applications. The WSP is a cross valley structure while the other two active mining area ponds are constructed with side-hill dams. Tables C.5.5-1 and C.5.5-2 summarize the design criteria for the sediment ponds.

Table C.5.5-1 Sedimentation Pond Design Criteria

Description	Criterion
Water Storage Volume and Discharge Pipe	
Water quality design flood	10 year
Retention time for sediment control	12 hours
Minimum Permanent pool depth	3 m
Embankment	
Embankment Slopes	3H:1V (downstream face) 2.5H:1V (upstream face)
Minimum embankment crest width	4 m (for vehicular traffic)
Emergency Overflow Spillway	
Inflow design flood (IDF) – for dam safety	Based on preliminary dam classification based on CDA (2014)
Minimum freeboard above IDF level	0.3 m
Channel Side Slope	2H:1V
Maximum channel bed slope	20%
Minimum freeboard in channel	0.3 m
Maximum slope in cut	1.5H:1V (overburden) 0.25H:1V (bedrock)
Maximum slope in fill	2.5H:1V

Table C.5.5-2 Preliminary Dam Classification and Inflow Design Floods

Pond Name	Classification Based on Incremental Losses			Overall Classification[1]	Inflow Design Flood
	Loss of Life	Environmental and Cultural	Infrastructure and Economics		
West Sediment Pond	Low	Significant	Low	Significant	200 year
East Sediment Pond	Low	Very High	Low	Very High	2/3 between 1,000 year and PMF[2]
Northeast Sediment Pond	Low	Very High	Low	Very High	2/3 between 1,000 year and PMF[2]

1. Recommended inflow design floods based on overall dam classification are:
   - Low – 100 year
   - Significant – Between 100 year and 1000 year selected on a basis of incremental flood analysis, exposure and consequence of failure
   - High – 1/3 between 1000 year and probable maximum flood (PMF)
   - Very High – 2/3 between 1000 year and PMF
2. PMF = probable maximum flood

Key design parameters for the sedimentation ponds and the emergency overflow spillways can be found in Tables C.5.5-3 and C.5.5-4. Figure C.5.5-1 shows a section through a typical sediment pond dam.

Table C.5.5-3 Sedimentation Pond Parameters

Operating Years	Pond Name	Water Quality Design Flood (m^3/s)	Water Storage Volume (m^3)	Dam Crest (masl)	Maximum Dam Height (m)	Dam Length (m)	Diameter of Discharge Pipe (mm)
1 to 27	West Sediment Pond	13	109,000	1,600.5	20.5	456.5	500
6 to 27	East Sediment Pond	13	125,000	1,581.5	11.5	626	500
14 to 27	Northeast Sediment Pond	11	115,000	1,645.4	17	429.5	600
1 to 27+	Plant Site Sediment Pond	-	20,000	1,461	8.5	430	350
1 to 27+	Load Out Settling Pond	1.32	6,350	n/a	n/a	n/a	1,000

Table C.5.5-4 Sedimentation Pond Emergency Overflow Spillways

Operating Years	Pond Name	Inflow Design Flood – Dam Safety (m^3/s)	Discharge Channel				Energy Dissipation Basin		
			Bottom Width (m)	Depth (m)	Length (m)	Slope (m/m)	Length (m)	Maximum Bottom Width (m)	Depth (m)
1 to 27	West Sediment Pond	33	5	2	479	0.089	9	15	2
6 to 27	East Sediment Pond	36	5.5	2	148	0.045	5.5	16.5	2

Table C.5.5-4 Sedimentation Pond Emergency Overflow Spillways

Operating Years	Pond Name	Inflow Design Flood – Dam Safety (m^3/s)	Discharge Channel				Energy Dissipation Basin		
			Bottom Width (m)	Depth (m)	Length (m)	Slope (m/m)	Length (m)	Maximum Bottom Width (m)	Depth (m)
14 to 27	Northeast Sediment Pond	59	8	2	73	0.083	9	24	2
1 to 27+	Plant Site Sediment Pond	-	1.5	1.5	192	0.052	4.5	4.5	1.5
1 to 27+	Load Out Settling Pond	n/a	1	0.77	125	0.02	4.5	4.5	1.5

C.5.5.2 Surge Ponds

Three surge ponds (NWSP, RWP, SESP) (Figure C.5.3-5) will be located downstream of the ex-pit waste dumps to collect toe seepage which is likely to contain elevated levels of selenium. An additional surge pond (SWSP) (Figure C.5.3-5) will be located immediately north of the plant site to collect dewatering flows from the active mining areas during the first nine years of mining. Due to the local relief, this pond will be constructed with side hill dams and will not have the required storage volume to settle out suspended solids. This pond will transfer the water to the raw water pond for use in the coal wash plant or else it will direct water north to the west sediment pond prior to discharge back to Blairmore Creek. Geotechnical foundation drilling has also been completed for these structures ahead of future Dam Safety applications.

Tables C.5.5-5 and C.5.5-6 summarize the design criteria for the surge ponds. Currently no criterion has been assigned for the active water storage volumes in the surge ponds since the sizes of the ponds are constrained by local relief, other mine infrastructure and private property. For dam safety, the surge ponds will have emergency overflow spillways sized to convey the inflow design flood, which was estimated for the largest catchment area reporting to each of the ponds during its operating life.

Table C.5.5-5 Surge Pond Design Criteria

Description	Criterion
Water Storage Volume	
Active storage volume	None
Minimum depth of dead storage	3 m
Embankment	
Embankment Slopes	3H:1V (downstream face) 2.5H:1V (upstream face)
Minimum embankment crest width	4 m (for vehicular traffic)
Emergency Overflow Spillway	
Inflow design flood (IDF) – for dam safety	Based on preliminary dam classification based on CDA (2014)
Minimum freeboard above IDF level	0.3 m
Channel Side Slope	2H:1V
Maximum channel bed slope	20%
Minimum freeboard in channel	0.3 m
Maximum slope in cut	1.5H:1V (overburden) 0.25H:1V (bedrock)
Maximum slope in fill	2.5H:1V

Table C.5.5-6 Preliminary Dam Classification and Inflow Design Floods

Pond Name	Classification Based on Incremental Losses			Overall Classification[1]	Inflow Design Flood
	Loss of Life	Environmental and Cultural	Infrastructure and Economics		
Northwest Surge Pond	Low	Significant	Low	Significant	200 year
Southwest Surge Pond	Low	Low	Low	Low	100 year
Raw Water Pond	Significant	High	Low	High	1/3 between 1,000 year and PMF[2]
Southeast Surge Pond	Low	Very High	Low	Very High	2/3 between 1,000 year and PMF[2]

1. Recommended inflow design floods based on overall dam classification are:
   - Low – 100 year
   - Significant – Between 100 year and 1000 year selected on a basis of incremental flood analysis, exposure and consequence of failure
   - High – 1/3 between 1000 year and probable maximum flood (PMF)
   - Very High – 2/3 between 1000 year and PMF
2. PMF = probable maximum flood

Key design parameters for the surge ponds and the emergency overflow spillways can be found in Tables C.5.5-7 and C.5.5-8. Figure C.5.5-2 shows a section through a typical surge pond dam.

Table C.5.5-7 Surge Pond Parameters

Operating Years	Pond Name	Water Storage Volume (m^3)	Dam Crest (masl)	Maximum Dam Height (m)	Dam Length (m)
8 to 27+	Northwest Surge Pond	35,000	1,600.5	12.5	129
1 to 27	Southwest Surge Pond	34,000	1,495	10	475
0 to 27+	Raw Water Pond	1,200,000	1,503	23	330
0 to 273+	Southeast Surge Pond	280,360	1,509.2	9.2	390

Table C.5.5-8 Surge Pond Emergency Overflow Spillways

Operating Years	Pond Name	Inflow Design Flood – Dam Safety (m^3/s)	Discharge Channel				Energy Dissipation Basin		
			Bottom Width (m)	Depth (m)	Length (m)	Slope (m/m)	Length (m)	Maximum Bottom Width (m)	Depth (m)
8 to 27+	Northwest Surge Pond	24	5	2	289	0.108	9	15	1.5
1 to 27	Southwest Surge Pond	12	2.5	2	498	0.07	6.5	7.5	1.5
0 to 27+	Raw Water Pond	37	5.5	2	1,231	0.059	7	16.5	2
0 to 27+	Southeast Surge Pond	21	4.5	2	140	0.047	4.5	13.5	1.5

C.5.5.3 Collection Ditches & Diversion Channels

Collection ditches will be located downstream of active mining areas, as required, during the operating life of the mine to receive and convey dewatering flows to the sediment ponds. Additional collection ditches will be required to perform the following:

- collect and convey toe seepage from the SRDA to the SESP in Year 5 when a portion of the dump is placed outside the natural pond catchment;
- collect and convey toe seepage from the NRDA back into the dump when a portion of the dump extends outside the natural pond catchment; and
- collect and convey stormwater runoff from the topsoil stockpile located south of the plant site to the RWP starting in year 1.

Diversion channels will also be used to minimize inflows to the RWP and SESP throughout their operation and to the NESP in the early years of its operation. Table C.5.5-9 presents the design criteria for the collection ditches and diversion channels. Due to the steep terrain the channels will generally be constructed along the contour. Typical channel sections are shown in Figure C.5.5-3.

Table C.5.5-9 Collection Ditch and Diversion Channel Design Criteria

Description	Criterion
Design Flood	25 year
Channel side slopes	2H:1V
Maximum channel bed slope	20%
Minimum freeboard in channel	0.3 m
Minimum width of access road	4.0 m
Maximum sustained grade of access road	10%
Maximum slope in cut	1.5H:1V(overburden) 0.25H:1V(bedrock)
Maximum slope in fill	2.5H:1V

C.5.5.4 Diversion Dams & Ex-Pit Berms

Diversion Dams will be constructed as part of collection ditches and diversion channels where these cross perennial streams. Design criteria for the diversion dams and berms is provided in

Table C.5.5-10. These structures will be constructed with similar section to the sediment pond dams (Figure C.5.5-1).

Table C.5.5-10 Diversion Dam and Berm Design Criteria

Description	Criterion
Maximum embankment height	6.0 m
Embankment slopes	3H:1V (downstream face) 2.5H:1V (upstream face)
Minimum embankment crest width	4 m (for vehicular traffic)

C.5.6 Water Management Construction Schedule

All three surge ponds will be developed within the first six years of the project development. The raw water pond, located immediately east of the plant and administration area, and the southeast pond will be constructed during the pre-development stage and are designed to immediately capture water that has percolated through the south rock disposal area which will be utilized in Year 1 (2019). A pipeline connecting the RWP and the SESP will be constructed in Year 2 (2020). The northwest surge pond will be constructed in Year 6 (2026) which will collect water from the NRDA. During the first year of operation of the NRDA it is expected that the water will be allowed to be released to Blairmore Creek once treated for TSS. Once selenium levels in the runoff from the NRDA show elevated levels of selenium, expected sometime in Year 7, all water will be captured and then pumped to the in-pit saturated zones where the water will be semi-passively treated for selenium attenuation.

The raw water pond is expected to store approximately 1.2 million m^3 of water, of which approximately 900,000 m^3 will be utilized annually for the wash plant. In Year 3, a portion of the pit will be backfilled (Figure C.5.3-1). At the northern edge of the backfill the first dike will be constructed across the pit to define Phase 1 of the first saturated backfill zone (SZ1465). Excess water from the raw water pond will be pumped into the in-pit waste rock for passive selenium attenuation. As the mine progresses north additional pit areas will be backfilled and additional dykes constructed across the pit to increase the overall selenium zone capacity.

Additional sediment ponds are constructed along the eastern and western flanks as mining progresses to the north. Table C.5.6-1 presents a summary of the water management infrastructure and timing.

Table C.5.6-1 Water Management Feature Construction Schedule

Item #	Structure	Type	Capacity (m^3)	Dam Height (masl)	Year of Construction	Discharges to:
1	Raw Water Pond	Surge Pond	1,200,000	1,503.0	Pre-production period	Plant feed water or saturated zone
2	South East Surge Pond	Surge Pond	280,000	1,509.2	Pre-production period	Gold Creek in year 1 then to RWP
3	Plant Site Sediment Pond	Sediment Pond	20,000	1,461.0	Pre-production period	Blairmore Creek
4	Loadout Sediment Pond	Sediment Pond	6,350	n/a	Pre-production period	Blairmore Creek
5	South West Surge Pond	Surge Pond	34,000	1,495.0	Year 1	transfers water to either RWP or WSP
6	SZ1465*	Phase 1 Dike	170,000	1,440.0	Year 2	decanted *via* dewatering well and pumped to either Blairmore/Gold Creeks
7		Phase 2 Dike	470,000	1,450.0	Year 4	
8		Phase 3 Dike	650,000	1,460.0	Year 5 and 6	
9		Phase 4 Dike	1,550,000	1,465.0	Years 7,8,9	
10		Phase 5	2,840,000	1,465	Year 12	
11	West Sediment Pond	Sediment Pond	109,000	1,600.5	Year 2	Blairmore Creek
12	East Sediment Pond	Sediment Pond	125,000	1,581.5	Year 6	Gold Creek
13	Northwest Surge Pond	Surge Pond	35,300	1,600.5	Year 6	Pumped to Saturated Zones
14	Northeast Sediment Pond	Sediment Pond	115,000	1,645.4	Year 13	Gold Creek
15	SZ1636	Saturated Zone	2,600,000	1,636m**	year 20	Drains south to SZ1465
16	SZ1700	Saturated Zone	3,220,000	1,700m**	end-of-mine	Drains west and then south into SZ1465
17	End-of-mine Lake (1700m)	Closure Lake			Full 15 years after closure	Drains east into Gold Creek

* – Capacities are the total capacity as each dike is added

** – Denotes the maximum height the water will rise inside an in-pit rock disposal area. No engineered structure required.

C.5.7 Performance Monitoring

The wastewater treatment plant will be routinely monitored for BOD_5, TSS and coliforms. This monitoring will be fully automated, as far as possible, to allow remote monitoring. Effluent water quality will be in accordance with relevant Canadian regulations as well as appropriate standards and any related Approval conditions. During operations daily checks by a trained operator are required which include completing required monitoring reports.

The runoff and wastewater treatment and control system will be routinely monitored for the following parameters:

- TSS;
- Turbidity (NTU);
- pH;
- floating solids;
- nitrate-nitrogen;
- visible foam;
- acute lethality test using rainbow trout (for any ponds within the system using approved floc agents); and
- oil and grease.

The monitoring parameters may vary depending on the type of pond and approval conditions. The frequency of sampling will vary depending on the whether the settling pond is classed as a major or minor pond in the approval. All sedimentation ponds will be equipped to use flocculants to assist with the removal of TSS, and will be classed as major ponds. Flocculants will be field tested for effectiveness and approved by the AER prior to use. Some products currently in use and that have been approved by the AER include a cationic product LT7990 which is a low toxicity product that is also commonly used in potable water treatment. Additional products that have been approved and are being used include Magnafloc LT-7996, Water Lynx 294, Water Lynx 297 and Soil Lynx 288.

Additional sampling will be conducted of the components of the runoff, wastewater treatment and control system (*e.g.* sedimentation ponds, surge ponds, saturated backfill zones, groundwater monitoring, Blairmore Creek upstream, Blairmore Creek downstream, Gold Creek upstream, Gold Creek downstream, Crowsnest River upstream, Crowsnest River downstream) on a monthly/quarterly/annual basis for the following parameters:

- inorganic parameters listed in the *Canadian Water Quality Guidelines for the Protection of Aquatic Life*, 2003, CCME as amended; and

- flow, nitrate-nitrogen, ammonia, BOD, BTEX, colour, oil and grease, phenols, total phosphorous, sulphate, TDS, temperature, total sulphide, selenium, hardness, TSS.

Compliance monitoring will be reported monthly and all monitoring (including effects monitoring) will be reported in an annual report.

C.5.8 Environmental Monitoring

The wastewater treatment plant will be routinely monitored for BOD, TSS and coliforms and this sampling will be completed at the discharge point from the plant. During operations daily checks by a trained operator are required which include completing required monitoring reports. The monitoring reports will include results from grab samples from both the untreated and treated wastewater systems. If any chemical was added to the wastewater treatment process the quantity of that substance will be recorded weekly. The name of the supervising operator responsible for the wastewater system will also be recorded.

The required sampling of runoff and wastewater systems will be completed at the discharge points of each settling pond. It is assumed that these locations will be specified in the approval. Sampling frequency would vary based on the time of year with more sampling taking place during the summer months. Sampling frequency will also be dependent on the parameter being sampled for with frequencies ranging from daily, twice a week, bi-weekly, monthly, annually and bi-annually. The parameters and the frequency to which they require sampling is expected to be provided in the Approval. Standard sampling procedures will be followed and field QA/QC protocols, such as trip blanks, will be completed. Sampling will also be completed downstream of the release locations to ensure compliance. In addition to this sampling, it would be expected that ambient surface waterbody sampling would be included in the Approval which require Benga to sample local surface waterbodies on a quarterly basis for various parameters.

Additional monitoring will be required to validate predictions and to ensure the function of the various mitigation, control and treatment measures. Hydrologic, including water quality, as well as aquatic monitoring, including benthic invertebrates and water course aquatic monitoring will be implemented as well to validate the wastewater system.

C.6 Miscellaneous

The mine infrastructure area (MIA) facilities have been designed to include for the following:

- administration building:
  - mine dry;
  - crib rooms;

  - car parking.
- warehouse;
- heavy vehicle workshops x 4;
- wash bay;
- cold storage;
- lube storage;
- fuel farm;
- emergency response (including first aid);
- potable & waste water treatment plants;
- propane facility;
- electrical substation and distribution;
- site security; and
- storage yards.

The facilities will be a combination of demountable style buildings, engineered buildings and fabric structures. All designed for safe operation in all seasons.

The MIA facilities are located to the south adjacent to the CHPP as shown in Figure C.2.4-1 and are interconnected with a general access road. At the northern end of the MIA facilities is the interconnection to the mine site haul road.

C.6.1 Office Complex/Mine Dry

The administration building is a series of demountable style buildings and includes for the mine dry and crib facilities (Figure C.6.1-1). It will be used to house the site management and administration personnel. The facility will include:

- reception area;
- site offices & open workspaces;
- meeting & training rooms;
- maintenance documentation storage;
- male/female ablutions;
- mine dry facilities (male/female):
  - lockers;
  - showers.

- crib facilities;
- power, communications, water & heating for all facilities; and
- car park (including electrical heating stations).

C.6.2 Warehouse

The warehouse structure will be a pre-engineered building with foam core insulated panel construction on the roof and walls to provide a heated and secure location installed as part of the MIA facilities for storing weather sensitive spares and tools.

The warehouse facility will contain the following:

- receiving area & local office;
- storage racking;
- fire rated walls; and
- services – air, water, power, HVAC.

The final inventory and sizing for the warehouse will depend on the equipment selected, operational strategy setup for the mine and plant, and ease of accessibility.

C.6.3 Tire Storage / Repair Area

The tire storage/repair area is located adjacent to the workshop/wash bay areas and is a fully enclosed, heavy-duty and flame resistant fabric building with forced air heating units. Access will be located at both ends and there will be one sectional overhead door for light/medium duty truck access. There will be uncovered tire storage on a gravel pad adjacent to the building including a heated slab for repairs.

C.6.4 Workshops

The service bays are designed to accommodate 300 tonne capacity class trucks. The facility will include four drive-through service bays and one welding bay. Sufficient area adjacent to this building has been left to allow for an additional pair of service bays, if required.

The service bay structure will be a pre-engineered building containing the following:

- steel sandwich cladding wall (min R20);
- flat roof with parapet and membrane;
- heavy haul rubber type overhead doors;
- steel embedded concrete floor slab with footings;

- roof height will allow for truck boxes to be open with sufficient bridge crane clearances;
- lube reels will be located at each bay (4 oil, 1 coolant, 1 grease) will be interconnected with the lubricants and fluids in the lube storage facility; and
- two 40/10T bridge cranes will be installed over the service bays on side of the facility.

The facilities would have a forced air HVAC system with enough make-up air capacity to allow trucks to run within building for required running tests. Exhaust capture and release system would be necessary.

C.6.5 Wash Bay

The truck wash will be a one-level pre-engineered structure tall enough to accommodate 300 tonne class trucks with a raised box. The wash bay will consist of a low pressure and high pressure system. The low pressure system will be used for general washing, while the high pressure system will be used for final detailing.

The facility will have a flat roof with heavy haul rubber type doors, concrete floor slab with footings and embedded rails. It will also include a forced air HVAC system, make-up air capacity to allow for trucks to run while being cleaned and in floor heating. Apron trench and roof drainage will be piped to ditches.

Adjacent to the wash bay will be a room housing the motor control center, compressor, water treatment system, pumps, and oil interceptor. The truck wash facility will accommodate washing of light and medium duty vehicles. Waste water will report to a collection cell for settling and solids removal.

C.6.6 Fuel and Lube Storage

The heavy (HV) and light vehicle (LV) fueling station will be as found in Table C.6.6-1.

Table C.6.1-1 Fuel Type and Storage Quantity

Fuel Type	Volume (litres)
Split Gasoline / Diesel (light duty vehicle fuelling station)	50,000
Diesel (truck fuelling station)	2 x 100,000

The HV tanks will be horizontal, double-wall tanks, and a covered refueling platform. Each side has a high volume pump, metering, tank safety valve, loading arm and mining refueling nozzle. Each system includes a high-volume Velcon aviation-level filtration system (required for Tier 4 engines).

The LV fuel tanks will be located separately to the HV fuel tanks (as shown on the MIA general arrangement), located above grade, will be double-walled for leak containment and skid mounted.

Both fueling stations will come integrated with hoses and pumps as well as a Fuel Master cardlock system and the tank levels are monitored by Pneumercator tank level monitoring, including the interstitial space between the primary and secondary tank to monitor for leaks.

After initial set up at the plant site administrative office, shop and maintenance area, additional fuel and lube facilities will be located at various points throughout the mine area. From time to time these facilities are relocated as activities and operations advance to new mine areas. The service islands will assist in operational efficiency by keeping fuel and lube supplies available to the large mobile equipment and readily accessible to haul trucks routes.

At these sites, mobile equipment will be provided with diesel fuel, engine coolants and lubricants. The satellite stations reduce the need to send equipment all the way to the main filling depot, resulting in time and energy savings as well as emissions reduction. All fuel depots have secondary containment berms around the storage tanks and site drainage is managed. Regular use and maintenance of these depots ensures that spillage and leakage is minimized. Depots are located close to active mining areas along the main haulroads and within the completed rock disposal areas. These satellite stations will mainly service haul trucks, while most mobile equipment (*i.e.,* dozers, excavators, blast hole drills, *etc.*) will be serviced by fuel/lube trucks.

C.6.7 Cold Storage Area

Cold storage will consist of both covered and lit structures and as well as uncovered gravel pads.

C.6.8 Covered Storage

The covered structure will be a fabric pre-engineered un-heated building (Figure C.6.8-1) and will include shelving and racks to optimize the storage of spare equipment that is susceptible to weather. Ground preparation will be compacted gravel and the fabric structure will be anchored against a row of lock blocks (there will no poured concrete foundation).

C.6.9 Uncovered Storage

Uncovered storage will provide area where equipment and materials can be stored that are not susceptible to weather. The yard will have a combination of racking for smaller items and ground storage for large items. Ground preparation will be compacted gravel.

Another area will be designated for hazardous waste and be designed with the appropriate regulations.

C.6.10 Lube Storage

Lubricant storage for light duty, mobile equipment, and mining trucks will be stored in a dedicated facility within the MIA. A network of small bore piping will connect the lube facility to the truck maintenance workshop. The tanks requiring venting to the atmosphere will be ventilated as necessary. Sufficient filtering and metering instruments will be included as part of this lube storage facility. Tanks that are containing combustible lubricants shall be double-walled for spill containment. All other tanks shall be single-walled. Delivery of lubricants to the shed will be to the outside of the facility *via* hose connections and pumps. There will also be the infrastructure to allow for mobile site lube trucks to be able to replenish lubricants from outside the maintenance facility.

C.6.11 Emergency Response and& First Aid

An on-site first aid station and emergency vehicles bay will be installed (Figure C.6.11-1). The facility will be heated. A rescue vehicle and fire truck will be available 24-hours per day for use in emergency rescue situations. These vehicles will be parked indoors.

C.6.12 Potable Water

Potable water at the plant site will be primarily used for the domestic facilities (showers, toilets and sinks). The water will be supplied from sealed potable water well(s) and then pumped to the treatment plant.

A single package potable water plant (with heating and lighting) delivering an average flow rate of 30 m^3/day will be installed at the CHPP pad. The plant also includes a 25,000 litre storage tank and pumping system, which will cater for the potable water needs of the MIA facilities and CHPP office.

Water quality will be in accordance with relevant regulations as well as applicable Canadian Standards.

The potable water plant will be supplied fully automated (as far as possible) and will be integrated into the overall CHPP supervisory control and data acquisition system (SCADA) to allow remote monitoring. During operations only basic daily checks by a trained operator are required.

C.6.13 Sewage

MIA facility sewage will be collected and treated in a sewage treatment package plant (c/w power, heating, communications and lighting) located on the MIA pad. The treatment plant will treat all sewage produced at the MIA facilities and has been based on an estimated sewage treatment requirement of 30 m^3/day.

Effluent water quality will be in accordance with relevant regulations as well as appropriate standards. The treatment plant effluent produced will be pumped to the plant site sediment pond (PSSP) located adjacent to the CHPP product stockpiles. Excess sludge will be collected for removal from the package treatment plant by vacuum trucks and disposal off site.

The waste water treatment plant will be supplied fully automated (as far as possible) and will be integrated into the overall CHPP SCADA system to allow remote monitoring. During operations only daily checks by a trained operator are required.

Sewage and grey water from the CHPP service buildings will be pumped to the water treatment plant for processing and discharge.

C.6.14 Site Security

Site security will be controlled entry *via* a boom gate and cameras, remotely controlled from the administration building. The location of the boom gate will be south of the product stockpile area along the mine access road to ensure no un-controlled site access to the CHPP and MIA. Registration and induction processes will be conducted at the administration building.

C.6.15 Site Power Supply and Communications

C.6.15.1 Site Power Supply

Power to the Grassy Mountain CHPP site will come from a 25 kV main feeder power line in the local area. This line will be extended to a nominated location adjacent to the TLO area where it will be split and reticulated to the TLO and CHPP substations. The proposed open pit mine is currently planned to be mined using diesel powered mine equipment. Cost/benefit studies are currently underway to investigate supplying power to the open pit and powering some of the equipment (stripping shovels, blasthole drills, dewatering pumps) electrically.

The 25-kV network will consist of two feeds to provide supply to the CHPP and TLO facilities. The 25 kV will be distributed to the local area substations and switchrooms. 25-kV metering boxes will be installed at each of the TLO and CHPP locations as the battery limit with the Fortis Alberta supplied scope of work.

The 25-kV network at the CHPP area will consist of an underground supply from the product reclaim substation to the product substation, CPP substations, raw coal substation, and rejects/ROM bins substations.

MIA facilities will be fed from the CPP Substation.

Raw Coal Substation – SU-101

The raw coal area will be supplied from the 25 kV reticulation around the CHPP area. The 25 kV will be transformed to 600V to supply local the MCC. The substation will consist of the following:

- 1 x 25-kV switchboard (SD-101);
- 1 x 25/0.6-kV outdoor transformer (TF-101) and compound area;
- 1 x 600-V MCC (MC-101); and
- Earth grid and fencing around transformer compound areas.

Coal Processing Plant Area – SU-401, SU-402 & SU-701

The CPP area will be supplied from the 25-kV underground line. The 25-kV will be transformed to 600 V to supply local MCCs. There will be three substations for this area. The substations will consist of the following:

SU-401 – CPP Substation 1

This substation will be inside the CPP building above the process pumps and will distribute power to CPP Feed and CPP loads. It will consist, as a minimum, of the following:

- 1 x 25-kV switchboard (SD-401);
- 1 x 25/0.6-kV transformer (TF-401) and compound area (external to building);
- 1 x 600-V MCC (MC-401); and
- Earth grid and fencing around transformer compound areas.

SU-402 – CPP Substation 2

This substation will be inside the CPP Building adjacent to the filtration building and will distribute power to CPP loads, filtration system, and hyperbaric air compressors. The substations will consist of the following:

- 1 x 25-kV switchboard (SD-402);
- 1 x 25/0.6-kV transformer (TF-402) and compound area (external to building);
- 1 x 25/0.6-kV transformer (TF-404), neutral grounding resistor and compound area (external to building);
- 1 x 600-V MCC (MC-402);
- 1 x 25-kV switchboard (MC-404); and
- Earth grid and fencing around transformer compound areas.

Rejects Area – SU-701

The rejects/ROM bins area will be supplied from the 25-kV reticulation around the CHPP area. The 25 kV will be transformed to 600V to supply local MCC. The substation will consist of the following:

- 1 x 25-kV switchboard (SD-701);
- 1 x 25/0.6-kV outdoor transformer (TF-701) and compound area;
- 1 x 600-V MCC (MC-701); and
- Earth grid and fencing around transformer compound areas.

Product Coal Area – SU-801

The Product Coal Area will be supplied from the 25-kV reticulation around the CHPP area. The 25-kV will be transformed to 600 V to supply local MCC. The substation will consist of the following:

- 1 x 25-kV switchboard (SD-801);
- 1 x 25/0.6-kV outdoor transformer (TF-801) and compound area;
- 1 x 600-V MCC (MC-801); and
- Earth grid and fencing around transformer compound areas.

Product Reclaim Area – SU-805

The product reclaim area will be supplied from the 25 kV reticulation around the CHPP area. The 25 kV will be transformed to 600 V to supply local MCC. The substation will consist of the following:

- 1 x 25-kV switchboard (SD-805);
- 1 x 25/0.6-kV outdoor transformer (TF-805) and compound area;
- 1 x 600-V MCC (MC-805); and
- Earth grid and fencing around transformer compound areas.

OLC Head Drive Station – SU-851

The OLC Head Drive Station will be located adjacent to the OLC head end drive station. It will be supplied from the 25-kV overhead line. The 25 kV will be transformed to 600 V to supply local MCC. The substation will consist of the following:

- 1 x 25-kV switchboard (SD-851);
- 1 x 25/0.6-kV outdoor transformer (TF-851) and compound area;
- 1 x 600-V MCC (MC-851); and
- earth grid and fencing around transformer compound areas.

Remote TLO facility – SU-852

The Remote TLO facility will be supplied from the 4.16-kV overhead line. The 4.16 kV will be transformed to 600 V to supply local MCC. The substation will consist of the following:

- 1 x 25-kV switchboard (SD-852);
- 1 x 25/0.6-kV outdoor transformer (TF-852) and compound area;
- 1 x 600-V MCC (MC-852); and
- Earth grid and fencing around transformer compound areas.

The site's estimated electrical loads by area are summarized in Table C.6.4.1.

Table C.6.4-1 Estimated Electrical Loads by Area

MCC#	Description	Installed kW	Demand Kw
MC101	RAW COAL MCC	1,239	908
MC401	CPP Transformer 1	3,255	2,427
MC402	CPP Transformer 2	3,387	2,457
MC404	HBF Compressor	4,480	3,373
MC701	Rejects/ROM Bins	1,087	795
MC801	Product Stacking	2,516	1,934
MC805	Product Reclaim	941	760
MC851	Overland Conveyor Head Station	1,333	1,089
MC852	Remote Train Load-out	412	329
Total		**18,650**	**14,072**

The 25/4.16 kV substation layouts will provide adequate spare space for any future expansions without the need of interrupt the existing operations.

C.6.15.2 Lighting & Small Power

Lighting is provided at each of the Fortis Alberta 25/4.16 kV substations, CHPP, MIA, raw water pumping and construction camp areas. Lighting in all other areas will generally be outdoor HPS type with additional flood lighting installed around areas that may require maintenance or operations work during nighttime. Lighting and small power, complete with local distribution boards will be installed in all areas. Road lighting is not been included.

C.6.15.3 On-Site Communications System

The overall on-site communications systems requirements for the project include:

- local area network (LAN)/wide area network (WAN) – for communications at the CHPP, MIA, construction camp and electrical substations; and
- wi-fi mesh – for communication within the construction camp.

Communications for the site will access a main Telus trunk line running adjacent to Highway 3. The 25 kV overhead power line infrastructure will be used to carry the site fibre trunk line to the MIA and TLO area substations. From the 25/4.16 kV substations, single-mode optical fibre cabling will be run

underground to the respective areas for further distribution. A wireless network will be installed to cover all work areas of the CHPP and MIA as well as the construction camp.

C.6.16 Fire Protection

C.6.16.1 Fire System Design Criteria

The fire protection system for the MIA will be designed for early fire detection, emergency warning and capability for pro-active response to an emergency fire situation. The fire protection system will be designed and installed in accordance with NFPA 24 and consist of the following:

- fire water tank and pumping system (including back up diesel pump);
- maximum system operating pressure but will not be less than 1,035 kPa;
- fire water pipeline servicing all of the MI facilities;
- hand activated manual alarm and fire protection activation panels located throughout the buildings;
- sounder and beacons;
- fire hose reels & 9 kg DCP portable fire extinguishers c/w PVC clear cover located;
- sub fire alarm panels located in the administration offices;
- 5 kg CO_2 portable fire extinguishers located adjacent to electrical service facilities;
- Class II hose station c/w foam depot boxes for hazard areas; and
- point type smoke detection in the office areas.

C.6.16.2 Fire & Wash-down Water

Fire and wash-down water will be reticulated in a common system around the MIA. The source of water for this system will come from the fire water system located adjacent to the CHPP.

Where the water distribution pipes are not installed inside heated facilities, it will be buried underground in accordance with regulatory recommendations that will prevent the pipes from freezing.

Wash-down water will generally be provided through 25 mm hoses located around the MIA area. Additional hose connections and ball valves will be provided at other locations as necessary.

C.6.17 Construction Camp

In order to construct the infrastructure associated with the proposed project an appreciable initial workforce will be required. The peak monthly workforce during the construction period has been

estimated to be approximately 400 people. Three options were considered for the construction accommodation:

- Option 1: offsite accommodation using the local townships;
- Option 2: onsite construction camp; and
- Option 3: combination of onsite and offsite accommodation.

Option 1 was determined not to be viable as the quantity of accommodation in the local area was not available. Option 2 required a considerable capital outlay to cover the short 400 person peak demand period, and therefore, was also deemed unsuitable. The third and proposed option was chosen and provides the following:

- a semi-permanent 228 person base camp. Approximately 15 to 18 beds would be required for camp operations and catering staff;
- the camp would be expandable for peak construction periods; and
- the local area, which includes Blairmore, Coleman and Bellevue has suitable accommodations to manage through short term peak periods.

The scope of work to put the temporary facility in service includes the following:

- bulk earthworks include platform, drainage, and access roads;
- construction camp infrastructure (utilising offsite accommodation strategy to manage peak periods);
- 228 rooms including all service facilities with expandability for an additional 132 rooms and service facilities;
- service facilities including the following:
  - potable water treatment plant and reticulation;
  - waste water treatment plant and collection network;
  - propane HVAC systems; and
  - power and communications services.

The construction camp will include the following:

- 228 single rooms, each with an ensuite bathroom (including basin, shower, and toilet). The room will be large enough to accommodate a double bed, side table and wardrobe, television, bar fridge, desk, and chair;
- onsite camp administration and operational staff (inclusive in the 228);

- common dining hall;
- recreational facilities;
- laundry facilities;
- enclosed and heated walkways;
- services;
- power;
- potable water (*via* truck haulage);
- fire water;
- HVAC (*via* propane tank);
- communications;
- wastewater management (*via* truck removal);
- car parking; and
- expansion capability for an additional 132 single rooms, each with a shared bathroom with the adjacent room, will be provided on a temporary basis to cover the additional manning levels required for the peak construction period from May 2018 to October 2018.

Operation of the construction camp would be outsourced to a specialist contractor who will be responsible for the following:

- administration;
- housekeeping;
- catering;
- laundry;
- maintenance of the buildings, fittings and furnishings;
- horticultural services including keeping the grounds neat and tidy; and
- pest control.

The construction camp and its service facilities will be procured from pre-qualified Canadian companies that have the experience in delivering these types of facilities suitable for operation in the regional conditions.

Power for the construction camp area will initially be supplied *via* a local generator until the 25-kilovots (kV) line to the MIA is installed. After which a local portable skid mounted transformer (and switchgear) may be installed.

Communications strategy for the camp includes the installation of a local area network and Wi-Fi network to cover all work areas.

Construction camp potable water will include two local 63,000-litre potable water storage tanks. This allows for approximately one and a half days of potable water storage for the construction camp based on an estimated daily usage of 225 litres per day per person at the maximum camp size of 360 beds. These tanks will be remotely filled by a potable water supplier.

Construction camp sewage will be collected locally and stored in two local 63,000-litre sewage collection tanks. This allows for approximately one and a half days of sewage storage for the construction camp based on an estimated daily potable water usage of 225 litres per day per person at the maximum camp size of 360 beds. These tanks will be remotely emptied by a third party tanker with the sewage treated off site.

C.6.18 Aboveground Storage Tanks

All storage tanks on the Grassy Mountain project will be located above ground. The majority of the tanks will be located on the CHPP/MIA pad area. Please refer to Figure C.6.18-1 for the locations of the tanks in the main infrastructure area. A second set of fire water tanks will be located across from the coal loadout bin. Please refer to Figure C.6.18-2 for the locations of the tanks near the TLO. Please refer to Table C.6.18-1 for a summary of the site's storage tank data.

Table C.6.18-1 Summary of Storage Tank Data

Tank Identification	Description	Materials of Construction	Contents	Tank Capacity	Corrosion Protection	Foundation or Base pad Prep	Type and Capacity of Secondary Containment	Measures to Prevent Overfilling	Method of Leak Protection
Coal Handling Processing Plant Area (CHPP)									
Coal Thickener (30m diameter)	Used to dewater the coal	Carbon Steel (All materials to AS3678/9 – 250/300 U.N.O)	Coal / water	2,600m^3 (approx.)	Thickener is sandblasted and painted	Base pad Prep – 300kPa bearing pressure Foundation design – heated underside with perimeter insulation. Pad footings.	Primary bund used to contain minor spillages. When required to completely drain thickener for inspections, thickener is drained to the emergency mineable cell.	Level sensor installed on overflow clarified water tank to detect overflow conditions. Thickener can be drained through manual drain valve.	Visual inspection
Tailings Thickener (30m diameter)	Used to dewater the tailings prior to sending to reject bin.	Carbon Steel (All materials to AS3678/9 – 250/300 U.N.O)	Clays / water	2,600m^3 (approx.)	Thickener is sandblasted and painted	Base pad Prep – 300kPa bearing pressure Foundation design – heated underside with perimeter insulation. Pad footings.	Primary bund used to contain minor spillages. When required to completely drain thickener for inspections, thickener is drained to the emergency mineable cell.	Level sensor installed on overflow clarified water tank to detect overflow conditions. Thickener can be drained through manual drain valve.	Visual inspection
Fire Water Tank	Used for on-site fire fighting	Galvanised Steel plate with HDPE liner in tank	Water	2 x 300,000L	NFPA standard	Base pad Prep – 250kPa bearing pressure Foundation will be concrete ring beam	Primary containment is the internal membrane. Secondary containment is the tank wall.	Control of water flow to tank will be by self-regulating float valve.	Visual inspection as per NFPA requirements – annual inspection *via* ROV (Robot)
Diesel Reagent Storage Tank	Reagents are used to assist with the operation of the plant flotation cells to process ultrafine coal.	Carbon Steel (ULC S601 Double Wall C.A.G.S.T)	Diesel	25,000L	Surface is external sandblasted to SSPC-SP6. 'Amershield' High Built white polyurethane coating.	Tank will be skid mounted.	Tank is double walled, therefore spillage will be contained inside second tank wall.	Overfill prevention valve – installed on feed line	Visual – inspection port
MIBC Regent Storage Tank	Reagents are used to assist with the operation of the plant flotation cells to process ultrafine coal	Carbon Steel(ULC S601 Double Wall C.A.G.S.T)	Methyl isobutyl carbinol	25,000L	External surface is sandblasted to SSPC-SP6. 'Amershield' High Built white polyurethane coating.	Tank will be skid mounted.	Tank is double walled, therefore spillage will be contained inside second tank wall.	Overfill prevention valve – installed on feed line	Visual – inspection port

Table C.6.18-1 Summary of Storage Tank Data

Tank Identification	Description	Materials of Construction	Contents	Tank Capacity	Corrosion Protection	Foundation or Base pad Prep	Type and Capacity of Secondary Containment	Measures to Prevent Overfilling	Method of Leak Protection
Cationic Flocculant Storage Tank	Flocculants are added to the plant thickeners to assist with settling.	FRP (with 2″ foam insulation with FRP protective covering)	Cationic Flocculant	40m^3	Tank is FRP. Agitator is painted.	Basepad prep – 250kPa. Foundation w/ perimeter insulation	Spillages contained within concrete bund.	Overfill prevention valve – installed on feed line Ultrasonic level transmitter installed on top of tank	Visual inspection
Anionic Flocculant Storage Silo	Flocculants are added to the plant thickeners to assist with settling.	Carbon Steel	Anionic Powder	90m^3	Interior/Exterior sandblasted to SSPC-SP 6 Interior/Exterior primed with 1.8-2.2 mms DFT Grey Zinc Primer Exterior finish 3mms white enamel	Basepad prep – 250kPa. Foundation w/ perimeter insulation.	Powder spillages contained within concrete bund.	Overfill prevention valve – installed ion feed line High level probe and radar level transmitter installed on top of tank	Visual inspection
Propane Storage Tank	Source of fuel for plant heaters	Carbon Steel Pressure vessel rated to 250PSIG @ 150F (Compliant with pressure vessel code)	Propane	18,000 USWG (68,000L)	External surface is sandblasted and painted	Tank will be skid mounted.	No secondary containment required, propane boils at -42^{o}C	Overfill prevention valve – installed on feed line	Visual inspection
Potable Water Tank	Storage tank for site's potable water. Receives water from dedicated groundwater well.	2.2m dia x 5.5m High 316SS tank within a custom-modified 20′ ISO liquid container	Potable Water	25,000L	N/A	Tank housed within container.	Container acts as second wall containment.	Level float control valves to control feed flow	Visual inspection

Table C.6.18-1 Summary of Storage Tank Data

Tank Identification	Description	Materials of Construction	Contents	Tank Capacity	Corrosion Protection	Foundation or Base pad Prep	Type and Capacity of Secondary Containment	Measures to Prevent Overfilling	Method of Leak Protection
Mine Infrastructure Area (MIA)									
Light Vehicle Fuel Station	Small vehicle fueling station.	Carbon steel (manufactured and labelled in accordance to ULC S-601-07)	Split Diesel / Gasoline	50,000L split tank	External surface is sandblasted to SSPC-SP6. Finished with aliphatic white polyurethane coating.	Tank will be skid mounted.	Tank is double walled, therefore spillage will be self-contained.	Overfill prevention valve – installed on feed line	Tank levels are monitored by Pneumercator tank level monitoring, including the interstitial space between the primary and secondary tank to monitor for leaks.
Heavy Vehicle Fuel Station	Fuel station for heavy mining equipment such as haul trucks, garders, bull dozers, front end loaders.	Carbon steel	Diesel	2 x 100,000L	External surface is sandblasted to SSPC-SP6. Finished with aliphatic white polyurethane coating.	Tank will be skid mounted.	Tank is double walled, therefore spillage will be self-contained.	Overfill prevention valve – installed on feed line	Tank levels are monitored by Pneumercator tank level monitoring, including the interstitial space between the primary and secondary tank to monitor for leaks.
Propane Storage Tank	Source of fuel for MIA heaters	Carbon Steel Pressure vessel rated to 250PSIG @ 150F (Compliant with pressure vessel code)	Propane	18,000 USWG (68,000L)	External surface is sandblasted and painted	Tank will be skid mounted.	No secondary containment required, propane boils at -42°C	Overfill prevention valve – installed on feed line	Visual inspection
Train Loadout Area (TLO)									
TLO Fire Water Tanks	Fire fighting water located next to train loadout.	Galvanised Steel plate with HDPE liner in tank	water	2 x 220,000L	NFPA standard	Basepad Prep – 250kPa bearing pressure. Foundation will be concrete ring beam	Primary containment is the internal membrane. Secondary containment is the tank wall.	Control of water flow to tank will be by self-regulating float valve.	Visual inspection as per NFPA requirements – annual inspection *via* ROV (Robot)

Table C.6.18-1 Summary of Storage Tank Data

Tank Identification	Description	Materials of Construction	Contents	Tank Capacity	Corrosion Protection	Foundation or Base pad Prep	Type and Capacity of Secondary Containment	Measures to Prevent Overfilling	Method of Leak Protection
Dustbinder Chemical Storage Tank	Used on top of coal once rail car is full to prevent dusting during travel to port.	HDLPE (Polyethylene) Insulated and Heat traced		37,850L	N/A SS fittings used	Basepad Prep – 250kPa bearing pressure. Concrete Foundation w/ perimeter insulation.	Spillages will be contained within a concrete bund.	Overfill prevention valve – installed on feed line. Ultrasonic level transmitter installed on top of tank.	Visual inspection
Anti-Freeze Chemical Storage Tank	Prevents rail car freeze up.	HDLPE (Polyethylene) Insulated and heat traced	Anti-freeze	37,850L	N/A SS fittings used	Basepad Prep – 250kPa bearing pressure. Concrete foundation w/ perimeter insulation.	Spillages will be contained within a concrete bund.	Overfill prevention valve – installed on feed line. Ultrasonic level transmitter installed on top of tank.	Visual inspection

C.7 ENVIRONMENTAL MANAGEMENT

C.7.1 Responsible Management

Benga is committed to providing responsible management for its operations:

- mine development is carried out in a professional and environmentally responsible manner;
- impacts on the biophysical environment are mitigated;
- Aboriginal Consultation Mitigation – mindfulness;
- human health, well-being and safety of its employees are safeguarded; and
- all management level staff are familiar with the company's policies regarding operating practices and environmental protection measures and that employees under their supervision receive proper instruction with respect to policy and procedures through training for on-site job and safety, health and environmental programs.

C.7.2 Environmental Protection Measures

Benga will ensure that environmental aspects and protection measures are taken into consideration during all phases of mine development, from planning to reclamation. Technically proven and economically feasible measures will be used which protect environmental quality for air, water, vegetation, wildlife and land resources.

Benga will establish pollution prevention as a priority to pollution clean-up responses. Benga will implement the following pollution prevention measures:

- reuse and recycling of products;
- substitution of products purchased with more environmentally friendly materials;
- equipment modifications and improved operating efficiencies; and
- conservation of materials and resources.

C.7.3 Participant in Environmental and Regulatory Initiatives

In the absence of any substantive long term remediation plan to address historical mining activities which largely terminated in the early 1960s, Benga plans to establish and be a catalyst for a Gold Creek Stewardship Program. The program will address some of the current issues that relate to the water quality and fisheries in Gold Creek. While the aquatic environment is the first priority of this program, the terrestrial and social components will also be captured. Benga will be the catalyst for this program and foresees involvement from a wide range of stakeholders, environmental groups, aboriginal communities, academia, researchers and regulators. A function of the program would be active engagement in local research and monitoring that would tie in to the Project.

As part of the Project mitigation strategy, Benga will actively participate in the recovery plans for the limber pine (*Pinus flexilis*) and whitebark pine *(Pinus albicaulis*), and the westslope cutthroat trout (*Oncorhynchus clarkia lewisi*) which are three species at risk found in the Project area.

Benga will also actively re-develop and subsequently reclaim the old legacy mining activities that occurred as a result of previous underground and surface mining activities. All lands disturbed by the Project will be reclaimed to today's standards.

C.7.4 Regulatory Compliance and Adaptive Management

Benga will commit to ensuring that its activities and operations comply with all relevant laws and regulations. This commitment is attained in numerous ways:

- designated Benga employees to be kept informed of relevant laws, regulations and operating guidelines through training programs;
- continual review and updating of emergency preparedness procedures; and
- continual review and updating of operating procedures including responsible handling, use and disposal of products and materials.

Environmental and Occupational Health and Safety Inspectors will routinely monitor Benga's site operations and regulatory compliance. Benga will continue carrying out its environmental and operating programs in the Project area using an adaptive management approach.

C.7.5 Respect the Interests of Public

Benga is committed to respecting all interested publics concerning Project development. Benga believes that the information provided and commitments made in this application will demonstrate its recognition of public engagement for this Project. Section G provides the details of the public engagement program and Section H provides the details of the Aboriginal engagement program.

C.7.6 Environmental Protection Program

The purpose of the Environmental Protection Program at the Benga is to first prevent and second to minimize adverse environmental impacts resulting from mine related operations. The program will be implemented in the Project area through the following on-site mechanisms:

- adaptive management approach to environmental risk assessment;
- Health/Safety/Environment Group comprised of key Benga employees;
- emergency response and wildfire control and prevention;
- waste management program;

- spill response and clean up procedures;
- operating policy commitments; and
- site reclamation.

A brief discussion illustrating how environmental impacts are prevented and/or minimized through each of these mechanisms is provided in the following sections.

C.7.6.1 Adaptive Management and Environmental Risk Assessment

Benga recognizes and will perform three stages of environmental risk assessment. Throughout these stages of risk assessment, Benga will adapt operating practices to ensure that environmental impacts are eliminated or minimized. Government regulation and public involvement ensure or promote successful implementation of environmental programs.

The first stage of adaptive management is carried out before mine development. At this stage, baseline environmental conditions are documented and potential environmental risks and impacts are assessed. Mine plans are developed to ensure that the risks and impacts are prevented or mitigated.

The second stage is carried out during mine operations. The potential risks and impacts that were identified before mine development are monitored to ensure that control and mitigation measures are effective or if adaptive measures are required. The purpose of monitoring is to determine if changes in the natural environment (*i.e.*, background conditions) have occurred after mining has started.

Potentially adverse environmental effects can be halted or mitigated prior to becoming a concern.

This is achieved by the following methods:

- continually updating relevant environmental baseline information throughout the life of the operation;
- determining whether the impacts and risks identified prior to development were correct, or whether all impacts and risks had been identified; and
- assessing whether existing mine plans and operations can be modified to further reduce environmental risk and impact.

The final stage is carried out following the completion of mine development. A post reclamation assessment is carried out to demonstrate that all environmental encumbrances and liabilities associated with mine development operations have been removed.

C.7.6.2 Health, Safety and Environment Committee

Part of Benga's Environmental Protection Program is the Health, Safety and Environment (H.S.E.) (or similar name) Committee. The purpose of the H.S.E. Committee is to act as a site custodian to ensure that the operation regularly evaluates, and if necessary, mitigates or eliminates adverse impacts on the environment.

The H.S.E. Committee consists of senior personnel from each of the following functional areas: Materials Management, Maintenance, Engineering, Pit Operations, Plant Processing, Safety, and Environment. The H.S.E. Committee has various responsibilities that include:

- initiating and recommending health, safety and environmental improvements to Site Management which mitigate adverse impacts as a result of mining operations or enhance baseline health, safety and environmental conditions; and
- developing materials and programs that communicate to the employees, government and public, Benga's commitment, efforts and accomplishments in environmental management.

C.7.6.3 Emergency Response and Wildfire Control and Prevention

Benga will implement an Emergency Response Plan in place for various emergency situations. As part of the Emergency Response Plan, an Emergency Response Team (ERT) will be set up and trained to assist in:

- fires;
- extrication of trapped persons;
- care of injured persons;
- chemical spills; and
- other emergencies.

Detailed emergency response plans will be specifically designed for various sites and will be present throughout in areas such as the Plant, office complex, maintenance and light duty machine shops, fuelling stations and pit operations are in place. These specific plans will rely on personnel training, leadership and communication between team members and all involved parties.

Benga will also prepare a Wildfire Control and Prevention Plan (Section C.7.7) which is updated annually for each wildfire season. This plan includes on-site fire prevention and control equipment, communication procedures as well as off-site communication with the public and firefighting authorities (AEP) and cooperative efforts in regional fire prevention and control. Fire prevention, detection, reporting, and suppression measures are the basis of this plan. The FireSmart Wildfire

Assessment System will also be referred to by Benga when developing new mining areas in further effort to decrease the chance of a wildfire caused by industrial activities.

C.7.6.4 Spill Response and Clean Up Procedures

Benga's team of environmental consultants has evaluated the various products to be used in the Project area and the potential risk of exposure to the general public and biota. Based on this review, three purchased products (*i.e.*, diesel fuel, ammonium nitrate, and flocculants) and two mining by-products (coal dust/PM_{10} and suspended sediment) were identified and have been evaluated for impact assessment. The results of the evaluations concluded that the products used in the mining of the Project area would not impact the general public or biota. Their assessment evaluated current operating practices. A comprehensive spill response program will be in place to prevent any adverse effects on the environment.

C.7.6.5 Spill Prevention and Detection Monitoring Procedures

All Benga employees are accountable for ensuring that a high level of spill prevention is maintained by following good housekeeping and maintenance practices. Programs will be in place which include product inventory monitoring, inspections of containment and transfer facilities and leak detection monitoring. Records of these practices will also be maintained. Facilities requiring repair will be brought to the attention of the maintenance department for follow up action.

C.7.6.6 Spill Containment Responsibilities

In the event of a spill, the effectiveness of response operations are influenced by the time in which the spill is detected, controlled and contained. The initial spill response is designed to address the issues of paramount concern such as personal safety, environmental and property protection. After a spill is detected, the following actions are taken:

- ensure that the source(s) of the spill has been shut-off;
- determine the level of hazard to personnel, property and the environment. If necessary, the senior foreman is called for assistance. The senior foreman may elect to handle cleanup operations with departmental personnel. If it appears that the spill could result in damage or harm to personnel, the environment or property, Benga's Emergency Response Team will be called and respond for clean-up. If additional manpower and spill response expertise is required, it will be obtained through mutual aid support groups, spill clean-up contractors and/or consulting services;
- start spill containment, recovery and cleanup operations with equipment on hand; and
- initiate spill notification procedures.

C.7.6.7 Spill Clean Up Procedures

Initial cleanup operations focus on containing the spilled product to prevent further contamination. The spill is contained to the smallest manageable area possible, to channel flow to containment areas, and to keep the spill out of watercourses.

The immediate area around a product spill will be secured and kept clear of nonessential personnel. Reference will be made to the product Material Safety Data Sheet (MSDS) for proper treatment and cleanup procedures. If practical and feasible, spilled material will be recovered and returned to a storage area for reuse or recycle. Spilled material which cannot be recovered will be picked up and stored for proper disposal. Procedures followed in the onsite disposal or short term storage of contaminated material will comply with regulatory requirements for disposal/storage.

C.7.6.8 Spill Training

Benga employees will receive instruction through health, safety and environment training programs to ensure they understand spill notification and clean up procedures. In addition, each departmental Senior Foreman and all Emergency Response Team Members receive spill prevention training (supplemented by appropriate training manuals) and "hands on" field training sessions. Benga will provide onsite Spill Containment and Clean up workshops for all Emergency Response Teams within the organization.

C.7.6.9 Site Reclamation

Another key component in Benga's Environmental Protection Program is the site reclamation program carried out following mine operations. Site reclamation activities for the Project area are discussed in detail in Section F of this application.

C.7.6.10 Construction on Previously Contaminated Land

Protection and remediation techniques and strategies for dealing with chemicals and processes related to previously contaminated land are well documented in Alberta regulatory requirements. Regulatory requirements related to current and future developments will also ensure potential contamination of the soil resource is identified and addressed. The confidence rating of previous contamination is considered moderate for the site due to the wide range of various activities within the RSA including oil and gas operations, forestry, recreation and historic mining.

The proposed footprint does contain legacy surface and underground workings and this material will be addressed as mining progresses. The coal and any related debris from previous workings (timbers, rail *etc*.) will be separated prior to being processed. Typically, this material is treated as overburden and will be disposed of in ex-pit rock disposal areas.

C.7.7 Wildfire Control and Prevention Plan

C.7.7.1 Introduction

Benga has followed the FireSmart Guidebook for the Oil and Gas Industry (FireSmart Guidebook) (GoA 2008) as a guideline their Wildfire Control Plan (WCP). Although the Project is a coking coal project, these guidelines still apply by:

- enhancing personnel safety during a wildfire event;
- enhancing emergency response capability;
- mitigating economic impact during shutdowns;
- mitigating infrastructure loss or damage; and
- reducing liability for industry-caused ignitions.

To address the dynamic nature of the Project over time, Benga proposes to review and, if needed, adapt the WCP annually.

The FireSmart Guidebook uses the following three zoning scales for assessing the threat of wildfires on oil and gas dispositions:

- Industrial Zone 1: 0-10 m from structures on the disposition;
- Industrial Zone 2: 10-30 m from structure(s) on the disposition; and
- Industrial Zone 3: 30 m or more from structures, extensive forest area surrounding individual or multiple dispositions.

As these zones are specific to oil and gas dispositions, Benga has altered the zoning to better assess the threat of wildfires for the Project. The altered zoning structure is:

- Industrial Zone 1: 0-10 m from the CHPP and mine infrastructure area (MIA);
- Industrial Zone 2: all areas within the disturbance footprint, except those included in Industrial Zone 1; and
- Industrial Zone 3: all areas within the Mine Permit Boundary, except those included in Industrial Zones 1 and 2.

C.7.7.2 Wildfire Planning and Mitigation

Benga incorporated industry best management practices and recommendations from the Firesmart Guidebook into their wildfire prevention and mitigation strategies. Descriptions of structures and mitigations are below.

C.7.7.2.1 Structures

C.7.7.2.1.1 Coal Handling and Processing Plant (CHPP) Services Buildings

The CHPP is described in Section C.2. All CHPP services buildings' exteriors are constructed with non-combustible siding and roofing. These buildings have a minimum setback of 10 m from all forest vegetation, on-site vegetation, and hydrocarbon storage. Reagent storage, which will designed and installed to Canadian Standards, is discussed in Section C.2.8.5.2. The CHPP's fire protection system is described in Section C.2.9.2.

The overland conveyor and rail loadout facility are part of the CHPP, but, due to their locations relative to the rest of the CHPP buildings, their fire hazard level has been assessed separately.

The CHPP buildings will be a combination of demountable style buildings, engineered buildings, and fabric structures, all of which are designed for safe operation in all seasons.

C.7.7.2.1.2 Mine Infrastructure

The facilities included in the MIA are listed and described and in Section C.6. The construction camp is part of the MIA and will be included in the mine infrastructure's fire protection system (Section C.6.16); however, due to its location relative to the rest of the MIA, its fire hazard level has been assessed separately.

To further reduce the risks of a fire, Benga will implement the following mitigation measures for hydrocarbon storage:

- storage tanks will be required to have leak prevention measures installed and spill containment features present (berms, ditches, *etc.*);
- all incidents of hydrocarbon spills on site will be cleaned immediately to reduce the presence of flammable substances;
- storage tanks will be sealed or vented in a way that prevents airborne embers from entering; and
- vegetation will be removed away from all hydrocarbon storage tanks to a distance of 5 m.

C.7.7.2.1.3 Power and Transmission Lines

At this time, all power and transmission lines are owned and operated by independent utility companies. These companies manage clearing widths and vegetation management for their dispositions.

C.7.7.2.2 Site Operations

C.7.7.2.2.1 All-Terrain Vehicle Activities

Utility vehicles (UTVs) are a key mode of transportation for employees and contractors at the Grassy Mountain Coal Mine. UTVs present a fire hazard due to the temperature of the exhaust system, which may ignite accumulated or nearby vegetation. To reduce the risks of a fire, Benga has set out the following mitigation measures:

- All UTV operators are required to undertake a certified UTV operations course.
- As part of the Riversdale Resources Safety Induction, UTV operators are advised to ensure to park the ATV on gravel or bare mineral soil and to regularly inspect the UTV's exhaust system and to remove any accumulated vegetation.
- Operators will not drive through forested vegetation (*i.e.*, off trail).
- Operators are instructed to inspect their UTVs more often if traveling through muskeg and peat areas.
- During prolonged periods of extreme fire danger levels and forest closures, Benga will monitor (and as necessary restrict) the use UTVs.
- UTVs are to be regularly maintained and kept clean to prevent the buildup of vegetation in areas of risk.
- All UTVs are equipped with fire extinguishers.

C.7.7.2.2.2 Heavy Equipment Activities

Heavy equipment will be used extensively on site for mining and clearing activities. Exhaust systems associated with heavy equipment can cause wildfire ignition. To reduce the risks of fire, Benga has set out the following mitigation measures:

- Contractors and staff are instructed to inspect and clean their equipment's exhaust systems on a regular basis.
- Whenever possible, all cleaning should be done on bare mineral soil, or on an area that has been recently sprayed down with water.
- While cleaning on mineral soil, operators with diesel engines are encouraged to throttle up in an attempt to expel any loose carbon particles.

C.7.7.2.2.3 Brush/Vegetation Clearing

Burning woody debris presents an increased risk for ignition of wildfire, especially if the piles are not properly extinguished. Benga does not intend to dispose of debris through burning. All non-

salvageable timber and brush will be chipped or windrowed to promote vegetation growth on disturbed areas. Heavy equipment guidelines described in Section C.7.7.2.2.2 will be followed.

C.7.7.2.2.4 Industrial Zone 1 and 2 Vegetation Management

To reduce wildfire risk, Benga will ensure permanent structures in Zones 1 and 2 are at least 10 m from any vegetation and at least 30 m from forested areas. Vegetation removal activities will be carried out along the border of forested areas that are adjacent to cleared Industrial Zone 1 areas containing permanent structures (*i.e.*, MIA and CHPP). Ground cover in Zone 1 areas will be maintained as bare mineral soil, gravel, or mowed grass.

The majority of Industrial Zone 2 areas are free of vegetation and are either gravelled areas surrounding infrastructure within Industrial Zone 1 or areas where mining operations are being undertaken. In Zone 2 areas, vegetation management will depend on the values at risk. If values at risk warrant protection, areas will be maintained as vegetation-free zones or a mowed grass. If risk does not warrant this extreme level of management, vegetation reduction will be implemented if flammable coniferous forest vegetation is present.

C.7.7.2.3 Emergency Response

C.7.7.2.3.1 Personnel Safety

To insure the safety of all employees and contractors on site, Benga provides mandatory annual safety inductions, which review wildfire prevention, wildfire preparedness, and emergency response plans for the Grassy Mountain site. The safety induction also outlines:

- evacuation staging areas and plans;
- evacuation and emergency alerts/sirens;
- evacuation routes for use during a wildfire event;
- methods of transportation for evacuation (air and ground); and
- communication requirements during an emergency.

Emergency contact lists are kept available and are updated regularly. If a wildfire occurs near or within the Project area, mine shutdown procedures will be followed and the number of staff onsite will be reduced to needed personnel. The number of personnel onsite will depend on the severity of the wildfire and its proximity to the mine.

C.7.7.2.3.2 Emergency Response Team

Benga's commitment to having an Emergency Response Team is described in Section C.7.6.3.

C.7.7.2.3.3 Communication

Local Fire/Rescue and Wildfire authorities are regularly apprised of the site, including the Emergency Muster Point, and are provided with a map of the site trails. Site tours are conducted annually with these authorities. All local emergency response radios are programmed with Benga's radio frequency.

Prior to any operations/exploration, Wildfire Alberta will be contacted and advised of the operations, locations, start dates, and end dates.

C.7.7.2.3.4 Evacuation Plans and Staging Areas

Benga's Evacuation Plan outlines procedures and routes to be taken. This plan is reviewed annually by employees and contractors during their required Safety Inductions.

There are two access routes to the Grassy Mountain site. The main Grassy Mountain Road runs 8 km north (to the site) of Highway 3,500 m west of Center Access to Blairmore, Alberta. The second access runs south from the Devon/Caseca Road (also known as Teddy's Trail).

Three potential helicopter landing areas have been identified. The coordinates (UTM Zone 11, NAD 83) for these areas are:

- north helicopter landing area: 686992E, 5509923N;
- top of Grassy Mountain: 686036E, 5506876N;
- south landing area: 685561E, 5504304N.

A construction/exploration phase staging area and an operation phase staging area have been identified for the mine. The construction/exploration phase staging area will remain the primary muster point during wildfire events until the mine is operational; at this time the operation phase staging area will become the primary muster point.

During the construction/exploration phase, the Site Emergency Muster Point is located at:

- Latitude 49.67083° and Longitude 114.425° or
- UTM Zone 11, NAD 83 685789E, 5505217N

During operations, staging will operate out of the MIA and CHPP area and the coal loadout facility, located at:

- CHPP and MIA:
  - UTM Zone 11, NAD 83 685063E, 5504029N; and

- Latitude 49.66038°, Longitude -114.435620°.
- coal load-out facility:
  - UTM Zone 11, NAD 83 684211E, 5499119N; and
  - Latitude 49.616521°, Longitude -114.449720°.

C.7.7.2.3.5 Water Sources

Water sources for the CHPP and MIA are described in Sections C.2.9.2 and C.6.16.2, respectively.

C.7.7.2.4 Communication

C.7.7.2.4.1 Internal Communication within the Coal Industry

Benga is committed to continually improving their operations. Industry best practices will be reviewed annually and applicable changes will be made to operations, including the Wildfire Protection Plan.

C.7.7.2.4.2 Industrial Wildfire Control Plan

Industrial Wildfire Control Plans are mandatory under Alberta's *Forest and Prairie Protection Act*. Benga will annually update the Project's Wildfire Control Plan to account for changes in wildfire risk and prevention measures.

C.7.7.2.4.3 Wildfire Reporting

Benga will report all wildfire sightings/occurrences to the local fire/rescue and wildfire authorities and to the AEP's wildfire reporting center at 310-FIRE (3473). Wildfire sightings by remotely located staff or contractors will be reported to the mine office *via* Benga's emergency mine radio frequency. Mine radios will then be used to inform all contractors and staff on site of the situation. If necessary, emergency response measures as outlined in Section C.7.7.2.3 will be undertaken.

C.7.7.3 Industrial Fire Assessment

A summary of Benga's FireSmart assessment, based on the structures and mitigations described in Sections C.7.7.1 and to C.7.7.2, is provided in Table C.7.7-1.

Table C.7.7-1 Grassy Mountain Coal Project FireSmart Assessment

Assessment Component[1]	Hazard Level	Mitigation Required
Zone 1 & 2 – Location and Industrial Assessments of Structures and Ignition Potential		
CHPP		
Location[2]	Low	No
Slope[3]	Low	No
Structural materials[4]	Low	No
Flammable material storage[5]	Low	No
On-site vegetation[6]	Low	No
Overland Conveyor		
Location[2]	Low	No
Slope[3]	Low	No
Structural materials[4]	Low	No
Flammable material storage[5]	Low	No
On-site vegetation[6]	Low	No
Rail Loadout Facility		
Location[2]	Low	No
Slope[3]	Low	No
Structural materials[4]	Low	No
Flammable material storage[5]	Low	No
On-site vegetation[6]	Low	No
Mine Infrastructure Area		
Location[2]	Low	No
Slope[3]	Low	No
Structural materials[4]	Low	No
Flammable material storage[5]	Low	No
On-site vegetation[6]	Low	No
Construction Camp		
Location[2]	Low	No

Table C.7.7-1 Grassy Mountain Coal Project FireSmart Assessment

Assessment Component[1]	Hazard Level	Mitigation Required
Slope[3]	Low	No
Structural materials[4]	Low	No
Flammable material storage[5]	Low	No
On-site vegetation[6]	Low	No
Zone 3 – Assessment of Vegetation Fuel[7]		
Vegetation flammability Quadrant 1 NW	Medium	Yes
Vegetation flammability Quadrant 2 NE	Medium	Yes
Vegetation flammability Quadrant 3 SW	Medium	Yes
Vegetation flammability Quadrant 4 SE	Medium	Yes
Assessing Liability		
ATV Activity[8]	Low	No
Disposal of Debris by Burning[9]	Low	No
Assessing Emergency Response Capability		
Assessing Personnel Safety[10]	High	Yes
Wildfire Evacuation	Evacuation plans are in place	
Access Roads and Water Sources[11]	Low	No
Evacuation Routes[12]	Low	No

[1] From FireSmart Guidebook for the Oil and Gas Industry (GoA 2008).
[2] Structure within 20 m to 30 m of forest – Low; Structure within 10 m to 20 m of forest – Moderate; Structure within 10 m of forest – High.
[3] Ignition potential is based on a combination of structure's distance from crest of slope (> 100 m, <100 m) and position on slope (base, mid-slope, upper slope).
[4] Ignition potential is based on combination of building materials, openings, loading dock base, distance from petroleum products and combustibles.
[5] Ignition potential is based on presence of hydrocarbons, flammable material rating, potential for accumulation of airborne embers on tanks, and distance from storage sites to forest vegetation.
[6] On-site vegetation is defined as grass, shrubs, and trees inside the fence line. None or >10 m from structure – Low, 3 m to 10 m from structure – Moderate, <3 m from structure – High.
[7] Based on species composition and forest age, surface vegetation continuity, and presence of ladder fuels that help carry a surface fire up a tree to the crown.,
[8] Ignition potential is based on a combination of frequency of UTV exhaust system inspection during fire season and where UTVs are parked or operated (mineral soil/gravel or forest vegetation).
[9] No debris will be disposed of by burning.
[10] High hazard level is high due to number of on-site daily personnel being greater than five.
[11] Hazard level is based on a combination of access road width, vegetation flammability along access road, presence/absence of ring road, and water supply (hydrant; pits, tanks, natural source; or alternative supply)
[12] Hazard level is based on a combination of identified evacuation routes, staging area, and helicopter landing area; evacuation plans in place; employees briefed on evacuation plans.

C.7.8 Waste Management

Waste is defined as any unwanted non-recyclable solid or liquid material that is intended to be treated or disposed of. Waste also includes refuse and garbage (Section 2(1) (t) of the Activities Designation Regulation of EPEA). As outlined in the *Alberta User Guide for Waste Managers* (AEP, 1994) the generator is responsible for classifying their waste and determining the proper disposal procedure for each waste product. Benga will investigate and evaluate required waste disposal activities.

C.7.9 Greenhouse Gas Management

Benga's business success is contingent on responsible resource development, which requires dedicated stewardship of air issues and air emissions. Benga is committed to responsible environmental management and continues to do its part to minimize potential impact. Benga will continue to develop effective management and operational approaches to comply with regulations designed to reduce greenhouse gas (GHG) emissions. Benga's GHG emission goals are:

- to continually improve efficiencies in energy use, thus reducing the GHG footprint; and
- to deliver on a long-term plan that meets industry standards.

Benga believe that execution of their GHG management programs can be achieved with proactive preparation, planning, and continued cooperation with industry regulators and with the communities where they operate.

Benga's long-term GHG management options fall into four broad categories:

- continuous improvement in technologies (particularly combustion technologies) during the operational phase;
- contribution to the Climate Change and Emissions Management Fund (CCEMF);
- trading of GHG offsets; and
- methane recovery.

The Project's GHG emissions, as provided in CR #1a Section 4.3, were calculated for Year 19, which is the year when maximum material movement and emissions are expected. GHG emissions for all other points in the Project's life cycle are expected to be less.

As discussed below, continuous improvement in technologies and contribution to the CCEMF are Benga's preferred approach.

C.7.9.1 Continuous Improvement

Benga is continually considering opportunities for GHG reductions. The approach to managing GHG emissions includes:

- continuous improvement to address direct emissions from combustion sources and mine fleet;
- monitor and measure performance, identify design gaps, and identify improvement opportunities;
- review corporate and project goals for GHG reductions; and
- continue to improve corporate and operational knowledge of technologies that lead to emission reduction and policy development.

Design measures to reduce GHG emissions in the Project include:

- optimizing and continuously improving energy efficiency in the design and operation of mine and haul equipment, processes and facilities;
- using a conveyor to transfer clean coal to the rail loadout;
- eliminating the coal dryer from operations; and
- considering emissions as a key criterion during future mine and haul fleet replacement.

Operational methods to minimize GHG emissions are expected to include:

- minimizing vehicle and equipment idling time. Employees would be required to turn off vehicles or heavy equipment when not in use. Idle reduction initiatives will be communicated and encouraged during site orientations and health and safety, and tailboard and progress meetings;
- regularly inspecting and maintaining combustion engines. Any parts showing excessive signs of wear or malfunction would be promptly replaced. Electric equipment would be used when possible;
- using equipment for its intended purpose only and within rated load capacities;
- maintaining all diesel and gasoline-powered vehicles and equipment to manufacturers' guidelines to maximize efficiency. A preventative maintenance program would be implemented for all diesel and gasoline-powered equipment (*e.g.*, 500 hours or sooner if required by manufacturer); and
- conducting daily inspections of equipment (including exhaust systems).

Other measures may include optimizing motor sizes and insulating piping to conserve energy.

C.7.9.2 Contribute to the Climate Change and Emissions Management Fund

Alberta has increased its planned price of carbon, payable to the CCEMF, to $30 per tonne CO2e by 2020. Benga will contribute to the fund any moneys that cannot be eliminated by offsets or efficiency improvements.

C.7.9.3 Offsets

Alberta's Climate Change and Emissions Management Act established offset trading as one option for achieving compliance with GHG emission reduction obligations. Benga will evaluate offset trading opportunities.

C.7.9.4 Carbon Capture

With respect to mine face emissions, the only feasible type of methane recovery to be deployed at surface mines is pre-mine drainage. In theory, some pre-mining degasification and recovery could occur at "gassy" surface mines. However, the low gas content of surface mines relative to that of underground mines makes it unlikely that significant recovery would be technically feasible, let alone cost-effective. The coal at the Grassy Mountain mine is not considered gassy and therefore methane recovery is not practical.

C.8 Geochemistry and Selenium Management

Benga undertook a geochemical characterization of mine wastes for the Project to support the development of geochemical design criteria for water and waste management, and the development of geochemical inputs into water quality predictions. The program design was site-specific, but based on learnings and experience from similar programs in the Elk Valley that have resulted in an appropriate level of characterization of host rocks and process wastes.

The geochemical and scoping level water quality effects assessments for the Grassy Mountain Project have shown that specific waste and water management measures may be needed to mitigate the following potential effects of the Project on water quality and stream sediments:

- selenium leaching;
- potential for acid rock drainage (ARD) and associated metal leaching; and
- leaching of explosives residuals.

The geochemistry program results have been provided in Appendix 10A - Grassy Mountain Project - Geochemistry Characterization.

C.8.1 Geochemistry Sampling Program

The geochemistry sampling program consisted of sampling three main sources:

- future waste rock – sampled the geologic profile while drilling new coal exploration holes;
- legacy waste material – legacy coal and slack coal piles exist in the Grassy Project area as a result of past underground and surface mining activities. These legacy waste materials were sampled as part of the program; and
- coal preparation plant waste material – coal samples were collected from the Project area and were sent to various labs to complete coal quality and wash-ability tests. The coal waste materials were also sampled as part of the program.

The sampling locations are shown on Figure C.8.1-1.

C.8.1.1 Future Waste Rock

Future waste rock was sampled from seven different coal exploration drill holes that were spatially distributed throughout the proposed pit area. These holes were selected because they provided a cross-section of the major stratigraphic units. Static geochemical characterization was completed on 146 individual samples. Kinetic tests using humidity cells have been completed on 15 of these samples. The results of the static and kinetic tests are provided in Appendix 10A – Appendices E, F, G (static) and Appendices H, I (kinetic).

C.8.1.2 Legacy Wastes

Areas of legacy waste were selected as sample locations using aerial imagery with particular emphasis on capturing samples from across the proposed mine footprint. Static geochemical characterization was completed on 39 individual samples from near surface locations. The results of the static tests are provided in Appendix 10A – Appendices E, F, G.

A test pit program was initially proposed to capture legacy waste samples several metres below surface; however, this approach was revised after an inspection of the site showed the legacy waste dumps were widely distributed across the lease and often relatively shallow (1 to 2 m) due to the historical end dumping over the existing sloping terrain.

C.8.1.3 Coal Handling and Processing Plant Residues

A residue sample was collected from pilot plant processing each of the three coal seams by ALS Coal in Newcastle, Australia. Each of the three samples was composed of the following residue composition (by weight, as-received moisture content) to represent the expected composition of final CHPP residues:

- 65% coarse reject,
- 17% fine reject, and
- 18% ultrafine reject.

Static geochemical characterization was completed on the three individual samples and kinetic tests using humidity cells was also initiated. The results of the static and kinetic tests are provided in Appendix 10A – Appendices E, F, G (static) and Appendices H, I (kinetic).

C.8.2 Results

C.8.2.1 Future Waste Rock

C.8.2.1.1 Selenium

Selenium concentrations ranged from less than 0.1 to 4.8 mg/kg. The highest concentrations of selenium were associated with claystone samples from the Mutz and Adanac members. Static test results combined with results from kinetic tests and seepage from legacy wastes provide supporting evidence that selenium leaching is a consideration for the Project.

C.8.2.1.2 Acid Rock Drainage

ARD potential was evaluated on the basis of the ratio of Modified NP and AP calculated from sulphide-sulphur expressed in common units of kg $CaCO_3$/t. A second ARD potential classification criterion was applied based on sulphide content such that all wastes that contain less than 0.1% sulphide sulphur were classified as non-PAG irrespective of their NPR. Any acidity produced by these low sulphide wastes is expected to be readily consumed through reaction with silicate minerals or alkalinity produced by silicate weathering.

The ARD potential classifications are:

- PAG: NP/AP<1 and sulphide S ≥0.1%.
- Uncertain: 2>NP/AP ≥1 and sulphide S ≥0.1%.
- Non-PAG: NP/AP≥2 or sulphide S <0.1%.

A total of 36 samples contained potential PAG material (25%), 8 samples were uncertain (5%) and 102 contained non-PAG material (70%). Non-PAG material was associated with the Hillcrest samples. Material classified as PAG or uncertain with respect to acid generation was associated with samples from the Cadomin (particularly the conglomerate), Mutz, Adanac, and Moose Mountain.

C.8.2.1.3 Trace Elements

A correlation matrix for trace elements was calculated to provide an initial evaluation of associations between elements and possible linkages to mineralogical hosts. Strong relationships were assessed from a correlation coefficient equal to or more than 0.7. When reviewed in combination with mineralogical analyses, the matrix indicated that:

- Hillcrest samples showed strongly positive relationships between sulphide sulphur and arsenic (r=0.76) and molybdenum (r=0.73).
- Moose Mountain samples showed a strongly positive relationship between sulphide sulphur and antimony (r=0.88), arsenic (r=0.97), cadmium (r=0.83), mercury (r=0.95), and selenium (r=0.85).
- The other rock units did not show any distinct correlations between sulphide sulphur and the trace elements; however, several trace elements that are commonly associated with iron sulphides were correlated with each other, including cadmium, selenium, lead, nickel, and zinc.

C.8.2.1.4 Kinetic Tests

Eleven of the fifteen waste rock humidity cells have yielded near-neutral leachates (pH 6.3 to 7.9) after 40 cycles of testing. The remaining four cells, containing Cadomin conglomerate (two samples), Adanac claystone and Moose sandstone, produced acidic leachate (pH less than 5). The former three tests had negligible initial NP and yielded pH below 5 from the first cycle whereas the Moose sandstone showed a delay of 25 weeks before showing a decline in pH. This sample contained NP of 4 kg $CaCO_3$/t. All four samples were classified as PAG using static geochemical classifications.

The three most acidic humidity cells produced the highest release rates for sulphate and dissolved metals including aluminium, cadmium, cobalt, copper, iron, manganese, nickel, and zinc. Selenium release rates are not determined by pH, but appear to be correlated with selenium content. The highest selenium release rates are associated with claystone from the Hillcrest, Adanac, Mutz, and Cadomin.

C.8.2.2 Legacy Wastes

C.8.2.2.1 Selenium

Mild cadmium enrichment was found in the -2 mm fraction from TP-02 (3.2 mg/kg). Cadmium and selenium concentrations in the legacy waste were typically intermediate of the concentrations found in the Cadomin and Mutz drill core samples.

C.8.2.2.2 Acid Rock Drainage

ARD classifications for the legacy waste samples (21 samples) contained low sulphur (less than 0.1%) and were classified as non-PAG. One bulk and two -2 mm fraction samples were acidic with paste pH of 4.6 to 4.9. Rinse pH for the 2 mm fraction samples were typically greater than paste pH and were all above pH 5.0, suggesting that the few sulphides that are present within the legacy wastes are not reactive unless fresh surfaces are exposed (for example, through sample pulverization to measure paste pH).

C.8.2.3 Coal Handling and Processing Plant Residues

C.8.2.3.1 Selenium

No elements were identified as enriched within the CHPP residues. Similar to sulphide, cadmium and selenium concentrations were greatest in residue from coal seam 1, and are likely to occur in association with iron sulphides such as pyrite.

C.8.2.3.2 Acid Rock Drainage

Residue from coal seam 1 was classified as PAG, whereas residue from coal seams 2 and 4 were classified as non-PAG.

C.8.2.3.3 Kinetic Tests

The humidity cells have remained near-neutral (pH 7.3 to 7.8) after 40 cycles. The more sulphur-rich Seam 1 reject yielded slightly lower pHs and distinctively higher sulphate. Element release rates generally declined and stabilized as the tests continued. Seam 1 reject yielded higher concentrations of cadmium, cobalt (initially), molybdenum, nickel, selenium, thallium and zinc.

C.8.3 Mitigation Strategy

C.8.3.1 Selenium Management

The Project will extract coal from the Mist Mountain Formation using comparable mining and processing methods to those employed in the nearby Elk Valley of southeastern British Columbia. Teck Resources is currently managing selenium leaching at its operations in the Elk Valley as a result of increasing selenium concentrations in the Elk River. Similar leaching effects are expected for the Project due to comparable selenium concentrations in the coal-bearing sequence.

Selenium concentrations in the Mist Mountain Formation within the Elk Valley typically range from less than 1 mg/kg to about 5 mg/kg (Kennedy *et al*. 2012; SRK 2014). This is comparable to selenium concentrations observed at Grassy Mountain within coal seam 1 residue (2.7 mg/kg) and drill core

from the Mutz Member (0.4 to 4.8 mg/kg) and Adanac Member (0.4 to 3.4 mg/kg) of the Kootenay Formation. Static test results combined with initial results from kinetic tests and seepage from future wastes, legacy wastes and coal plant residues provide supporting evidence that selenium leaching is a consideration for the Project (Appendix 10A – Geochemical Characterization – Appendices E, F, G (static) and H, I (kinetic)).

A number of passive and active measures are potentially available to limit selenium leaching effects including:

- subaqueous disposal in backfilled pits and artificial impoundments to limit availability of oxygen and consequent oxidation of pyrite, which is assumed to be the source of leachable selenium;
- measures to decrease the contact of water with wastes including diversions around waste management facilities and/or covers on wastes;
- passive or semi-active treatment of contact waters in sub-oxic saturated zones of backfilled pits resulting in sequestration of selenium in adsorbed and precipitated forms; and
- active management using water treatment plants.

Benga has selected the passive to semi-active treatment of contact waters in a sub-oxic environment using saturated zones of backfilled pits. Examples of where saturated zones are being used to attenuate selenium are provided in Appendix 10C – Water Quality Management (Section 3.3.2).

Selenium attenuation in saturated backfills was assumed to amount to 99% or a final concentration of 0.015 mg/L (15 ppb), which ever was lower. Irrespective of uncertainties associated with the water quality model results, it can be concluded that highly effective selenium attenuation will be required for the Grassy Mountain Project in order to present water quality effects in the local creeks.

The processes involved in attenuation of selenium and nitrate in saturated backfill zones are described in the geochemical assessment (Appendix 10A). The attenuation principle is simple: anoxic conditions promote the conversion of soluble selenate ions (SeO_4^{2-}) to selenite (SeO_3^{2-}) or elemental selenium metal (Se^0). Selenite is less soluble and tend to adsorb to mineral surfaces. Elemental selenium is insoluble. Therefore, the conversion of selenate causes the reduced selenium species to become attenuated within the saturated backfill. Nitrate (NO_3^-) is reduced to nitrogen gas (N_2).

The key to the attenuation process is the formation of anoxic conditions. Anoxic conditions are generated by microorganisms as they metabolize carbon and nutrients. The presence of carbon and nutrients in the mine water is required for the process to work. The waste rock in the saturated backfill serve as a substrate for the microorganisms.

Waste rock seepage at coal mines typically include appreciable concentrations of dissolved organic carbon that can serve as a source of carbon for microorganisms. However, the dissolved carbon may not be easily metabolized or available to microorganisms. If the carbon is not suitable or adequate, anoxic conditions mat may not develop and selenium and nitrate may not become attenuated.

If organic carbon in the mine water at the Project is unsuitable or inadequate for generating anoxic conditions in the saturated backfill zones a managed saturated backfill system may be required. Sources of organic carbon that have been used in similar applications include molasses and methanol. Managed saturated backfills simply consists of a system for adding an organic carbon source and nutrients to the mine water as it flow to the saturated backfill zones and a series of monitoring wells. This is identical to the process used in active water treatment plants for selenium removal such as the ABMet process developed by GE Water only on a much larger scale.

The proposed mine plan has been developed to provide saturated backfill areas as early as possible in the mine life.

C.8.3.2 Acid Rock Drainage Management

The static and kinetic geochemical characterization of waste rock and CHPP residues identified that some waste components have potential to generate acid which has been confirmed for some materials in humidity cell tests. The quantities are such that these strata may require active management to prevent ARD and/or the accelerated leaching that can accompany oxidation of potentially ARD-generating (PAG) strata.

Near-surface legacy wastes appears to have negligible ARD potential with all samples containing less than 0.1% sulphide sulphur. Some ARD potential appears associated with CHPP residues from seam 1 coal; whereas residues from seams 2 and 4 were non-PAG.

Management measures that address ARD potential so that PAG wastes do not become acidic include:

- subaqueous disposal will involve placement of PAG rock underwater as part of backfilling where inundation needs to occur before acidification to avoid the water column acidifying or possibly having unacceptable chemistry; and
- blending of PAG and non-PAG wastes so that the blended waste performs as non-PAG.

The proposed method of managing PAG materials at Grassy Mountain is blending to produce an overall non-PAG waste rock mixture. The composition of the PAG and non-PAG components of the waste rock at the Project indicate that it may be amenable to blending. This measure has been implemented or permitted at several coal mines in northeastern BC (Perry Creek Mine, Trend Mine,

Quintette Coal Operation). The current understanding is that neither ARD nor accelerated metal leaching has been detected from blended wastes at Perry Creek Mine or Trend Mine.

The following design requirements are needed for blending:

- detailed short range planning will be needed to ensure that sufficient non-PAG rock is available to meet the mass balance needs for blending;
- target mixing ratio for PAGMUs in the Mutz and Moose is 50:50 Non-PAG:PAG where any non-PAG rock can be used;
- target mixing ratio for PAGMUs in the Cadomin and Adanac Formations is 75:25 Non-PAG:PAG where Mutz needs to be the Non-PAG rock; and
- placement of PAG and non-PAG wastes so that they become sufficiently mixed to prevent PAG wastes from generating acid. This may be achieved by end-dumping, push-dumping or horizontal layering.

C.8.3.3 Leaching of Explosive Residuals

Assessment of potential water quality effects arising from the use of ammonium nitrate (AN)-based explosives using a generic prediction model developed in the Elk Valley (Ferguson and Leask 1988) has shown that mitigation for leaching of explosives residuals (primarily nitrate) may be needed.

The preferred approach is to minimize the residual AN in waste rock through explosives management practices including avoidance of spills, avoidance of long gaps between loading of blast holes and blasting, use of appropriate measures to limit loss in wet holes, minimization of misfires, and measures to recover explosives from misfires.

Nitrate loadings can also be addressed by directing contact waters through saturated pit backfills resulting in nitrate reduction by the same mechanism as for selenium attenuation. Conversion of nitrate to nitrogen gas occurs under the same conditions that convert selenium to less oxidized forms. Sources of organic carbon that have been used in similar applications include molasses and methanol. The dose of organic carbon required depends primarily in the concentration of dissolved oxygen and nitrate in the mine water. Approximately 3 g of methanol is required to attenuate 1 g of nitrate.

For the purpose of this project, an assumption that up to 95% of the influent nitrate loading could be removed from water routed through a saturated backfill with more than one year residence time.

C.9 Accidents or Malfunctions Assessment

This section assesses the risk and potential environmental effects of accidents and/or malfunctions that could occur through all phases of the Project. Benga is committed to constructing and operating

the Project in accordance with all applicable legislation and to the highest standards of safety, operation, security and health.

The following risk assessment has been completed in accordance with the FToR as well as the Final Guidelines outline by the CEAA (Appendices 1 and 2). Potential accidents and malfunctions were identified from a variety of sources, including:

- internal risk assessment discussions;
- a desktop review of industry standards for assessing accidents and malfunctions associated with mining;
- professional judgment and direct experience with other mines;
- the FToR and Final CEAA Guidelines; and
- input and comments received from stakeholder and Aboriginal engagement.

Only those accidents and malfunctions deemed important, with a reasonable potential of occurrence have been addressed. Based on these considerations, potential accidents and malfunctions assessed for the Project are:

- open pit wall failure;
- waste rock disposal area failure;
- water management dam failure;
- explosives accident;
- water management pipeline break;
- vehicle incidents;
- hazardous materials spills or releases; and
- train derailment.

C.9.1 Methodology

The accidents and malfunctions methodology includes:

- A description of each accident or malfunction scenario that may have the potential of occurring at any point during the Project for which an environmental effect or concern has been identified. This includes a description of the likelihood under which such a potential accident or malfunction might occur.
- A description of the project design measures and operational safeguards that will be implemented to mitigate risk from each potential accident or malfunction.

- The identification of potential interactions between each accident or malfunction and the associated VC for the Project, with only those interactions for which an environmental effect of concern was identified carried forward to the next step of the assessment.
- A description of the potential environmental impacts and assessment of risk that may result from accidents or malfunctions should mitigation measures and operations safeguards be ineffective, including a consideration of environmental effects as they are identified in Section 5 of the CEAA 2012 (CEAA 2012).

Each credible potential accident or malfunction was assessed and ranked according to the likelihood of occurrence and the magnitude of the impact. Based on these two rankings, an overall risk rating of low, medium or high was assigned to each scenario (Table C.9.1-1). The greater the likelihood or magnitude, the greater the overall risk.

The likelihood of occurrence was defined as follows:

- Rare (*i.e.*, the event may occur only in exceptional circumstances);
- Unlikely (*i.e.*, the event may occur at some time);
- Likely (*i.e.*, the event could occur at some time);
- Expected (*i.e.*, the event will probably occur in most circumstances); and
- Almost certain (*i.e.*, the event will occur).

The magnitude of the impact was defined as follows:

- Nil (*i.e.*, no change from background conditions anticipated after mitigation);
- Low (*i.e.*, disturbance predicted to be somewhat above typical background conditions, but well within established or accepted protective standards and normal socio-economic fluctuations, or to cause no detectable change in ecological, social or economic parameter);
- Moderate (*i.e.*, disturbance predicted to be considerably above background conditions but within scientific and socio-economic effects thresholds, or to cause a detectable change in ecological, social or economic parameters within range of natural variability);
- High (*i.e.*, disturbance predicted to exceed established criteria or scientific and socio-economic effects thresholds associated with potential adverse effect, or to cause a detectable change in ecological, social or economic parameters beyond the range of natural variability); and
- Severe (*i.e.*, severe long-term, irreversible environmental impacts, severe breach of regulations with operations suspended, closure severely impacted).

Table C.9.1-1 Criteria for Risk Matrix

Likelihood	Magnitude				
	Nil	Low	Moderate	High	Severe
Almost Certain	Low	Moderate	High	High	High
Expected	Low	Moderate	Moderate	High	High
Likely	Low	Low	Moderate	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Rare	Low	Low	Moderate	Moderate	High

C.9.2 Risk Assessment

Potential interactions between each accident or malfunction and associated VCs are identified in Table C.9.2-1. A check mark indicates that an interaction may occur. A detailed discussion of each scenario, mitigation measures, potential environmental effects and associated risks follows.

Table C.9.2-1 Identified Interactions of Potential Project Accidents or Malfunctions on Valued Components

Accident or Malfunction	Air Quality	Noise	Hydrogeology	Hydrology	Water Quality	Aquatic Resources	Soils	Vegetation	Wildlife	Land Use	Historical Resources	Human Health
Open Pit Wall Failure	✓	✓					✓	✓				✓
Waste Rock Disposal Area Failure	✓	✓		✓	✓	✓	✓	✓		✓		✓
Water Management Dam Failure				✓	✓	✓	✓	✓	✓		✓	✓
Explosives Accident					✓	✓	✓				✓	✓
Vehicle Incidents					✓	✓						✓
Hazardous Materials Spills or Releases	✓		✓	✓	✓	✓	✓	✓	✓			✓
Train Derailment	✓			✓	✓					✓	✓	

C.9.3 Open Pit Wall Failure

The project is an open pit operation where trucks/shovels remove the overburden (rock) in order to uncover and mine the coal. A preliminary pit slope stability assessment was completed (Appendix 9a).

The rock at Grassy Mountain is that typically found in the presence of coal seams such as mudstones, siltstones and sandstones. The site is generally overlain by soil and weathered bedrock in thicknesses up to 20 m.

The site is divided into three structural domains. The western domain contains sedimentary strata that dip between 25 to 30 degrees towards the west at the southern end increasing to 40 to 60 degrees at the northern end. The strata in the central domain generally dip between 25 to 35 degrees towards the west-northwest, increasing to about 50 degrees at the northern end. The third domain (eastern) contains the most steeply strata at between 60 and 70 degrees.

C.9.3.1 Scenario Description

The stability of the rock slopes for the Grassy Mountain open pit was evaluated against two different failure mechanisms:

- Structurally Controlled Failure Mechanisms: Structurally controlled failure in rock occurs as the result of sliding along pre-existing geologic discontinuities; and
- Rock Mass Strength Failure: Slopes excavated in weak or heavily fractured rock masses, or very high slopes, can be susceptible to overall rock mass failure, which involves the development of pseudo-circular type failure zones through intact rock.

Improperly designed pit walls or poor drilling and blasting practices could result in failures of the open pit walls causing safety concerns to miners. Large failures, should they occur at the ultimate pit wall as opposed to an interim wall, would lead to an increased mine footprint.

C.9.3.2 Design and Operations Safeguards

In support of the wall design recommendations a geotechnical field program was carried out on the Grassy Mountain Site in 2014. The work included:

- surface reconnaissance;
- drilling of seven HQ-3 diamond cored geotechnical holes;
- description of structural discontinuities;
- field assessment of rock strength and point load testing;

- hydrogeological characterization through packer testing;
- collection of core samples for laboratory strength testing; and
- installation of three piezometers.

Laboratory testing included unconfined compressive strength testing of the collected core samples. The recommended wall designs for the various structural domains are contained in Table B.8.5-1. During excavation, Benga staff will be assigned to perform routine geologic mapping. This mapping will be done to confirm/check the orientation of the structure against what is expected in the geologic model and to look for the presence and orientation of faults in the pit walls. Review of groundwater monitoring will be performed on an on-going basis to establish site groundwater trends prior to mining.

C.9.3.3 Potential Environmental Effects

Should there be a wall failure, despite the best efforts of the design and operations team, there would be a number of VCs impacted. These could include:

- dust is likely to be generated; would be of short duration and would be expected to dissipate fairly rapidly;
- noise levels would increase; would be of short duration and partially attenuated by the walls of the open pit;
- potential to impact human life should mining activity be occurring below the failure zone;
- slightly larger disturbance area with soil and vegetation material negatively impacted; and
- hydrology, water quality or aquatic resources would be minor in nature as water collected at the toe of the failure zone will still have the opportunity to be pumped to the nearest sediment pond for treatment before release back to the environment.

Small, localized wall failures or sloughing could be expected to occur (a likely rating). The magnitude for a small failure is listed as low which results in a low risk rating. Given the knowledge gained in a similar geotechnical environment (the Elk Valley) a large scale wall failure has been assigned a likelihood rating of rare with a moderate magnitude resulting in a moderate overall risk.

C.9.4 Waste Rock Disposal Area Slope Failure

C.9.4.1 Scenario Description

The Grassy Mountain Mine plan includes two external rock disposal areas – the SRDA and the NRDA. As mining progresses from the south to the north the SRDA also extends north and progressively backfills the mined out portion of the pit. In order to keep the disposal areas out of the

valley bottoms they have been located just to the south and to the north of the ultimate pit. A major slope failure could result in rock being transported downslope into either Gold or Blairmore creeks. A significant run-out of the SRDA could also impact the plant site.

C.9.4.2 Design and Operations Safeguards

In support of the Grassy Mountain feasibility study, a waste dump and infrastructure geotechnical program was completed. Stability analysis was performed on the north and south rock disposal areas with both areas achieving acceptable factors of safety. A run-out analysis was performed to provide an estimate of the distance that waste rock could travel from the toe of the disposal area in the event of a failure. A significant run-out from the SRDA was not anticipated given the relatively shallow foundation slope. The analysis did show that given its topography, should a run-out occur at the NRDA, that travel distances would be significant.

One of the main design safeguards is to progressively re-slope the waste dumps to 23 degrees. This positively impacts the stability greatly and provides a factor of safety of 1.78 which is greater than the minimum suggested design value. The in-pit portion of the SRDA has also been designed so that the toe of the re-sloped disposal area does not exceed the crest of the ultimate pit. This will provide a solid toe thus increasing the geotechnical integrity of the in-pit portion of the disposal area.

The geotechnical report includes a number of ground improvement/construction recommendations which include:

- stripping the 'A' and 'B' topsoil horizons (currently part of conservation and reclamation plan);
- weak, organic or fine grained soils to be stripped within 50 m of toe of the dump foundations to prevent failure through soft foundation soils;
- inspection of foundations prior to rock placement;
- excavation of soft soils within abandoned stream channels (NRDA) and backfill with select, competent rock; and
- ditching to direct water towards sediment ponds away from rock disposal areas.

C.9.4.3 Potential Environmental Effects

There would be a number of VCs impacted by a waste rock disposal area slope failure. These could include:

- increase in particulate emissions through the generation of a large dust plume; for a relatively short period of time (hours) the regional air quality would be expected to return to background conditions;

- noise would be generated; would return to background levels once movement ceased;
- fish habitat and fish passage could be impacted by rock covering the stream;
- WQ including TSS levels in the stream would increase significantly; would eventually dissipate;
- WQ including metals could leach out of the deposited rock should there be a long delay in clean-up measures; and
- vegetation, wildlife and land use would all be negatively impacted by the increased disturbance area.

Rock disposal areas will be equipped with monitoring devices to alert the mine operator of any potential issues and mitigative measures such as directing the rock to alternate disposal areas and lowering the height of each successive dump lift will be initiated. As disposal areas are completed they will be re-sloped to 23° which will help with the disposal area integrity. A rigorous field program will be completed in November, 2015 to investigate the foundation conditions of both the NRDA and SRDA. A detailed geotechnical assessment of these disposal areas will be included in a future mine licence application. Given the high factor of safety assigned to these dumps in the preliminary geotech assessment, an unlikely rating has been assigned. Given the large number of VCs that would be affected a high magnitude has been assigned resulting in an overall risk rating of moderate.

C.9.5 Water Management Dam Failure

C.9.5.1 Scenario Description

All water from the pit dewatering program and from surface runoff will be captured on the mine site. Four ponds (PSSP, WSP, ESP and NESP) will be created to capture water for treatment/removal of total suspended solids and release to Gold Creek and Blairmore Creek. Three surge ponds (RWP, SESP, NWSP) will be constructed to capture water that has the potential to be selenium enriched and will require on-site attenuation before release. A fourth surge pond (SWSP) will be used to collect water from the initial mining area. Water from this pond will either be pumped to the RWP or the WSP.

A variety of factors could contribute to the catastrophic failure of one of the water management dams, including (CANMET 1977):

- overflow as a result of flooding, pump failure or a combination of the two;
- slope failure as a result of engineering design or geological/tectonic instability;
- foundation failure as a result of shear stress;

- liquefaction; and
- erosion as a result of heavy rainfall or subsurface erosion through seepage along pipes.

Failure of a water management dam could release large quantities of untreated water and perhaps some of the trapped sediment from one or more of these ponds into the receiving environment. The magnitude of the impact on the environment could range from moderate to high, depending on the quantity of water being stored in each pond, how many dams fail simultaneously, the height of each dam and whether it was a surge pond or a sediment pond that was released. The worst case scenario would involve a release of large quantities of untreated, selenium contaminated water from the surge ponds into Gold Creek, which also flows through private property, is a drinking water source for eastern communities and wildlife and also provides habitat for the SARA listed species westslope cutthroat trout.

C.9.5.2 Design and Operations Safeguards

The primary method to prevent catastrophic failure of a water management dam is through engineering design and site selection. The dams will be constructed as per the Canadian Dam Association 2014 Technical Bulletin "Application of Dam Safety Guidelines to Mining Dams". The mitigation measures with respect to the sediment and surge ponds are listed below.

C.9.5.2.1 Sediment Control and Release Ponds (PSSP, WSP, NESP, ESP)

These ponds have been designed as wet ponds with permanent pools. Outflows from the ponds up to the water quality design flood will occur *via* discharge pipes through the embankments, which will have inverts at the levels of the permanent pools. Pond capacities and discharge pipes have been sized to provide the required retention for specified water quality design flood. For dam safety, the sediment ponds will also have emergency overflow spillways to convey the inflow flood design. Both the water quality design flood and the inflow design flood were estimated using hydrologic modelling for the largest catchment area reporting to each of the ponds during its life.

C.9.5.2.2 Surge Ponds (NWSP, SWSP, RWP, SESP)

Three surge ponds will be located downstream of the ex-pit waste dumps to collect toe seepage, which is expected to have elevated selenium levels (RWP, SESP and NWSP). These ponds will be constructed with cross-valley dams and, with the exception of the NWSP, are located outside of the 100 m riparian buffer. The downstream face of the embankment for the NWSP is located 30 m from Blairmore Creek in order to maximise the water storage capacity in this pond. Water collecting in these surge ponds will be pumped directly and/or indirectly to the saturated backfill zones.

For dam safety, the surge ponds will have emergency overflow spillways sized to convey the inflow design flood, which was estimated for the largest catchment area reporting to each of the ponds during its operating life.

Additional mitigation measures beyond engineering design include:

- routine inspection;
- implementation of the Benga's Emergency Response Plan; and
- Implementation of Benga's SOPPs.

C.9.5.3 Potential Environmental Effects

In the event that water is released from one of these ponds, the primary concern would be the impact to the aquatic environment. These could include:

- WQ including TSS could have harmful effects on aquatic life, including damage to fish gills and interference with feeding and egg incubation;
- increase in volume of water that results in flooding and altering of fish habitat;
- WQ including the release of selenium contaminated water which may result in adverse effects on water quality, fish and fish habitat;
- soils and vegetation could be subject to scour and erosion; would be of short duration and be restricted to the immediate vicinity of the release; and
- wildlife and public safety would be limited to the immediate vicinity of the release.

Such effects could be of moderate to high magnitude, depending on the size, location and duration of the release. However, through the implementation of mitigation measures such as engineering design, site selection, routine inspection and implementation of Emergency Response Plans, such an event is considered rare probability and moderate magnitude resulting in an overall moderate risk rating. If water released as a result of dam failure entered Blairmore Creek or Gold Creek, the contaminated water would be flushed downstream and diluted to background levels quickly. The effects would be localized in nature of be of short duration. Furthermore, in the event of a dam failure, Benga would implement its Emergency Response Plans immediately. Therefore, impacts to wildlife, human health and public safety are or rare probability and of low magnitude resulting in an overall risk rating of low.

C.9.6 Explosives Accident

C.9.6.1 Scenario Description

Drilling and blasting is required in the mine to break up the overburden rock prior to excavation. The explosives planned for Grassy Mountain are expected to be an industry standard ammonium nitrate/fuel oil (ANFO) mixture along with an emulsion blend.

Modern explosives in use at mines around the world are very hard to inadvertently detonate as long as safe handling procedures are followed. Ammonium nitrate prill will be transported to site by a third party explosives provider. This prill is not explosive on its own and poses little threat of accidental detonation. Once on site, the prill is mixed with fuel oil and becomes an explosives product (ANFO). On its own ANFO is also a very stable product and will not initiate without assistance. A high explosive combined with a blasting cap is required to initiate the blast and this combining of materials only occurs right at the blast hole.

Explosive accidents/incidents can occur with improper blasting techniques. Events that can occur include:

- people/equipment too close to blast;
- misfires;
- fly-rock; and
- over-blasting leading to pit wall instability.

C.9.6.2 Design and Operations Safeguards

The Explosives Safety and Security Branch (ESSB) of Natural Resources Canada is responsible for administering the *Explosives Act*. This project will have both an explosives magazine and an explosives manufacturing area. Guidelines have been issued by the explosives branch which governs the quantity and distance principals to be applied witch respect to storage volumes and the locating of these facilities.

Benga mining will be engaging a specialized explosives contractor to provide blasting services to support the mine operation. Prior to mine operations Benga Mining will develop a number of Standard Operating Policies and Procedures (SOPPs) to govern all aspects of the mine operations. A drill/blast SOPP will be developed to ensure compliance with all federal regulations and will include, but not be limited to, items such as:

- blast clearance limits;
- pit clearing procedures;

- pre and post notification procedures;
- signage;
- training requirements;
- blast design sign-off procedures;
- blast decking and stemming procedures;
- personnel responsibilities;
- ammonium nitrate spill clean-up procedures; and
- misfires.

C.9.6.3 Potential Environmental Effects

The VCs affected by blasting accidents/incidents are largely safety related leading to socio-economic and human health impacts. These could include:

- fly-rock is a rock fragment that is propelled further than expected *i.e.*, the blast clearance radius. This rock has the potential to harm humans and damage equipment but could also impact other VCs such as soil and vegetation due to the deposition of rock in unintended locations; and
- water quality including nitrate loadings in water courses with inadequate ANFO spill procedures. The mine will need to ensure that proper procedures are in place prevent ANFO that has been spilled/un-blasted from entering the receiving environment.

A blasting incident has been assigned an unlikely probability along with a low magnitude which results in a low overall risk rating.

C.9.7 Vehicle Incidents

C.9.7.1 Scenario Description

A vehicle incident on site is likely to occur as a result of human error, although adverse weather conditions and/or slope instability could also be a contributing factor. On-site vehicle incidents are more likely to involve smaller personnel than large haul trucks. Spills or releases as a result of haul truck rollovers are addressed in Section C.9.3.6.

With the implementation of mitigation measures below, the probability of such a scenario is unlikely and could be of low to severe magnitude, depending on the extent of human injury/loss.

C.9.7.2 Design and Operations Safeguards

Mitigation measures in place to prevent and respond to vehicle incidents include:

- drivers will meet all applicable training and legal requirements;
- transportation of material during hazardous conditions or conditions of limited visibility will be avoided where possible;
- lighting to installed in loading and unloading areas;
- ensuring adequate road maintenance equipment and surfacing materials;
- development and adherence to an SOPP that speaks to methods of road construction, maintenance and operation;
- vehicles will be maintained in good condition and inspected on a regular basis;
- speed limits will be strictly adhered to; and
- haul roads to be constructed in accordance to Alberta occupational health and safety regulations (specification of berm heights and run-out ramps for grades greater than 5%).

C.9.7.3 Potential Effects

The primary concern would be human injury and/or fatality. Although the probability of such an event is unlikely through the implementation of mitigation measures, the magnitude could be low to high, depending on the location of the incident and the size and load of the vehicle. This results in an overall risk rating of moderate.

C.9.8 Hazardous Materials Spill or Release

An on-site hazardous material spill is a spill considered to be hazardous due to its inherent physical or chemical properties or because of its toxicity, flammability, corrosiveness, or explosiveness. Hazardous materials on-site for the Project include petroleum products (*e.g.*, diesel), process chemicals (*e.g.*, MIBC) and explosives (*e.g.*, ammonium nitrate). Pumps and piping to transport the reagents from the storage tanks to the flotation circuit will be provided. The storage area and associated distribution networks are classified as hazardous areas and will be designed and installed in accordance with Canadian Standards. The explosives planned for Grassy Mountain are expected to be an industry standard ammonium nitrate/fuel oil mixture along with an emulsion blend, which will be mixed on site by a third-party explosive provider at their facility in accordance with all applicable legislation.

C.9.8.1 Scenario Description

A hazardous material spill could range in magnitude from a small leak over time, which evades normal detection systems, to a complete rupture of storage facilities, releasing large quantities of hazardous materials on-site. Such a spill could arise from equipment leakage, a trucking accident on-site from the mine equipment refueling/lube truck, a spill from a ruptured fuel storage tank or a spill within the CPP or CHPP. The magnitude of the impact would range from low to moderate,

depending on the size and location of the spill as well as the material(s) released. The worst case scenario would involve a spill of the entire contents of a reagent storage facility (*i.e.,* diesel and/or MIBC) which escapes secondary containment measures, or the release of large quantities of ammonium nitrate. In most cases, however, hazardous materials spills would be restricted to the immediate footprint of the Project area.

C.9.8.2 Design and Operations Safeguards

Reagents such as diesel and MIBC will be stored inside double-walled tanks inside of a concrete protection bund. The reagents required to operate the flotation cell (*i.e.,* diesel and MIBC) will be stored in a purpose built facility (fuel farm). The fuel farm will consist of one (1) storage tank for collector and one (1) storage tank for frother. Storage and handling of explosives will comply with the **Guidelines for Bulk Explosives Facilities** issued by Natural Resources Canada. Operational safeguards would include:

- daily inspections of all fuel lube storage locations;
- a volume accounting procedure to be put in place which would include comparing volumes in tanks against expected consumption;
- spill kits to be located at storage facility and also on board mobile lube truck; and
- lube truck drivers to be trained in safe driving procedures.

C.9.8.3 Potential Environmental Effects

The primary concern associated with a hazardous material spill would be adverse impacts on groundwater quality as well as a release of VOCs if fuel is released to the open air. However, any minor adverse environmental effects on air quality will cease once clean-up is complete. Environmental effects associated with spills are anticipated to be confined to the footprint of the Project and the immediate vicinity of the release. As such, it is unlikely that a spill would interact with the surrounding environment and other VCs. With the implementation of mitigation measures, the probability of a hazardous material spill is unlikely. The magnitude of a spill would be high, should the spill directly enter the watercourses, which results in an overall risk rating of moderate.

C.9.9 Train Derailment

C.9.9.1 Scenario Description

According to the report "Statistical Summary of Railway Occurrences 2014" issued by the Transportation Safety Board of Canada in June, 2015, there were 1,225 rail accidents reported to the Transportation Safety Board (TSB) in 2014. A review of the last 10 years of data suggests that 2014 was an average year. The TSB defines a reportable railway accident as:

- a serious human injury or fatality as a result of:
  - getting on or off or being on board the rolling stock; or
  - coming into contact with any part of the rolling stock or its contents.
- the rolling stock or its contents:
  - are involved in a collision or derailment;
  - sustain damage that affects the safe operation of the rolling stock;
  - cause or sustain a fire or explosion; or
  - cause live damage to the railway that poses a threat to the safe passage of rolling stock or to the safety of any person, property or the environment.

Information contained in the report includes the following:

- The largest proportion of reported rail incidents comprised non-main track derailments and collisions (62%).
- Most non-main track accidents are minor, occurring during switching operations at speeds less than 10 mph.

Given a review of the statistics the most likely derailment scenario would occur within the rail loop during switching operations. This could result in the toppling of a number of cars with the discharge of coal into the ditches alongside the tracks. As highlighted in Table C.9.2-1, the impacted VCs could include air quality and hydrology/water quality.

C.9.9.2 Design and Operations Safeguards

The rail loop drainage design includes a sediment pond where all water collected in the track's drainage ditches is directed. This water is treated for total suspend solids before it is released into the environment.

C.9.9.3 Potential Environmental Effects

Immediately following a derailment there would be a release of coal dust into the atmosphere. Combined with windy conditions there is the potential for the finer particles to become airborne. The prevailing winds generally blow from west to east creating the potential for dusting of the residences located south-east of the rail loop. It could be expected that cleanup operations may take a few days. A potential mitigative measure to minimize airborne contaminants after the spill would be to spray water on the spilled coal until it can be picked up with a backhoe and trucked back to the CHPP for reprocessing.

The overturned cars and coal would end up in the drainage ditch below the rail grade. The water in the drainage ditches alongside the tracks will report to the sediment pond located at the western end of the rail loop. Should water ponding occur due to interference of the derailment on the drainage ditch, then pumping may be necessary. The sediment pond will provide the ability to treat the water for suspended solids before discharge to the environment. Therefore, a derailment in the rail loop is not expected to adversely affect these VCs. An unlikely probability combined with a nil/low magnitude results in a low overall risk.

C.9.10 Summary and Conclusions

Table C.9.10-1 summarizes the assessment of risk and potential effects of accidents and/or malfunctions that could occur through all phases of the project. In some cases, a number of VCs are affected with differing resultant risk. This table includes the highest resultant risk rating determined for each particular malfunction/accident.

Table C.9.10-1 Summary of the Assessment Risk and Potential Effects of Accidents

Malfunction/Accident	Issue of Concern	Likelihood	Magnitude	Resultant Risk
Open Pit Wall Failure	Large scale wall failure causing a safety concern and possible increase in disturbance footprint	Rare	Moderate	Moderate
Waste Rock Disposal Area Failure	A number of VCs impacted	Unlikely	High	Moderate
Water Management Dam Failure	Uncontrolled release of water entering Blairmore or Gold creeks damage to aquatic life downstream	Rare	Moderate	Moderate
Explosives Accident	Could have either a fly-rock incident which is largely a human health concern or an ammonium nitrate spill which would be an environmental impact	Unlikely	Low	Low
Vehicle Incidents	Human health concern due to vehicle collision or roll over	Unlikely	Low to High	Moderate
Hazardous Materials Spills/Releases	Damage to receiving environment – soils, streams, groundwater	Unlikely	Low to High	Moderate
Train Derailment	Coal entering ditches alongside rail line – water quality issue	Unlikely	Nil/Low	Low

C.10 Effects of the Environment and Climate Change on the Project

The natural environment and changing climate have the potential to impact the Project through delays or interruptions in construction and operations, damage to infrastructure, or increased risk to the public or the environment. The sensitivities of the Project to the environment and changing climate were assessed based on potential impacts to the Project, in terms of delays in construction or operations and in damage to infrastructure, as well as potential impacts to the public and the environment. Based on Project design, existing mitigation and monitoring plans, and professional judgement, Project sensitivities were rated as nil, low, medium, and high, following recommendations in the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment's (2003) *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners*.

C.10.1 Effects of Local Conditions and Natural Hazards

Sensitivities of Project phases and components to local conditions and natural hazards are summarized in Table C.10.1-1. Discussion of sensitivities is provided below for extreme weather and climate conditions, geophysical and geotechnical hazards, and fire hazards.

C.10.1.1 Effects of Extreme Weather and Climate Conditions

Climate in the area is characterized by (CR #1a Appendix C, Section 4):

- median temperatures range from a low of about -6°C in January to a high of about +14°C in July;
- most precipitation occurs during the May to September period (with peak precipitation occurring in June) and average annual precipitation is around 570 mm. Average monthly snowfall is approximately 20 cm during the winter; and
- winds in the area are a function of terrain.

Extreme conditions in the area may potentially include:

- extreme cold/hot temperatures;
- extreme high/low precipitation; and
- extreme wind velocity.

The Project is not expected to be sensitive to extreme temperatures. Infrastructure, including the construction camp and water treatment plants, is designed to handle winter, summer, and extreme weather conditions. Should extreme temperatures become unsafe/unsuitable for workers, Project

activities may be temporarily suspended until conditions improve, resulting in a low impact to the Project.

Sensitivities to extreme precipitation conditions or events are predicted to be predominantly low (Table C.10.1-1). Unusually wet or dry conditions may result in temporary changes to Project activities:

- higher than usual annual precipitation (rain and snow) will be manageable with the proposed water management system and mitigations;
- extreme accumulations of snow are expected to result in a nil to low sensitivity of Project infrastructure to avalanches, due to locations of infrastructure, access corridor, and construction camp. Temporary suspension of Project activities may occur if avalanches deposit snow/debris on the main access corridor;
- low annual precipitation or ongoing increased evaporation resulting in dry conditions may result in low levels in the raw water pond. In extended drought conditions, the CPP may not be able to run at full production due to water shortages; and
- dry conditions may increase dust suppression requirements; and
- extreme wet or dry conditions may suspend reclamation activities and alter reclamation trajectories.

Project design (Section C.1.2, C.2 to C.6), environmental management plans (Section C.7), and proposed mitigations (Section A.6.4, A.11.4, A.11.5, A.11.7) are anticipated to result in low Project sensitivities to extreme weather events (Table C.10.1-1):

- Extreme wet precipitation events or quick extreme snowmelt events may result in accidents or malfunctions related to water management dam failure described in Section C.9.5.
- The location of the southeast surge pond, which is in close proximity to Gold Creek, results in this pond having a low to medium sensitivity to extreme rainfall events. To further mitigate this sensitivity, detailed designs will be submitted as part of the Project's dam safety considerations.
- Visibility issues arising from extreme rain and snow events may result in temporary suspension of activities.
- Extreme wind may result in temporary suspension of activities.

Extreme weather conditions and events have the potential to increase erosion in the Project area, predominantly from increased runoff from extreme rainfall or snowmelt events. Project design (Section C.1.2, C.2 to C.6), environmental management plan (Section C.7), mitigations

(CR #5 Section 4.1.1.2, CR #7 Section 7.1.3.2, CR #8 Section 4.1.5.1), and elements of the C&R Plan (Section F.1.5, F.2.7, F.3.1, F.3.6.2, F.3.6.3.2, F.3.8, F.4.2, F.4.4.4) result in nil to low Project sensitivities to erosion (Table C.10.1-1).

C.10.1.2 Effects of Geophysical and Geotechnical Hazards

Project location (Section A.4) and design (Section C.1.2, C.2 to C.6) lead to low Project sensitivities to geophysical and geotechnical hazards such as landslides, subsidence, and seismic events (Table C.10.1-1):

- the Project is in a relatively low seismic hazard zone;
- construction areas and camp are not located in areas sensitive to landslides;
- geotechnical designs for the rail loop, loadout facility, in-pit/ex-pit waste disposal areas and pit walls were completed using the results from numerous field investigations (Section B.8) at appropriate factors of safety to reduce Project sensitivities to landslides; and
- infrastructure components have been designed around legacy mining areas to minimize risk of subsidence.

C.10.1.3 Effects of Fire Hazards

The Project design and mitigations comprising the Fire Protection system (Section C.6.16) and Wildfire Control and Prevention Plan (Section C.7.7) will result in nil to low Project sensitivities to fire hazards (Table C.10.1-1). Sensitivities include damage to infrastructure and evacuation of personnel, both resulting in temporary suspension of Project activities. Wildfire in reclaimed areas will setback reclamation progression and may alter reclamation trajectories.

Table C.10.1-1 Sensitivities of Project Phases and Components to the Environment

Local Condition or Natural Hazard	Project Phases / Components									
	Construction	**Main Access & Overland Conveyor**	**Rail Loop and Loadout**	**Coal Handling & Preparation Plant**	**Mine Infrastructure Area**	**Raw Water Pond**	**Water Management Ponds**	**Disposal Areas**	**Energy Infrastructure**	**Decommissioning and Abandonment**
Mean Temperature[1]	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Frequency and/or Severity of Extreme Temperature[2]	Low - may temporarily suspend construction if conditions are unsuitable. Construction camp designed to withstand extreme weather	Nil - Low - may temporarily suspend conveyor operations if conditions are unsuitable	Nil	Nil - Low - may temporarily suspend operations if conditions are unsuitable	Nil	Nil	Nil	Nil	Nil	Low - may temporarily suspend decommissioning and abandonment activities if conditions are unsuitable
Total Annual Rainfall and/or Snowfall	Low - may temporarily suspend construction if conditions became unsuitable	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Low - may temporarily suspend decommissioning/abandonment activities if conditions became unsuitable
Frequency and/or Severity of Precipitation Extremes[3]	Low - may temporarily suspend construction if conditions became unsuitable	Low - may impact traffic access	Low - may impact bridges over creeks	Low - Plant requires water for processing. Production could be limited by lack of water which would be a financial impact to operator.	Low - extreme rainfall events may impact traffic on the mine site.	Low - pond to be kept pumped down during rainy season. Transfer water to other ponds. Emergency spillways used as last resort as untreated water would be discharged directly to Blairmore Creek.	Low - ponds to be kept pumped down during rainy season. Water can be transferred to other ponds or into pit during extreme events. Emergency spillways used as a last resort as water with elevated TSS levels would be discharged to nearby creeks.	Low - increased precipitation events could increase sediment load on the nearby sediment ponds. The result is that the ponds may require more frequent clean out. Would have an impact on overall disposal area stability but still within design factor of safety.	Nil	Low - may temporarily suspend decommissioning/abandonment activities if conditions became unsuitable
Lake Levels and Streamflows[4]	Nil	Low - culverts along main access road could be impacted by high stream flows	Low - Blairmore Creek culvert under rail line to loop is designed for high flows	Low - infrastructure is placed at higher elevations than nearby creeks.	Low - located topographically higher than local creeks	Low - the toe of the raw water pond dam is over 40m higher than the nearest point of Blairmore Creek.	**Low - medium - most of the dams for the water management ponds are between 4 m and 22 m above the nearest creek. The exception is the south east surge pond (SESP), which is built in relatively close proximity to Gold Creek. Detailed designs will be submitted as part of dam safety considerations. Significant downstream flooding would be required before SESP dam impacted.**	Low - all creeks are located topographically lower than all disposal areas. The mine plan was designed around minimizing the interaction with local creeks.	Low - site power runs along the same corridor as main access road and overland conveyor. Powerline will be located at the highest topographic point along the corridor.	Nil

Table C.10.1-1 Sensitivities of Project Phases and Components to the Environment

Local Condition or Natural Hazard	Project Phases / Components									
	Construction	**Main Access & Overland Conveyor**	**Rail Loop and Loadout**	**Coal Handling & Preparation Plant**	**Mine Infrastructure Area**	**Raw Water Pond**	**Water Management Ponds**	**Disposal Areas**	**Energy Infrastructure**	**Decommissioning and Abandonment**
Soil Moisture and Groundwater	Low - elevated levels of soil moisture could make construction activities more difficult and increase sedimentation	low	Nil	Low - plant will be constructed with highly compacted clay fill materials that will reduce the ability of the material to get saturated, impacts would be increased sedimentation	Nil	Low - the dams will be constructed using highly compacted clay fill materials that will not become saturated with increased soil moisture, so will not compromised the dam integrity	Low - the dams will be constructed using highly compacted clay fill materials that will not become saturated with increased soil moisture, so will not compromised the dam integrity	Low - conservative assumptions have been built into geotechnical analysis for both pit walls and rock disposal areas.	Nil	Low - lower groundwater levels could reduce the returns expected to Gold and Blairmore Creek at closure and higher levels could increase the returns. Increases soil moisture could result in more sedimentation and pressure on the release ponds.
Evaporation Rate	Nil	Nil	Nil	Nil	Nil	Low - a higher evaporation rate would lower the available processing water and water that ultimately returns to Gold and Blairmore Creeks.	Low - would lower the amount of water available for return to the local watershed.	Low - could cause more dusting on the disposal areas. Would require increased use of the site's water truck to mitigate effects.	Nil	Low - a long-term higher evaporation rate would increase the time it takes to fill the end-of-mine lake, delaying the ultimate return of water to Gold Creek.
Wind	Low - may be an increased risk to personnel and equipment	Nil - Low - the overland conveyor will be covered along its length to protect it from the elements.	Nil - Low - Loadout bin has been designed to include additional shielding to extend well past the active car loading area to shield the falling coal against wind effects.	Nil -Low - dust may be an issue for the ROM bin and clean coal stockpile. The clean coal stockpile will be susceptible to dust issues under extreme wind conditions. Would need to dump coal out with a higher moisture content under these conditions.	Low - extreme wind may impact worker safety and cause temporary suspension of activities.	Nil	Nil	Low - excessive wind would cause surface of disposal areas to dry out more quickly. Would need to run water truck more often. Progressive reclamation has been built into mine plan to re-establish vegetation on dump slopes to protect it from wind erosion.	Nil - plant has backup power source in case of loss of main power source.	Low - wind erosion, increased dust, low visibility

Table C.10.1-1 Sensitivities of Project Phases and Components to the Environment

Local Condition or Natural Hazard	Project Phases / Components									
	Construction	Main Access & Overland Conveyor	Rail Loop and Loadout	Coal Handling & Preparation Plant	Mine Infrastructure Area	Raw Water Pond	Water Management Ponds	Disposal Areas	Energy Infrastructure	Decommissioning and Abandonment
Avalanches	Nil - Low - location of infrastructure and camp not in active avalanche areas. Could be some minor impact from snow coming off hill side located to the east of camp.	Nil - Low - main access corridor not located in a known avalanche area. Could be some minor impact of snow coming off hillside located to the east of main access corridor.	Nil	Nil	Nil	Nil - Low - may have minor snow sloughing off topsoil pile located just to the south of raw water pond, and off slopes above sediment and surge ponds.		Nil	Nil	Nil
Erosion[5]	Low – erosion is not expected to have an impact. Ditches to be designed at a 25-year design flood criterion.	Low - erosion may have a minor impact on the ditches along the main access road.	Low - ditches designed to a 25-year design flood criterion. A sediment pond will also be sited in the rail loop area to treat water for TSS. No wind effects expected.	Low - sediment ponds are located in strategic places to deal with high TSS. Collection ditches are designed to a 25-year design flood criterion. No wind erosion expected.		Low - proper pond management and increased maintenance will ensure minimal impacts from water erosion.		Low - disposal areas may be subjected to minor erosion. Sediment from disposal areas will be captured in surge ponds. Disposal areas will be successively re-sloped and revegetated to reduce the effects of erosion. Diversion channels will be used to minimize inflows through disposal areas. Collection ditches and diversion channels have been designed to a 25-year design flood criterion. May result in increase pressure on sedimentation ponds, requiring more clean out activities.	Low - will be sighted in areas that are not impacted by water erosion.	Low - reclamation will begin soon into the mine plan, eliminating long-term erosion. Additional pressure on the sedimentation ponds may require more clean out activities.
Landslides	Low - construction areas and camp are not located in sensitive areas.	Nil - Low - main access road does not require large cuts along its length.	Nil - Low - geotech design to ensure long-term stability of areas of cut required for rail loop.	Nil - Low - in-pit rock dumps located to the east of the infrastructure are designed to toe-in below the crest of the ultimate pit at the long-term reclamation angle of 23 degrees.		Low - the south disposal area has been split on either side of an existing 500Kv powerline. This offset will also keep the disposal area toes away from the raw water pond. As part of progressive reclamation the disposals areas will be re-sloped to a much	Low - the site's water management ponds are generally located downslope of all rock disposal areas. The in-pit disposal areas have been designed to be contained entirely within the pit and will toe-in at the 23 degree reclamation slope below the crest of the ultimate pit to ensure stability. External dumps	Low - poor foundation material will be removed prior to disposal area construction. External disposal areas will be constructed from the bottom-up with each lift re-sloped from the angle of repose (36 degrees) to a shallower (and more stable) 23 degrees. These disposal areas will be	Nil	Low - geotechnical considerations will be built into the operating practices which will ensure long-term stability post-closure.

Table C.10.1-1 Sensitivities of Project Phases and Components to the Environment

Local Condition or Natural Hazard	Project Phases / Components									
	Construction	Main Access & Overland Conveyor	Rail Loop and Loadout	Coal Handling & Preparation Plant	Mine Infrastructure Area	Raw Water Pond	Water Management Ponds	Disposal Areas	Energy Infrastructure	Decommissioning and Abandonment
						shallower 23 degrees which will increase its long term stability.	will be re-sloped to 23 degrees and progressively reclaimed, which also greatly increases their long-term stability.	progressively reclaimed, contributing to their long-term stability. In-pit dump toes have been designed to stay entirely within the crest of the open pit.		
Subsidence[6]	Low	Nil - The main access road crosses over the legacy Greenhill's mine only where the workings are more than 300 m below.	Nil	Low		Nil	Nil	Nil - external disposal areas are not located above historical workings. Areas of previous underground mining will be mined out and backfilled.	Low	Nil
Seismic Events[7]	Low	Low	Low	Low	Low	Low	Low	Low	Low	Nil
Fire (wildfire or Project-related fire)[8]	Low - temporary suspension of activities	Low - temporary suspension of some operations activities. May pose a threat to the mine's power feed line and the conveyor.	Low - temporary suspension of some operations activities. Risk of damage to infrastructure.		Low - Risk of damage to permanent infrastructure.	Nil	Nil	Nil	Low	Low – damage to reclaimed lands, delayed progress, alteration of reclamation trajectories.

1 All infrastructure is designed to withstand extreme temperatures and wind.

2 Project infrastructure is designed to handle both summer and winter conditions.

3 Based on 200-yr dry return period (300 mm) and 200-yr wet return period (1,260 mm).

4 Hydrology: low flow (10-yr return) = 1.43 L/s/km2 for Blairmore Creek and Gold Creek, and 1.91 for Crowsnest River at Frank; peak flow (100-yr return) = 0.86 m3/s/km2.

5 Wind and water erosion from normal and extreme weather conditions or events

6 Foundation investigation has been completed in the infrastructure area. Historical underground maps were used for initial locating of infrastructure. Foundation drilling has confirmed stability of chosen locations. Additional foundation drilling will be undertaken as part of the final design stage to help delineate areas of historical underground mining.

7 Project is located in relatively low seismic hazard zone.

8 Project has a fire protection system and a Wildfire Control and Prevention Plan.

C.10.2 Effects of Long-Term Climate Change

A summary of existing climate parameters and projected changes, by 2050s, to selected climate parameters (number of warm and cold days, seasonal precipitation, and frost free days) for the Project region is provided in CR #1a, Section 5.14.1.

Predicted changes in the 2050s near Project closure are provided in Table C.10.2-1. The changes are largely independent of whether a low or high carbon future emission scenario is used: a substantial increase in the number of hot days and a decrease in the number of cold days, a 3% increase in precipitation with an increase in spring and a decrease in summer, and a 15% increase in the frost-free period.

Table C.10.2-1 Projected Climate Parameters near Pincher Greek based on the Average of 12 GCMs (PCC 2016)

Parameter	Baseline Value (1961 – 1990)	High Carbon Prediction, 2050s	Low Carbon Prediction, 2050s
Number of Days above 30 °C	7.6	17.2	15.2
Number of Days below -30 °C	3.0	0.6	0.9
Precipitation (mm)	474.7	487.0	489.2
Total Winter	76.6	79.4	82.2
Total Spring	134.8	151.3	150.8
Total Summer	175.4	164.1	165.5
Total Fall	87.9	92.2	90.7
Frost Free Days	114.3	133.2	129.9

C.10.2.1 Sensitivity to Climate Change

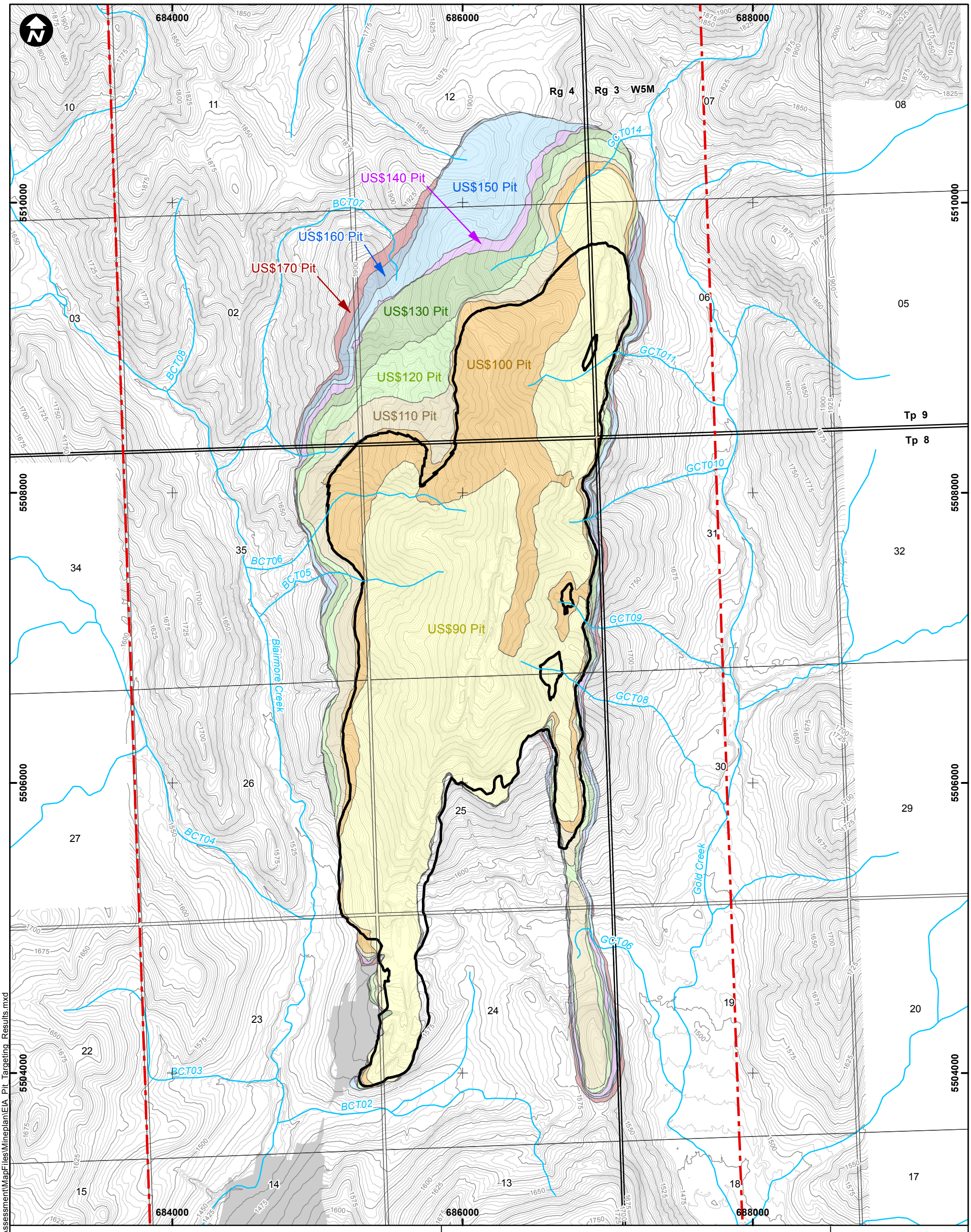
Based on the project climate parameters in Table C.10.2-1, the sensitivities of the Project's components and phases to climate change were determined and are summarized in Table C.10.1-1. The projected climate parameters through to the 2050s indicate that any sensitivities to long-term climate change will arise from increased mean annual temperature and increased frequency of days with temperatures >30°C. Precipitation is not predicted to change substantially from current levels.

Potential sensitivities include increased evaporation, which results in drier conditions that may:

- increase fugitive dust emissions, which can be readily mitigated by adapting the fugitive dust mitigation plan to changing conditions (Section A.11.1.1).
- reduce levels in the raw water pond, and thereby reduce the amount of water available for coal processing and peripheral activities; and
- increase the risk of wildfire, which will be mitigated though ongoing adaptation of the Wildfire Control and Prevention Plan.

Other than increasing fugitive dust emissions, the predicted increased frequency of extreme temperatures will have little effect on air quality parameters (CR #1a, Section 5.1.4.3). Concentrations of biogenic VOCs may increase slightly in the summer, and this may slightly increase ozone concentrations. These changes are not expected to be significant.

Figures



LEGEND

- Proposed Mine Permit Boundary
- Township
- Section (23)
- Ultimate Pit Crest
- Drainage
- Historical Underground Mining
- Major Surface Contour (25 m Interval)
- Minor Surface Contour (5 m Interval)

Pit Targeting Results

- US$90 Pit
- US$100 Pit
- US$110 Pit
- US$120 Pit
- US$130 Pit
- US$140 Pit
- US$150 Pit
- US$160 Pit
- US$170 Pit

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

Golder Associates

TITLE

PIT TARGETING RESULTS

NOTES

Plant and Facility Data – Sedgman, 2015
Surface Water Control Data – Golder, 2015
Mine Plan Data - Golder, 2015
Topographic LiDAR Data - Riversdale, 2014
Datum/Projection: UTM NAD 83 Zone 11

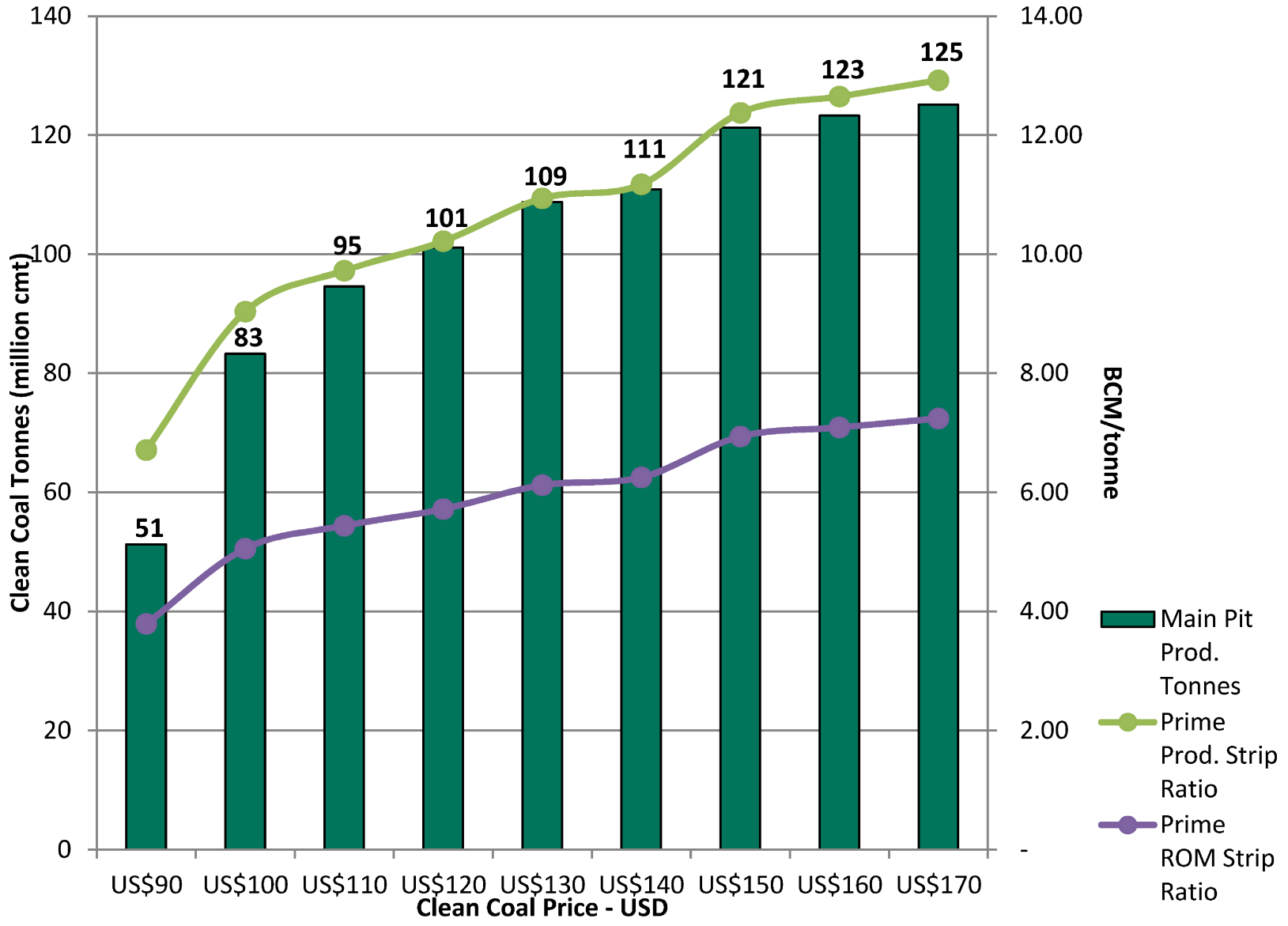
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DRAWN BY:	LH
CHECKED BY:	SP
DATE:	Oct 15, 2015

0 500 1,000 2,000
Metres

FIGURE

C.1.2-1

Document Path: P:\Riversdale_1406422\GIS\Environmental_Impact_Assessment\MapFiles\Mineplan\EIA_Pit_Targeting_Results.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

CLEAN COAL TONNES VS SELLING PRICE

PROJECT: 14-00201-01

DRAWN BY: CP

CHECKED BY: MB

DATE: OCTOBER 21, 2015

NOTES

MEMS, 2015

SCALE BAR: N/A

FIGURE

C.1.2-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.1.2-2 Clean Coal Tonnes vs Selling Price.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

Caudron Creek

Blairmore Creek

Gold Creek

Morin Creek

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2018 (YEAR -1)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

Caudron Creek

Blairmore Creek

Gold Creek

Morin Creek

SWSP

SESP

RWP

PSSP

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2019 (YEAR 1)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

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Kilometres

FIGURE
C.1.3-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
WSP
SWSP
SESP
RWP
PSSP
Reclamation Material Storage
Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2020 (YEAR 2)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
WSP
SWSP
SESP
PSSP
RWP
Reclamation Material Storage
Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2021 (YEAR 3)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

WSP
SWSP
SESP
PSSP
RWP

Reclamation Material Storage

Baldmore Creek
Caudron Creek
Gold Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2022 (YEAR 4)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
WSP
SWSP
SESP
RWP
PSSP
Reclamation Material Storage
Bluemore Creek
Caudron Creek
Gold Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2023 (YEAR 5)

NOTES

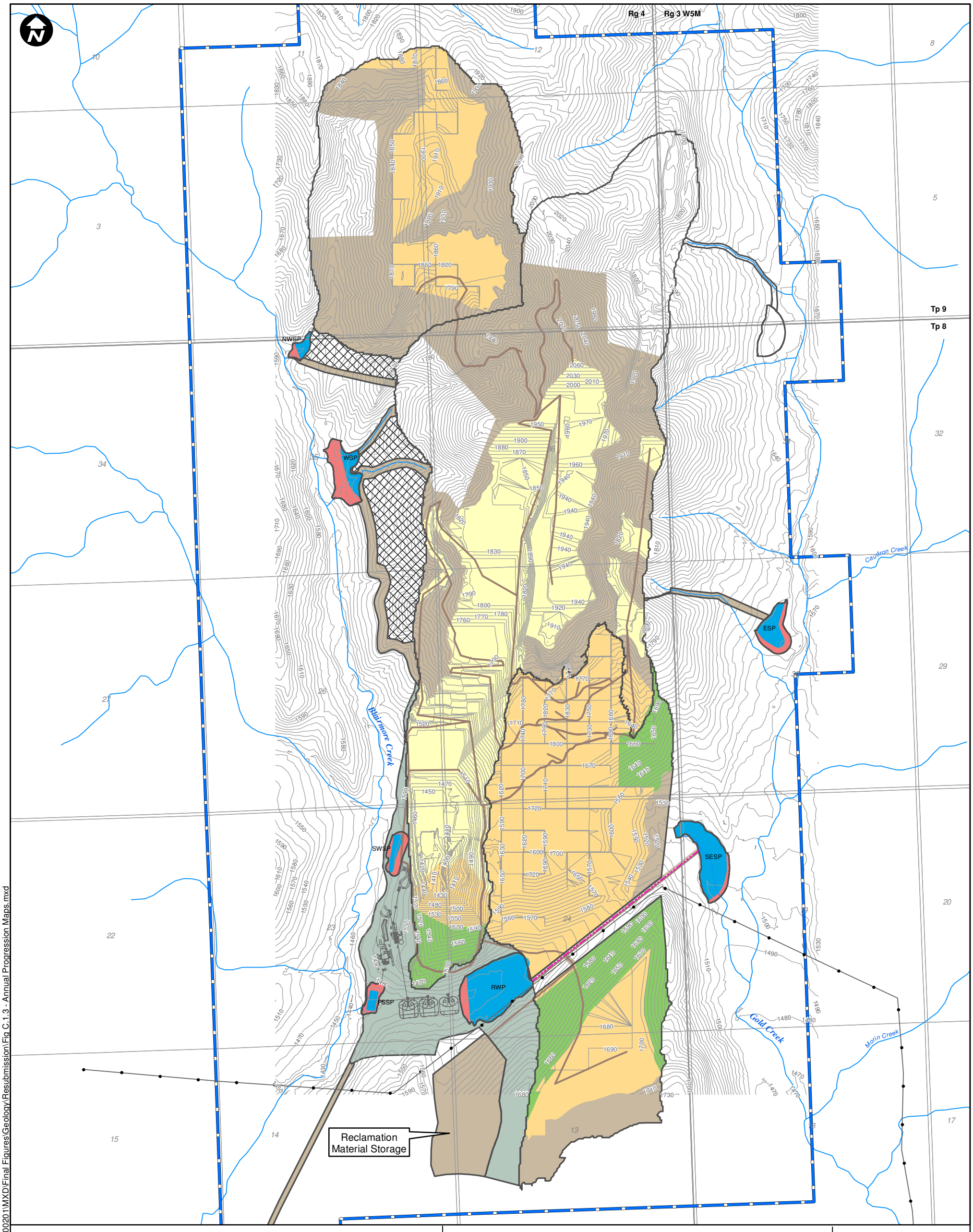
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CHECKED BY:	DM
DATE:	JULY 15, 2016

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Kilometres

FIGURE
C.1.3-6

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2024 (YEAR 6)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE

C.1.3-7

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
NWSP
WSP
SWSP
SESP
ESP
PSSP
RWP
Reclamation Material Storage
Blairmore Creek
Gold Creek
Caudron Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2025 (YEAR 7)

NOTES

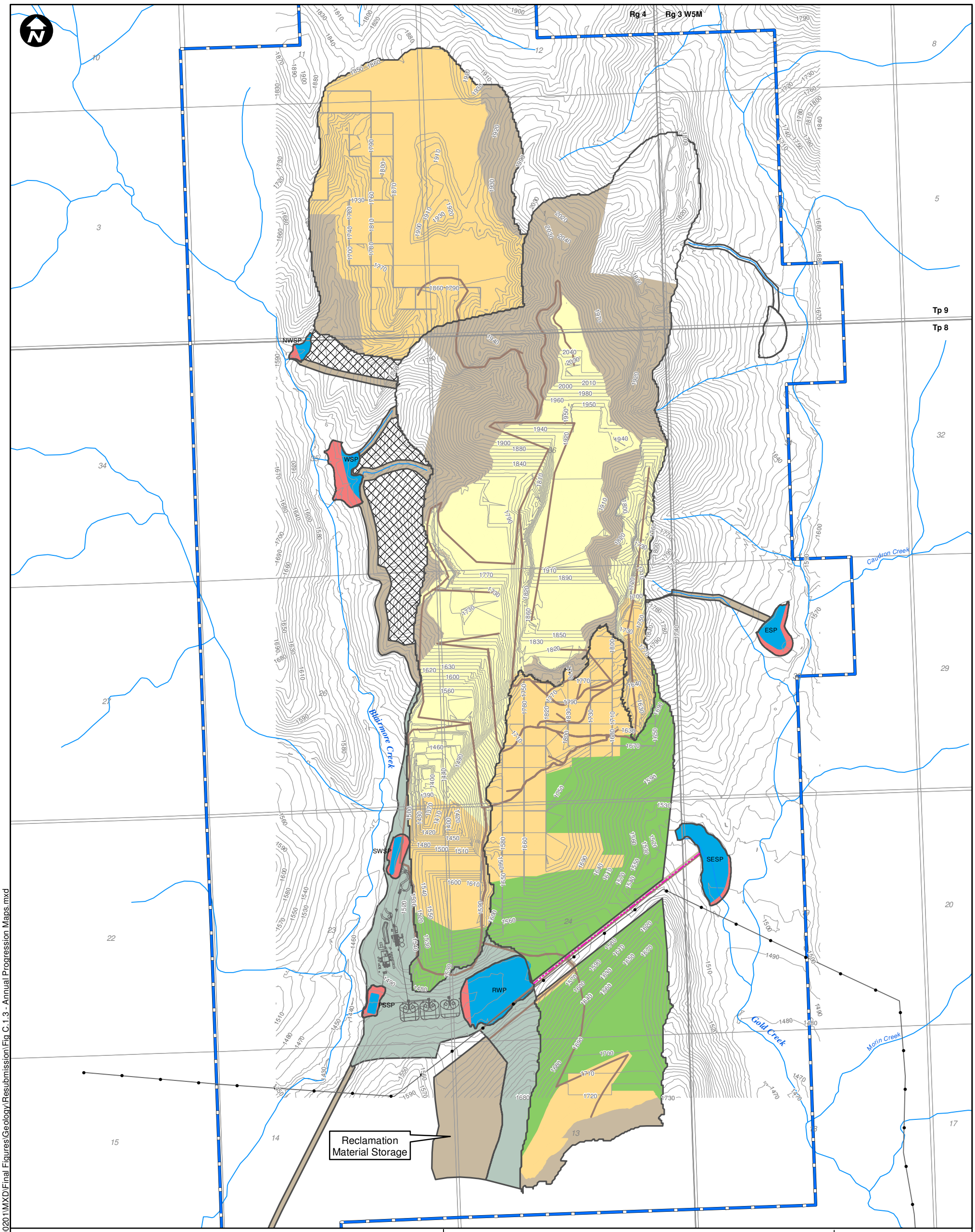
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Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-8

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
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- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2026 (YEAR 8)

NOTES

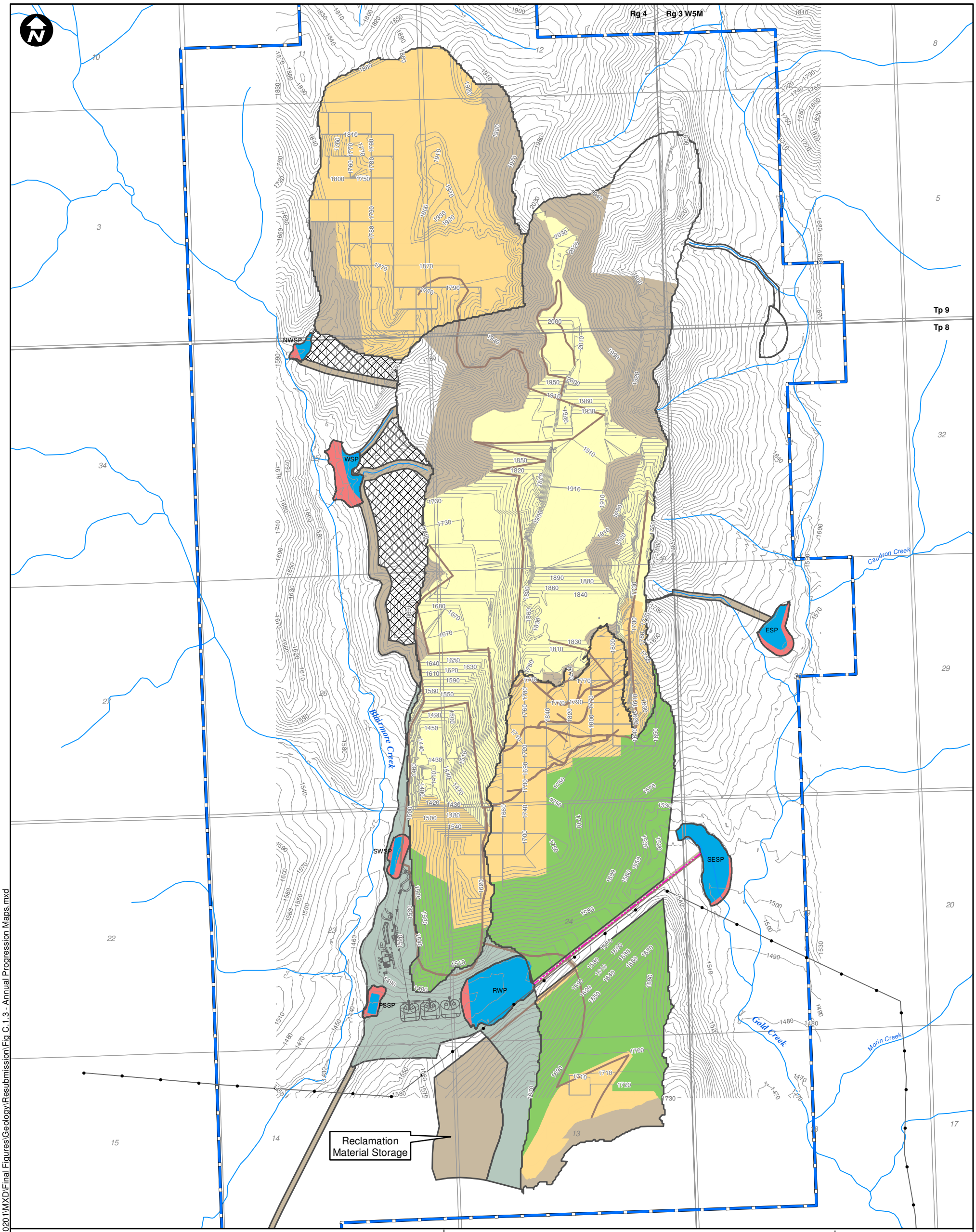
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Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-9

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
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- Undisturbed Area
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- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2027 (YEAR 9)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-10

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

NWSP
WSP
SWSP
PSSP
RWP
ESP
SESP

Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2028 (YEAR 10)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-11

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9

Tp 8

NWSP

WSP

SWSP

SESP

ESP

RWP

PSSP

Reclamation Material Storage

Blairmore Creek

Caudron Creek

Gold Creek

Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2029 (YEAR 11)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

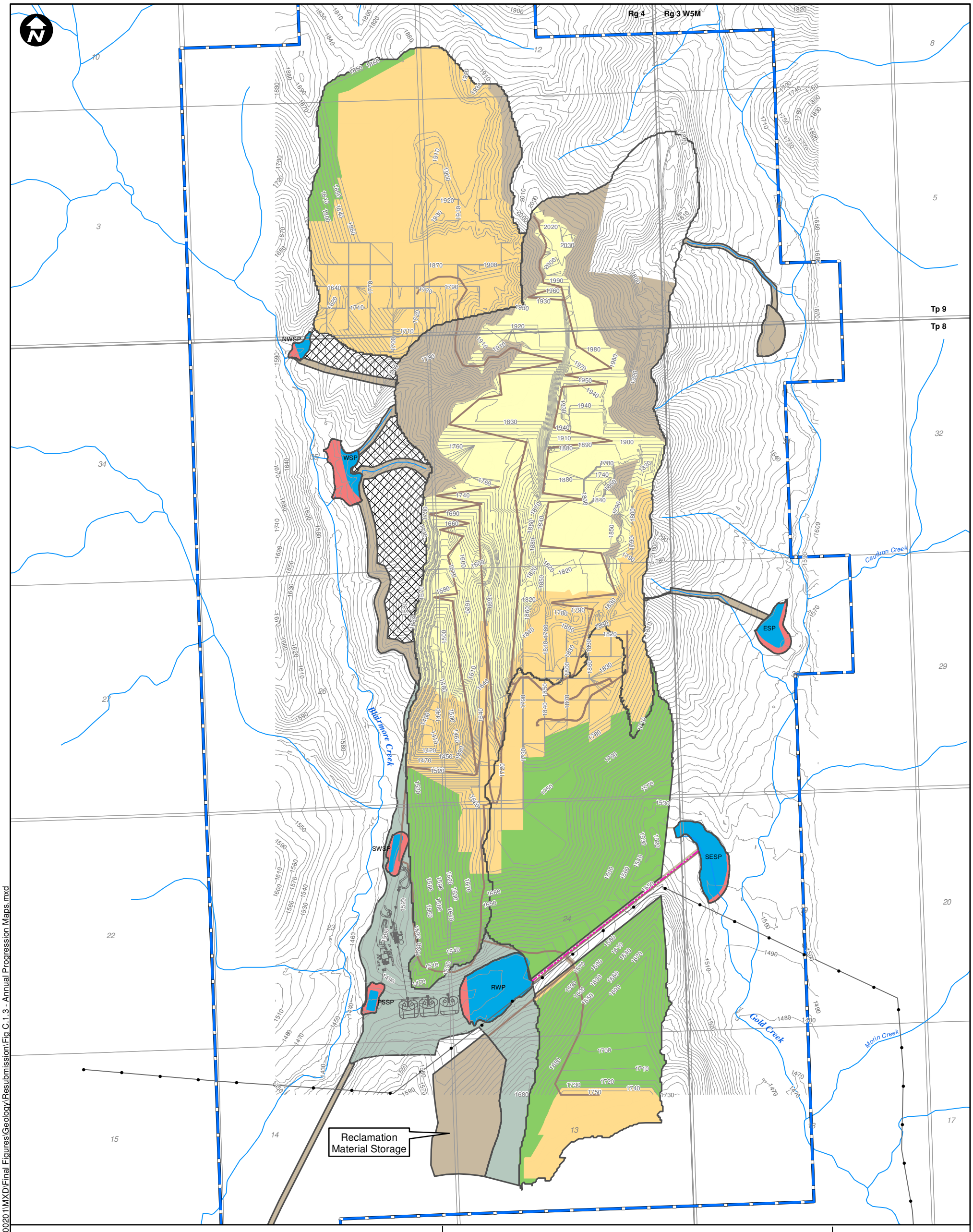
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CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE

C.1.3-12

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2030 (YEAR 12)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

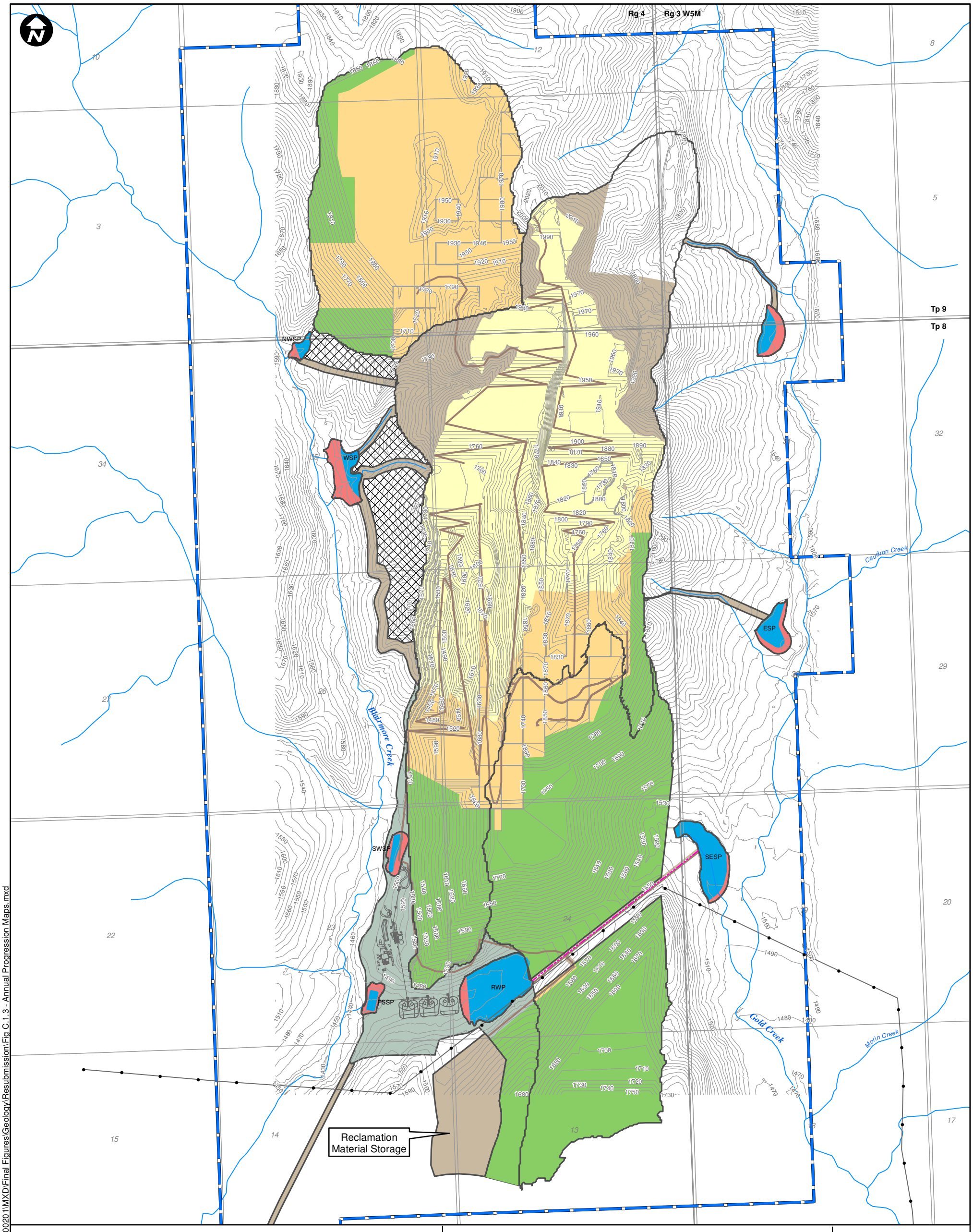
PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE

C.1.3-13

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2031 (YEAR 13)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE

C.1.3-14

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

NWSP
WSP
SWSP
PSSP
RWP
ESP
SESP

Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2032 (YEAR 14)

NOTES

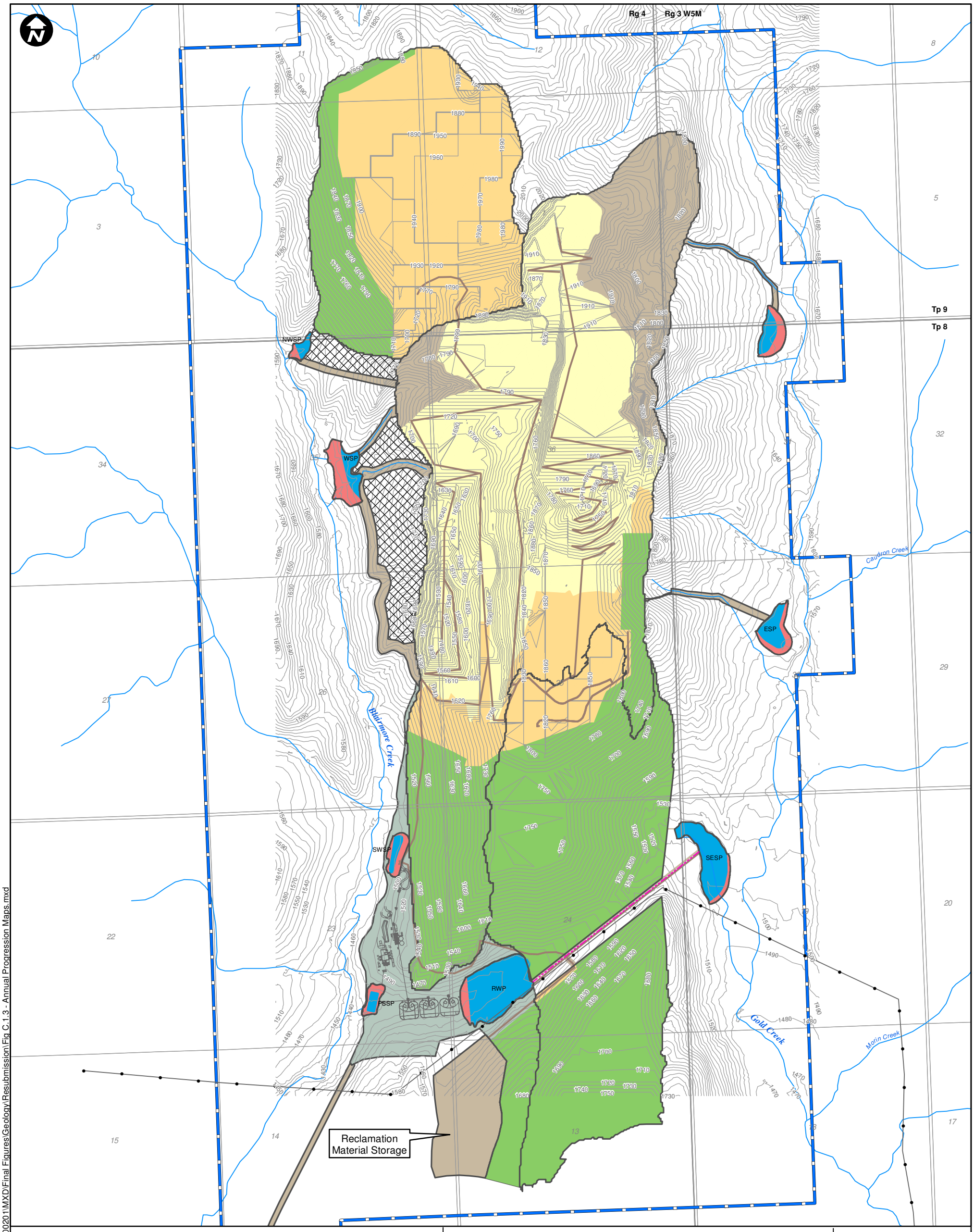
AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-15

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2033 (YEAR 15)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-16

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

NWSP
WSP
ESP
SWSP
SESP
RWP
PSSP

Caudron Creek
Blairmore Creek
Gold Creek
Morin Creek

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2034 (YEAR 16)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-17

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

NWSP
WSP
ESP
SWSP
SESP
RWP
PSSP

Caudron Creek
Blairmore Creek
Gold Creek
Morin Creek

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2035 (YEAR 17)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-18

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
NWSP
WSP
ESP
SWSP
SESP
RWP
PSSP
Reclamation Material Storage
Caudron Creek
Bluemore Creek
Gold Creek
Marin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2036 (YEAR 18)

NOTES

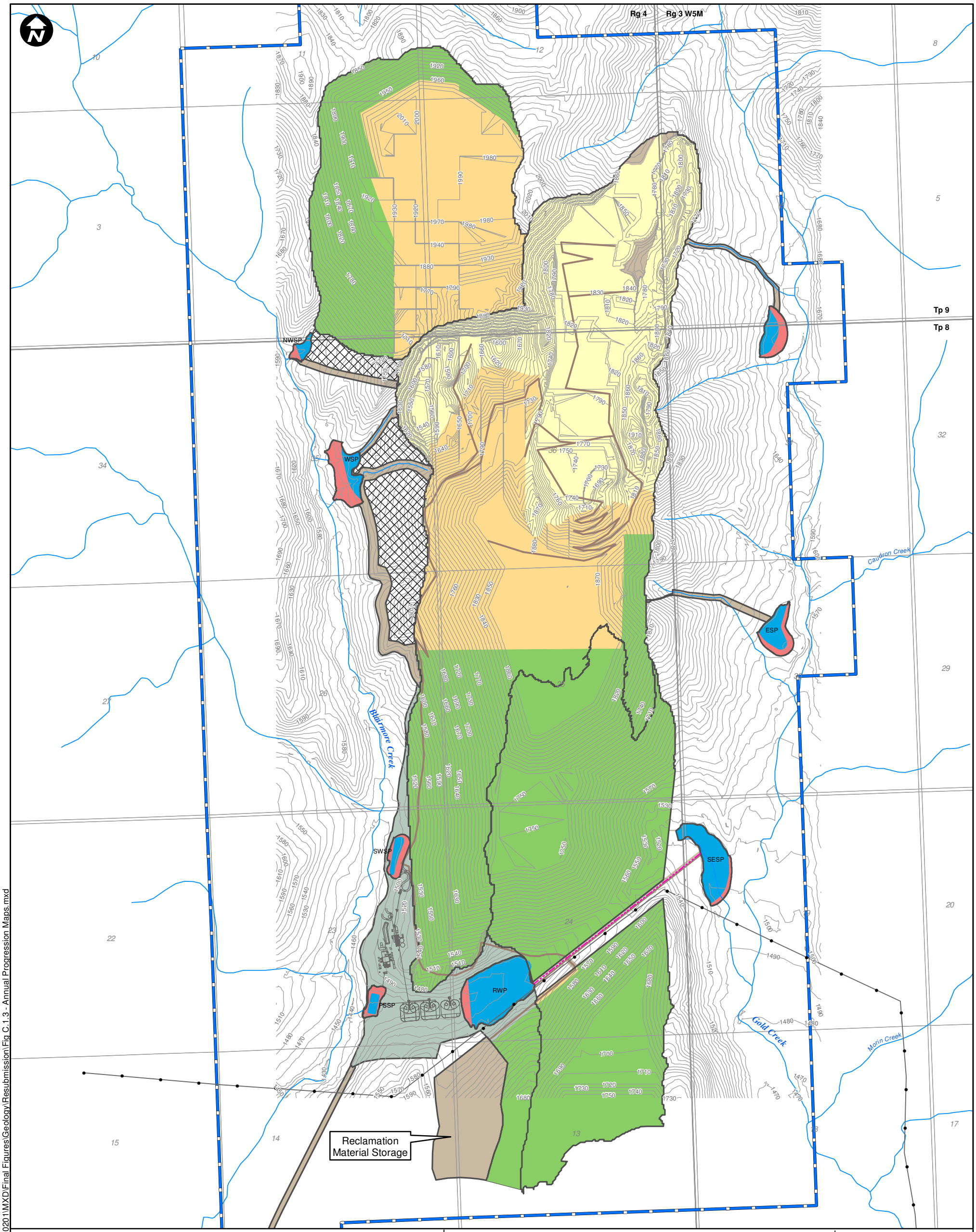
AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-19

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2037 (YEAR 19)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-20

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4 Rg 3 W5M

Tp 9
Tp 8

NWSP
WSP
SWSP
ESP
SESP
RWP
PSSP

Caudron Creek
Blairmore Creek
Gold Creek
Morin Creek

Reclamation Material Storage

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2038 (YEAR 20)

NOTES

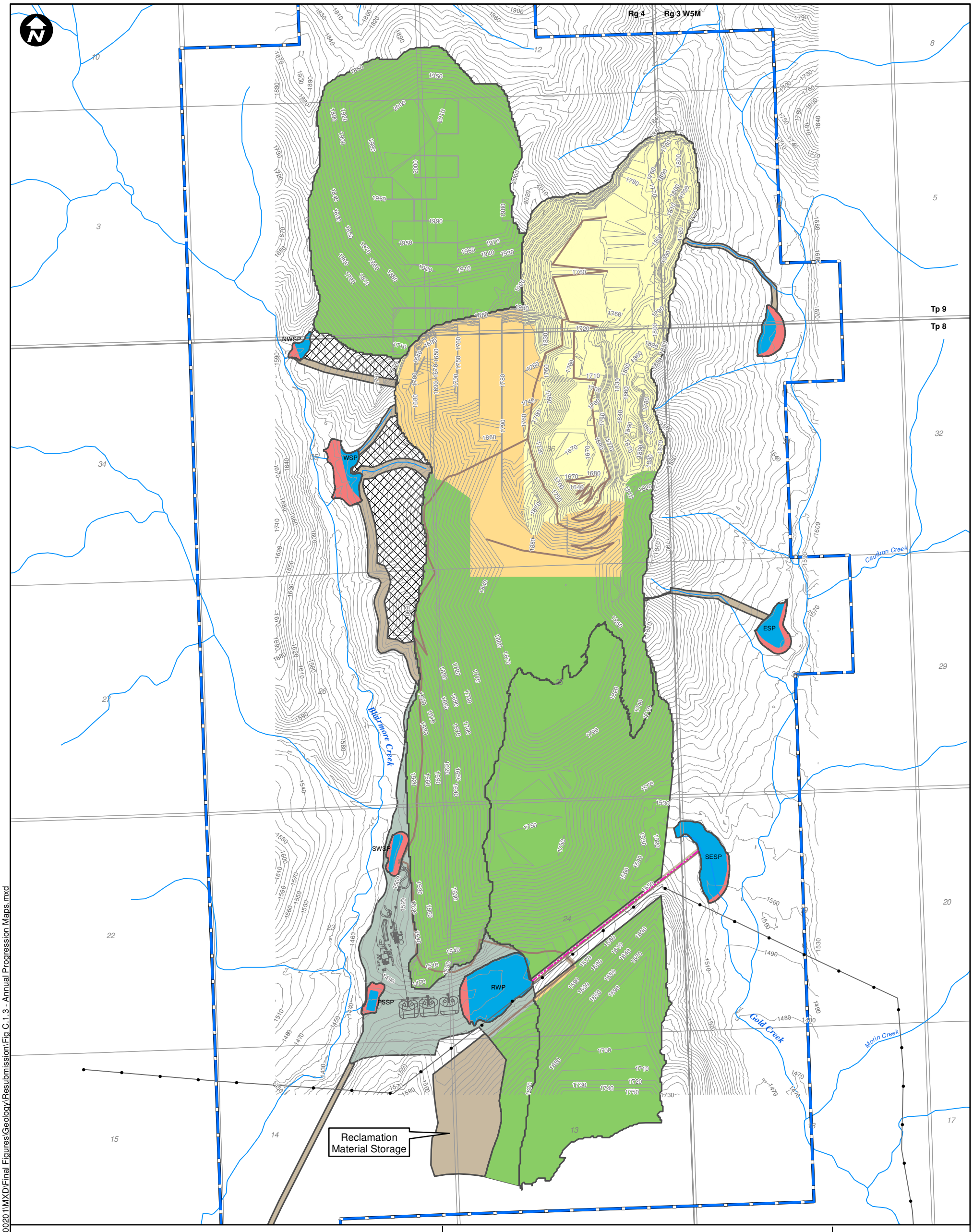
AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-21

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2039 (YEAR 21)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE

C.1.3-22

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
NWSP
WSP
ESP
SWSP
SESP
RWP
PSSP
Reclamation Material Storage
Bituminous Creek
Caudron Creek
Gold Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2040 (YEAR 22)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-23

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
NWSP
WSP
SWSP
PSSP
RWP
SESP
ESP
Reclamation Material Storage
Caudron Creek
Gold Creek
Marin Creek
Blairmore Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2041 (YEAR 23)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-24

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
NWSP
WSP
SWSP
PSSP
RWP
ESP
SESP
Reclamation Material Storage
Bluemore Creek
Caudron Creek
Gold Creek
Morin Creek

LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2042 (YEAR 24)

NOTES

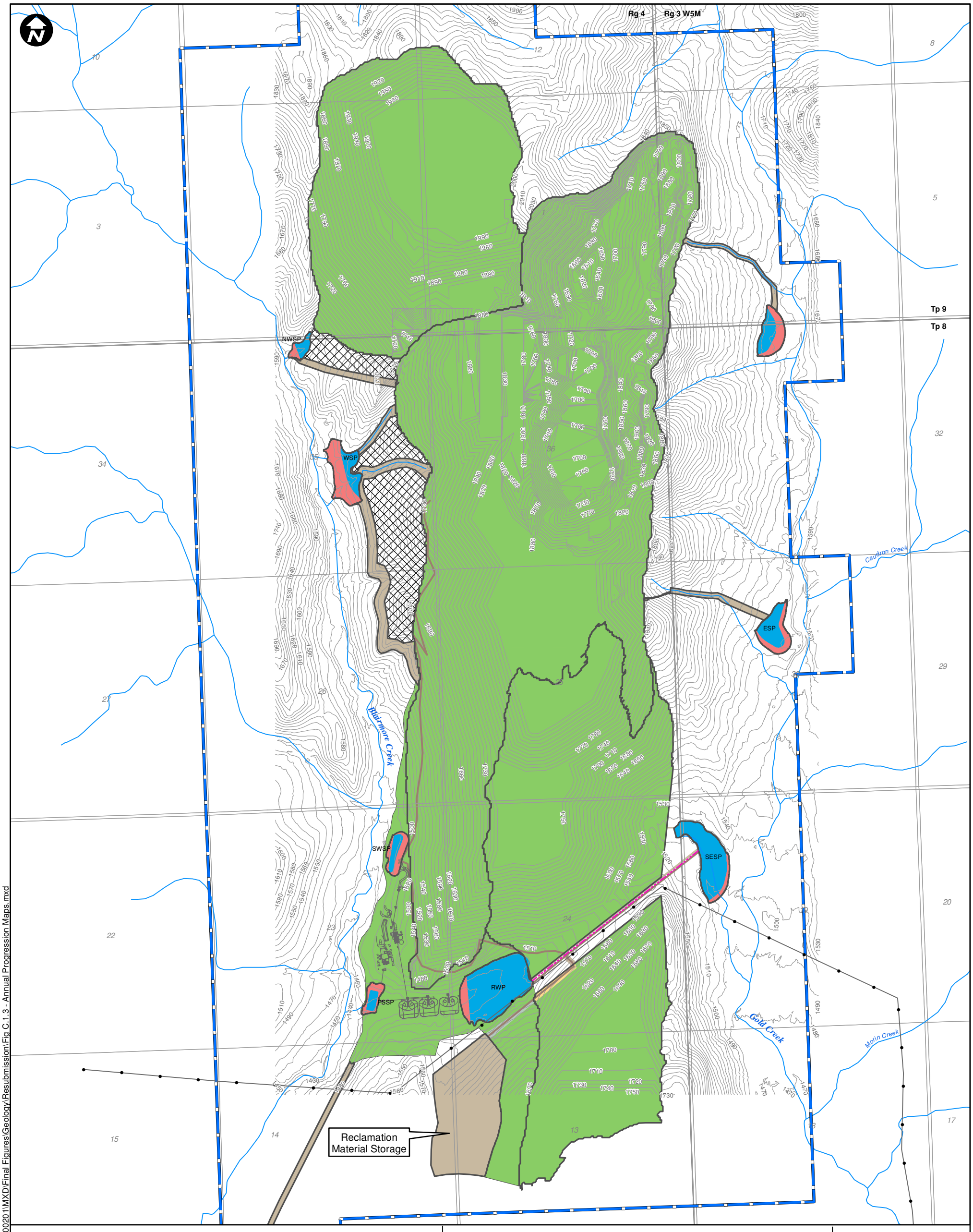
AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

0 0.5 1 2
Kilometres

FIGURE
C.1.3-25

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd



LEGEND

- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Haul Road
- Surface Water Drainage
- Surface Contour (10m Interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Coal Handling Processing Plant and Infrastructure
- Undisturbed Area
- Reclamation Area
- Active Mining Area
- Rock Disposal Area
- Disturbed Area
- Pond
- Dam

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ANNUAL PROGRESSION MAP - EOY 2043 (YEAR 25)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JULY 15, 2016

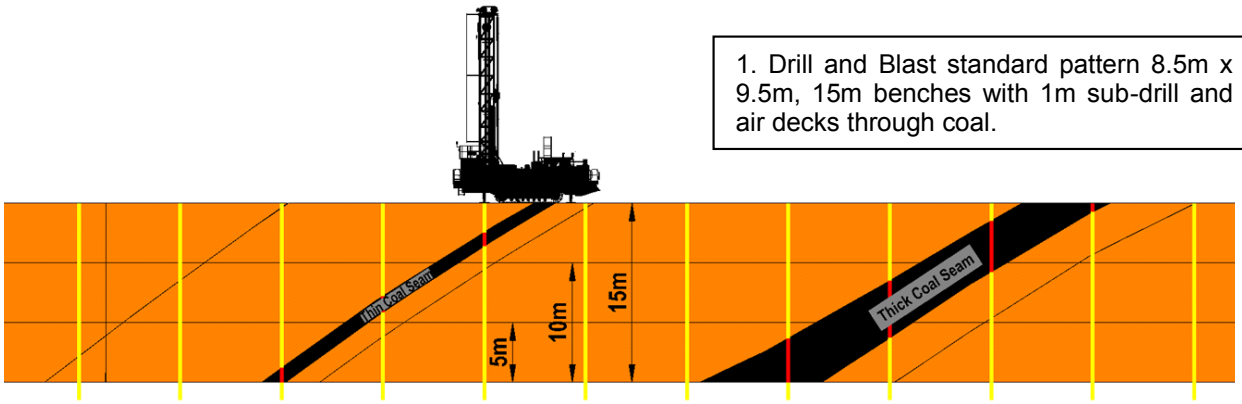
0 0.5 1 2
Kilometres

FIGURE

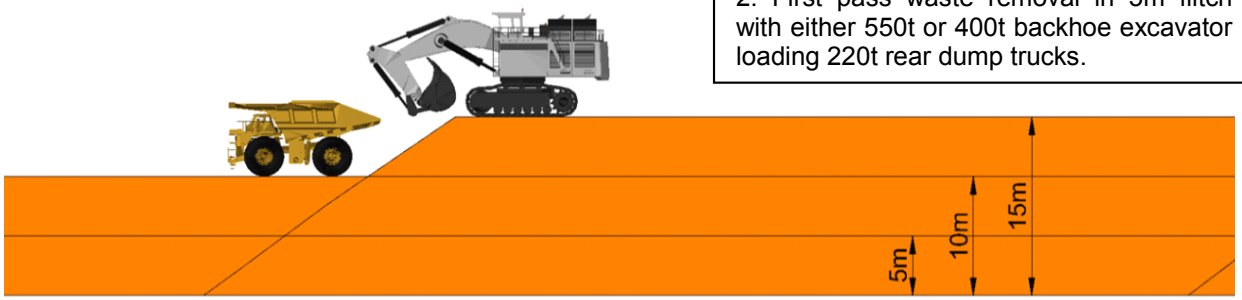
C.1.3-26

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.3 - Annual Progression Maps.mxd

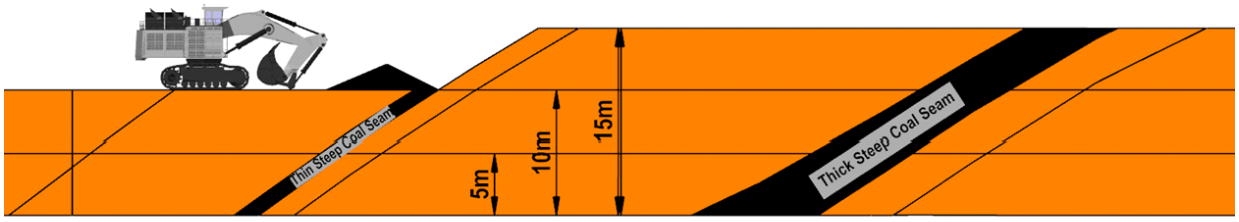
1. Drill and Blast standard pattern 8.5m x 9.5m, 15m benches with 1m sub-drill and air decks through coal.



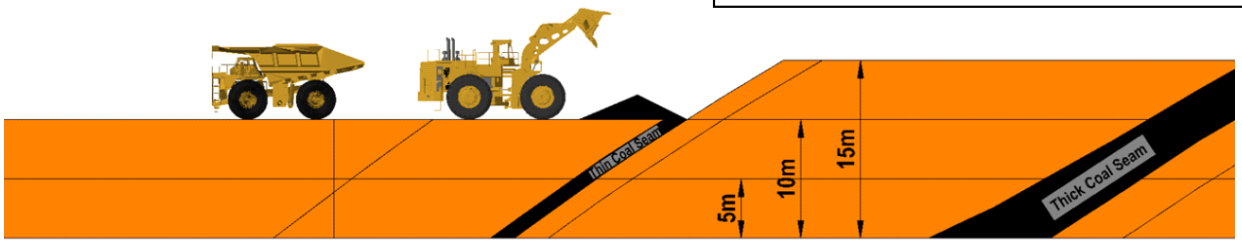
2. First pass waste removal in 5m flitch with either 550t or 400t backhoe excavator loading 220t rear dump trucks.



3. Thin coal seam cleanup and stockpiled with small excavator, no haulage.



4. Stockpiled thin coal loaded by FEL into 220t rear dump trucks with coal bodies.



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

MINING METHODOLOGY - STANDARD 5m LIFT

NOTES

RIVERSDALE, 2016

PROJECT: 14-00201-01

DRAWN BY: CP/SL

CHECKED BY: JM

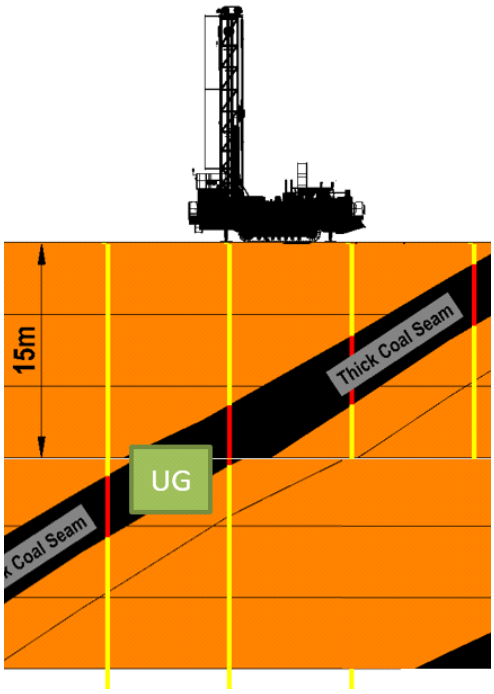
DATE: JUNE 15, 2016

SCALE BAR: N/A

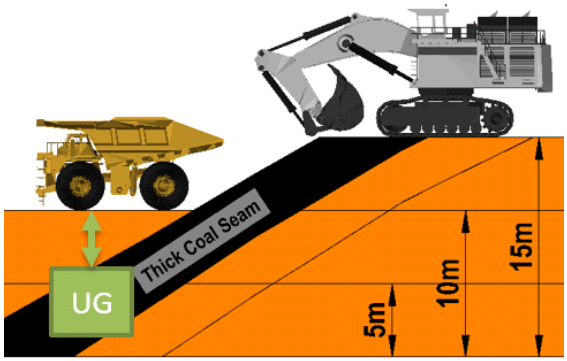
FIGURE

C.1.5-1

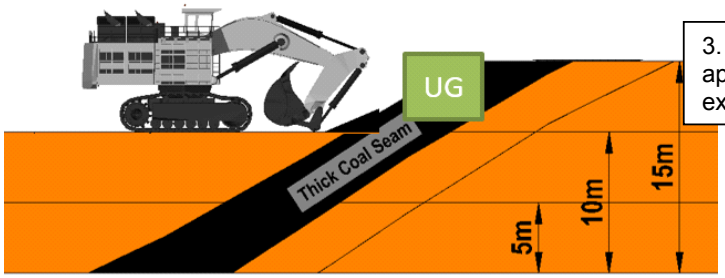
Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.5-1 Mining Methodology - Standard 5m Lift.mxd



1. Preferentially collapse voids with D&B. Extend drilling into lower bench if UG void in top of next bench.



2. Maintain minimum vertical offset to potential void



3. Overhand digging when approaching historic UG workings to expose and collapse

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

UNDERGROUND MINE RECOVERY SCHEMATIC

NOTES

RIVERSDALE, 2016

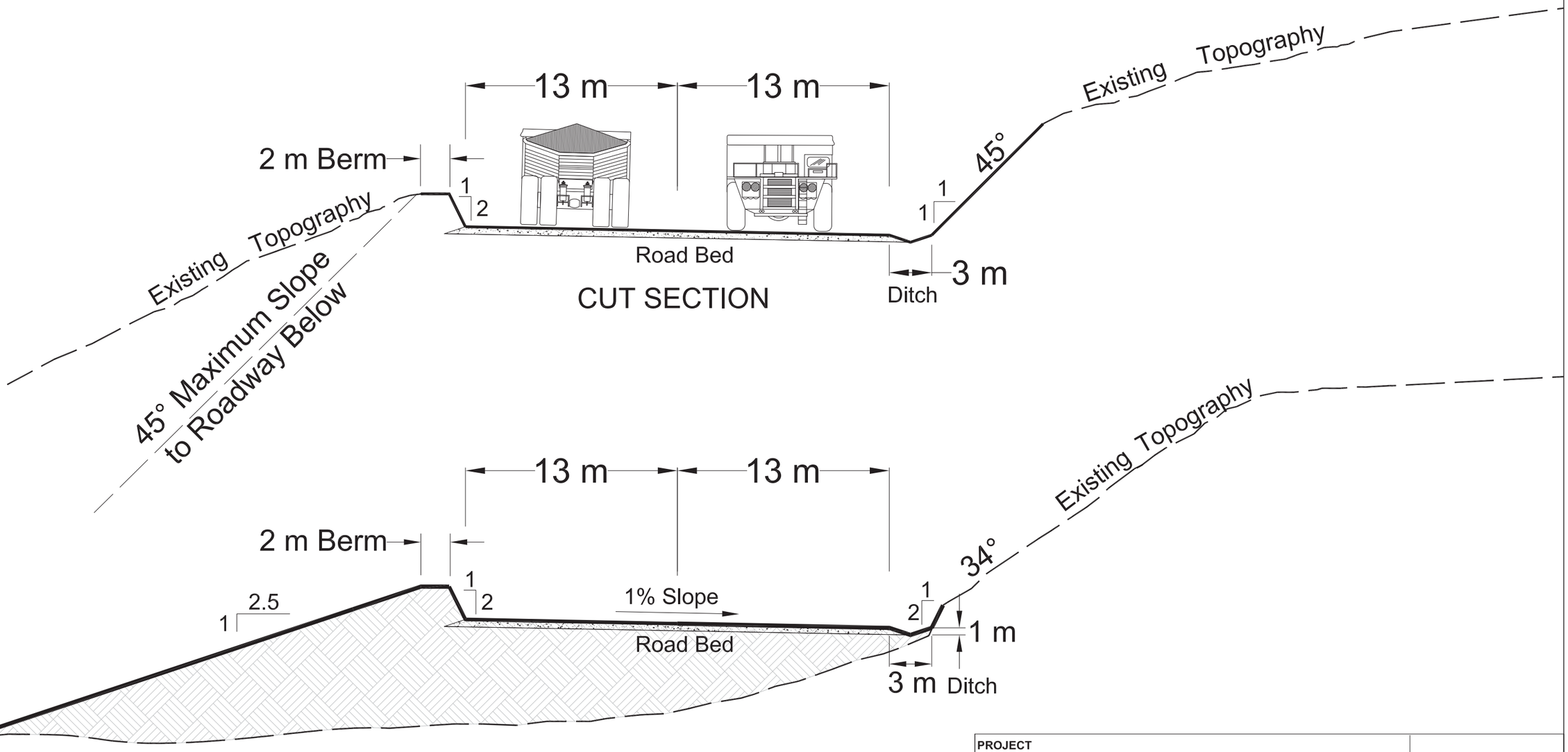
PROJECT: 14-00201-01	
DRAWN BY: CP/SL	
CHECKED BY: JM	
DATE: JUNE 15, 2016	

SCALE BAR: N/A

FIGURE

C.1.5-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.1.5-2 Underground Mine Recovery Schematic.mxd



PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

Golder Associates

TITLE

TYPICAL HAUL ROAD CROSS SECTION

NOTES

1.) Haul road design reflects primary roads designed for two-way traffic flow and largest truck size.

PROJECT:	1406422
DRAWN BY:	WJS
CHECKED BY:	CH
DATE:	OCTOBER 15, 2015

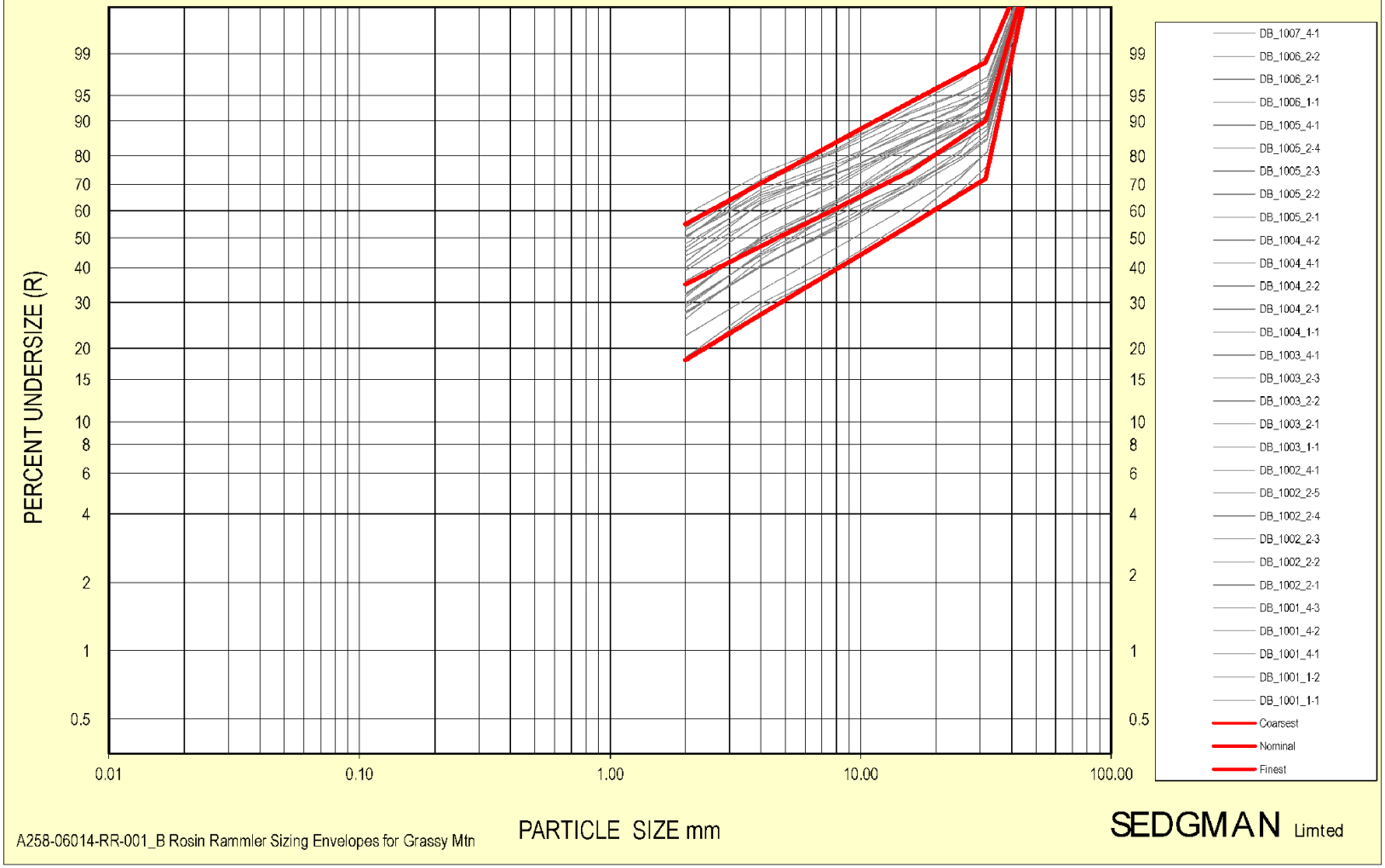
0 5 10 20
Metres

FIGURE

C.1.7-1

A258- Grassy Mountain

Plant Feed Sizing (50 mm Topsize) - Including Dilution



A258-06014-RR-001_B Rosin Rammler Sizing Envelopes for Grassy Mtn

SEDGMAN Limted

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.2-1 Plant Feed Sizing Data.mxd

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

PLANT FEED SIZING DATA

NOTES

SEDGMAN, 2015

SCALE BAR: N/A

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201-01

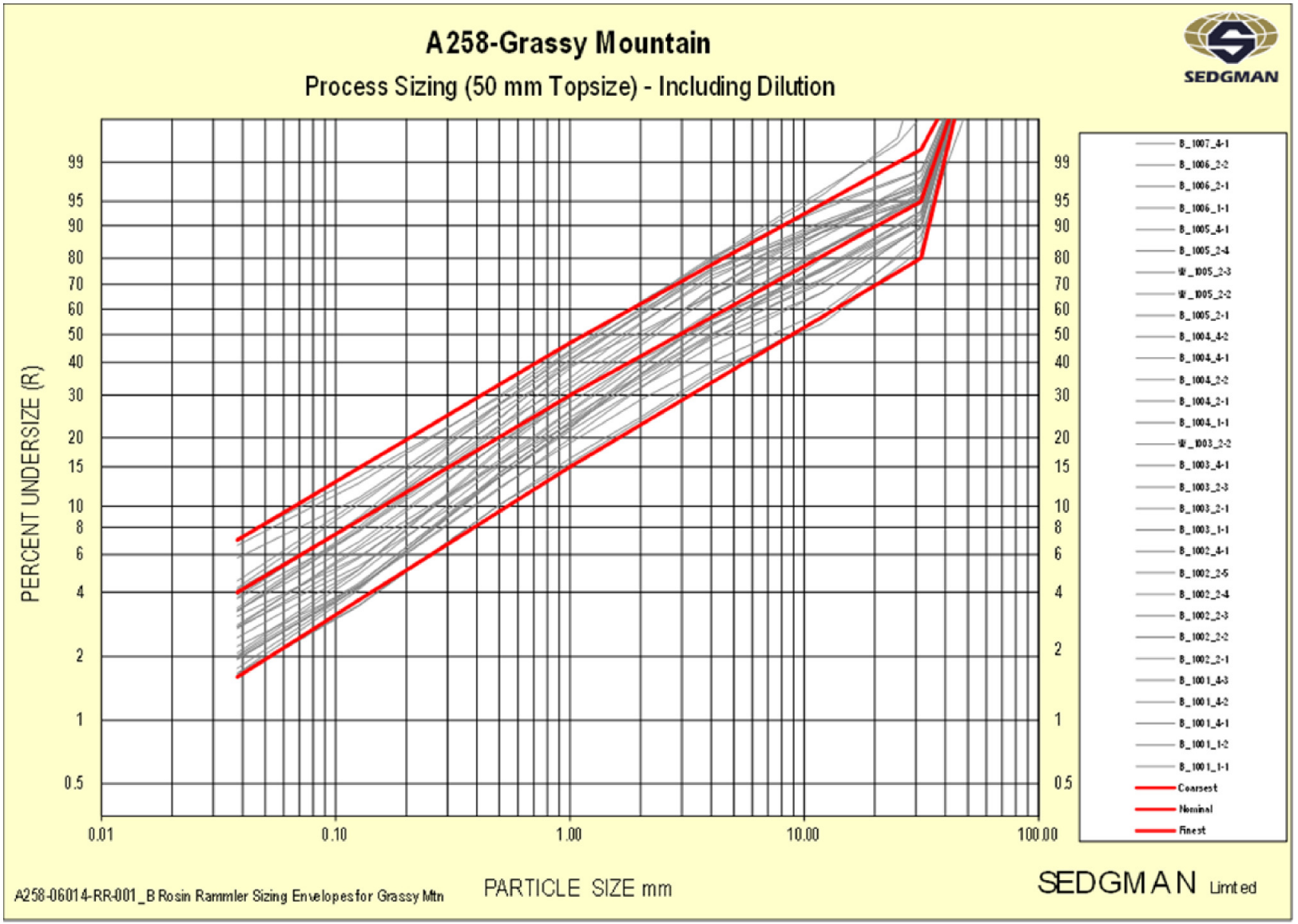
DRAWN BY: CP

CHECKED BY: JM

DATE: OCTOBER 19, 2015

FIGURE

C.2.2-1



Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.2-2 Process Sizing Data.mxd

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

PROCESS SIZING DATA

PROJECT: 14-00201-01

DRAWN BY: CP

CHECKED BY: JM

DATE: OCTOBER 19, 2015

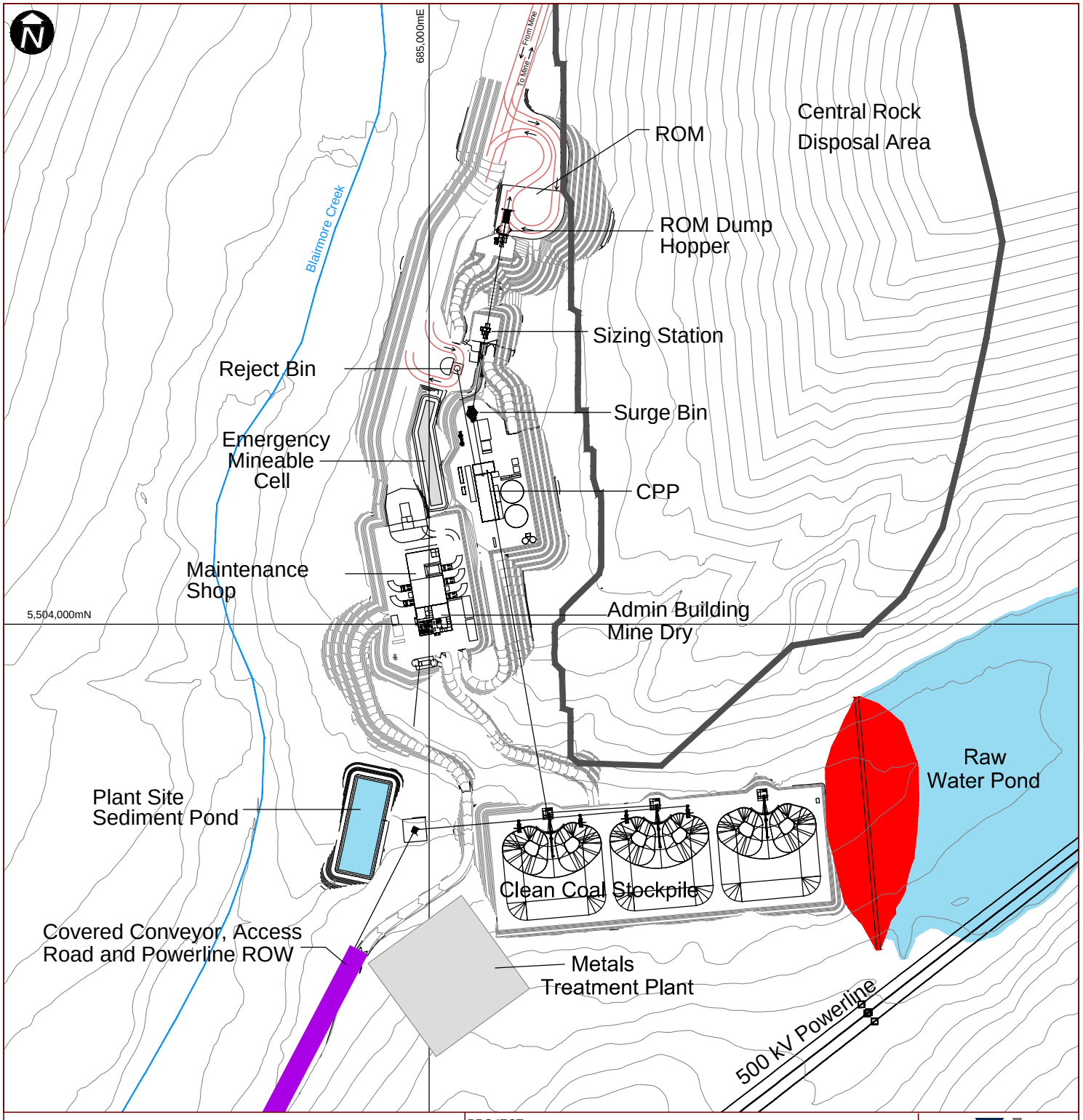
NOTES

SEDGMAN, 2015

SCALE BAR: N/A

FIGURE

C.2.2-2



PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

COAL HANDLING AND PREPARATION PLANT AND MINE INFRASTRUCTURE AREA LAYOUT

NOTES

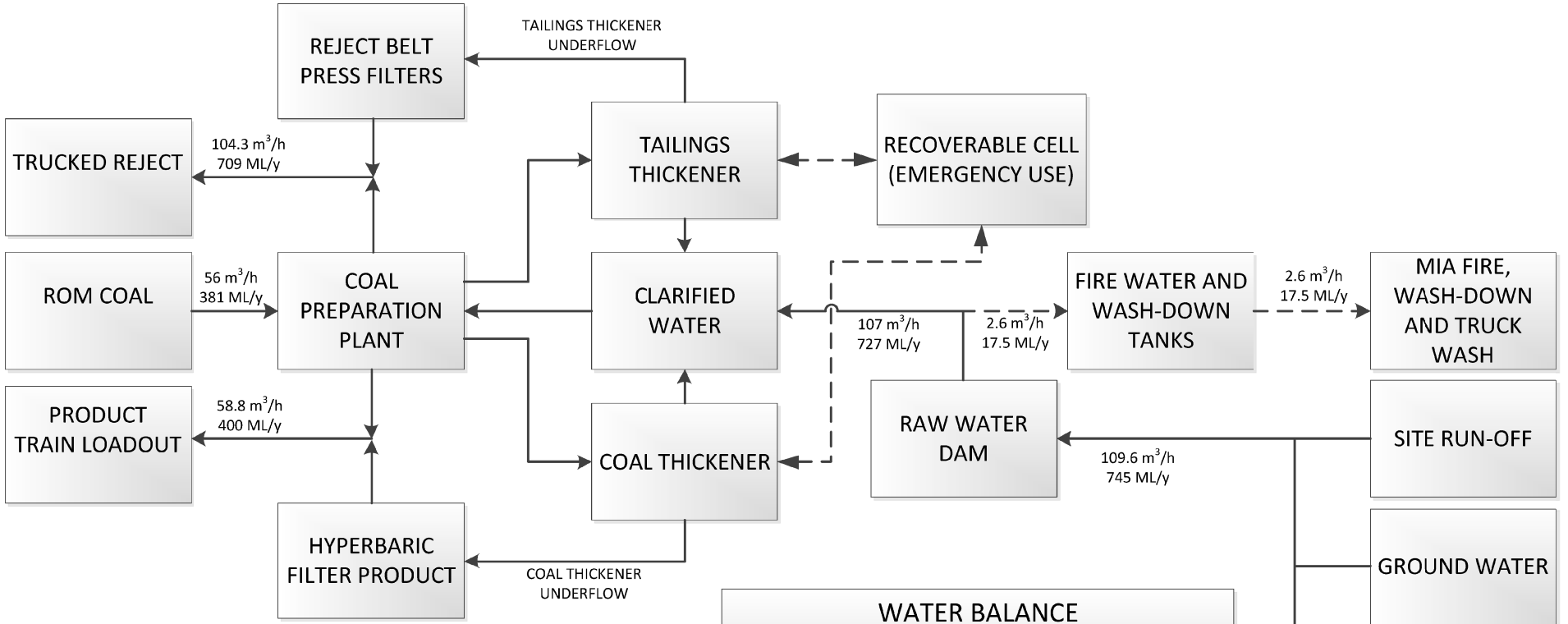
MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: JM/SL
CHECKED BY: DM
DATE: JULY 21, 2016

0 100 200 400
Metres

FIGURE

C.2.4-1



WATER BALANCE			
IN FLOWS		OUT FLOWS	
RAW WATER	109.6 m³/h 745 ML/y	PRODUCT COAL	58.8 m³/h 400 ML/y
PLANT FEED COAL	56 m³/h 381 ML/y	REJECT COAL	104.2 m³/h 708.5 ML/y
		WASHDOWN WATER	2.6 m³/h 17.5 ML/y
TOTAL IN	165.6 m³/h 1126 ML/y	TOTAL OUT	165.6 m³/h 1126 ML/y

LEGEND
Constant Flow
Intermittent Flow

PROJECT
RIVERSDALE RESOURCES
GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE
PLANT WATER BALANCE

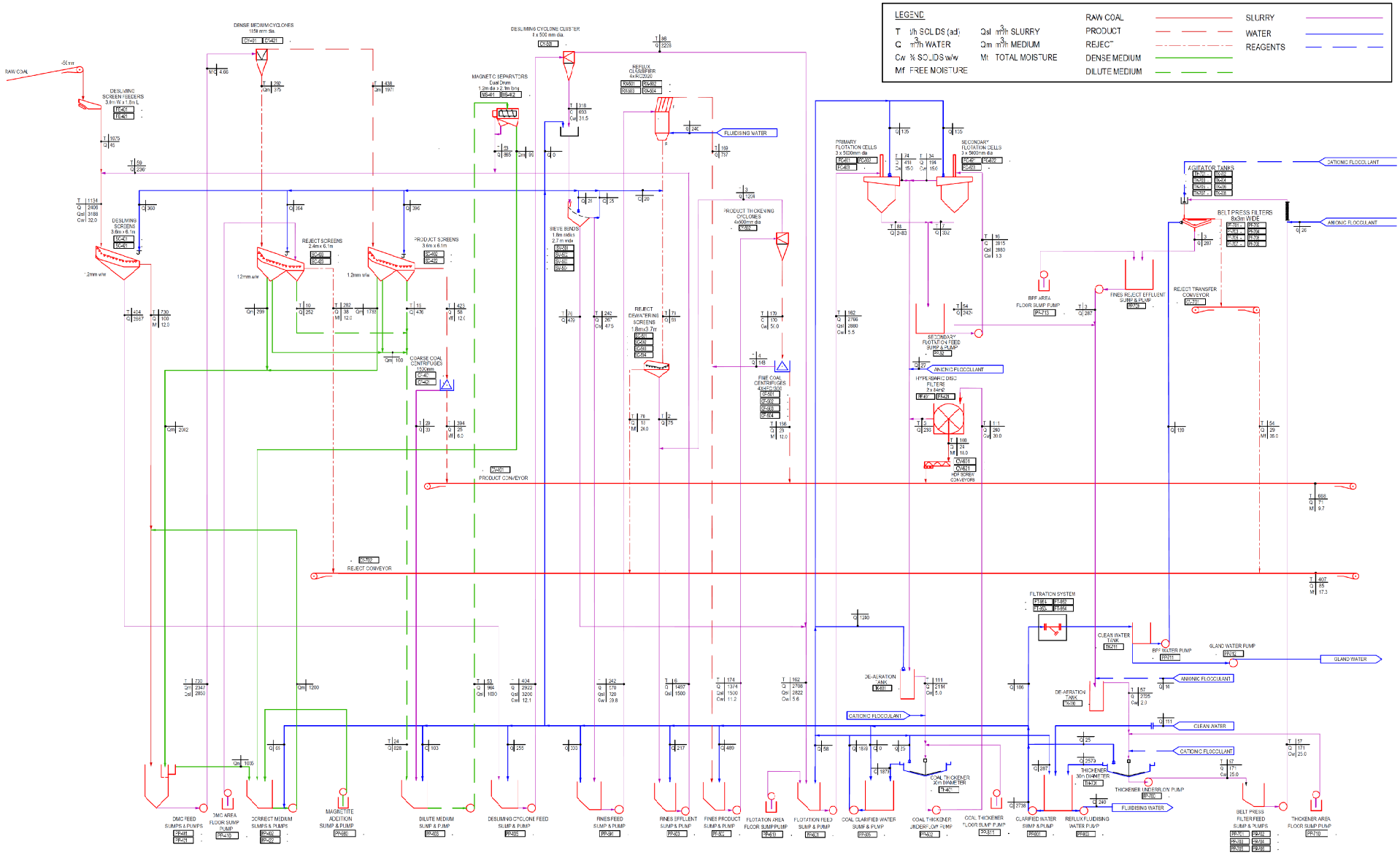
PROJECT: 14-00201-01
DRAWN BY: CP
CHECKED BY: JM
DATE: OCTOBER 06, 2015

NOTES
Sedgman, 2015

SCALE: N/A

FIGURE
C.2.5-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.5.1 Plant Water Balance.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

OVERALL CHPP MATERIAL BALANCE

NOTES

SEDGMAN, 2016

SCALE: N/A

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201-01

DRAWN BY: SL

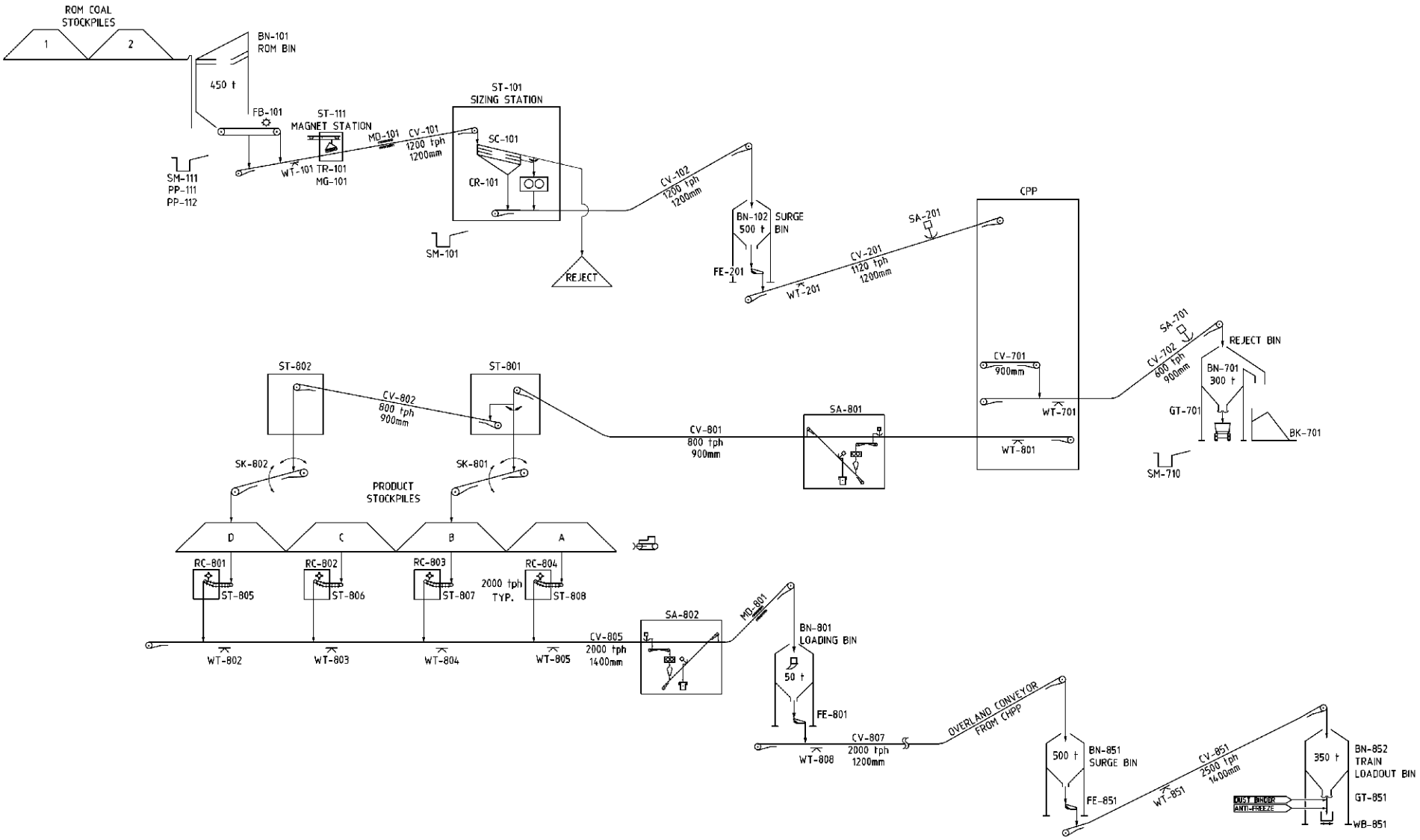
CHECKED BY: JM

DATE: JULY 19, 2016

FIGURE

C.2.5-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.5-2 CHPP Material Balance.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

OVERALL MATERIAL FLOWSHEET

NOTES

Sedgman, 2016

SCALE: N/A

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201-01

DRAWN BY: MGM/SL

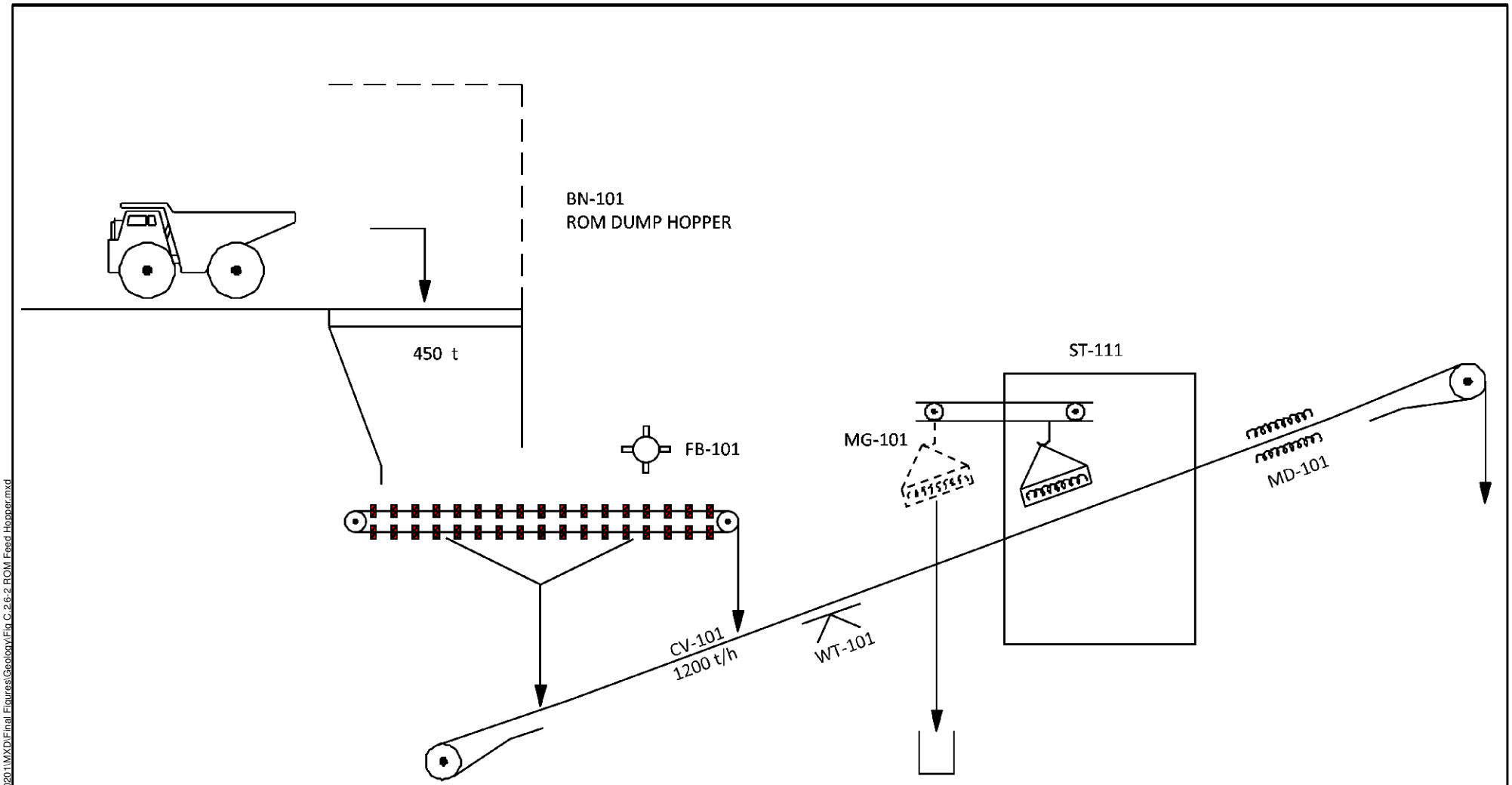
CHECKED BY: JM

DATE: JUNE 15, 2016

FIGURE

C.2.6-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-1 Overall Material Flowsheet.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ROM FEED HOPPER

PROJECT: 14-00201-01

DRAWN BY: JL

CHECKED BY: JM

DATE: SEPTEMBER 21, 2015

NOTES

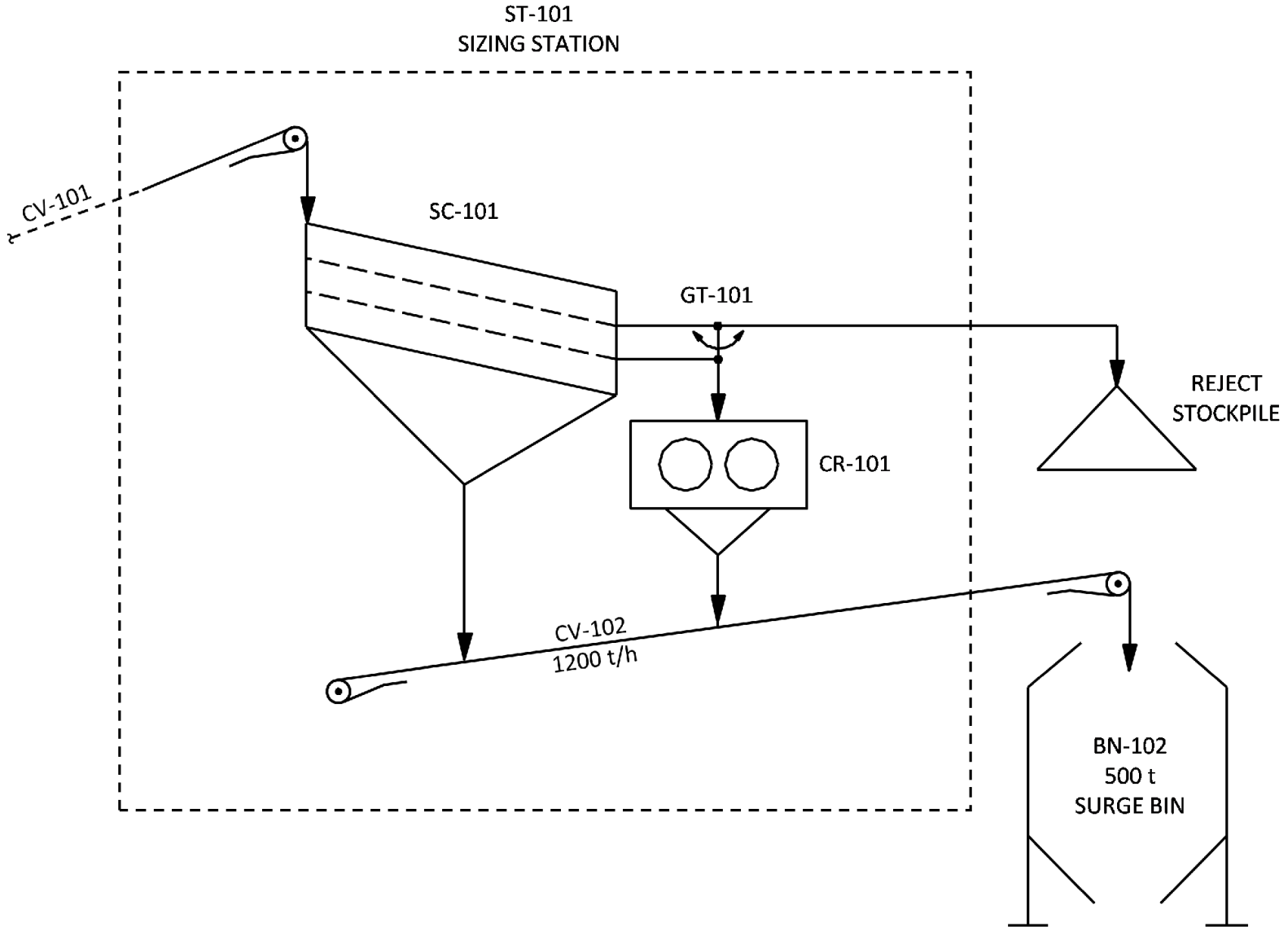
MEMS, 2015

SCALE BAR: N/A

FIGURE

C.2.6-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.6-2 ROM Feed Hopper.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RAW COAL SIZING STATION

PROJECT: 14-00201-01

DRAWN BY: JL

CHECKED BY: JM

DATE: SEPTEMBER 21, 2015

NOTES

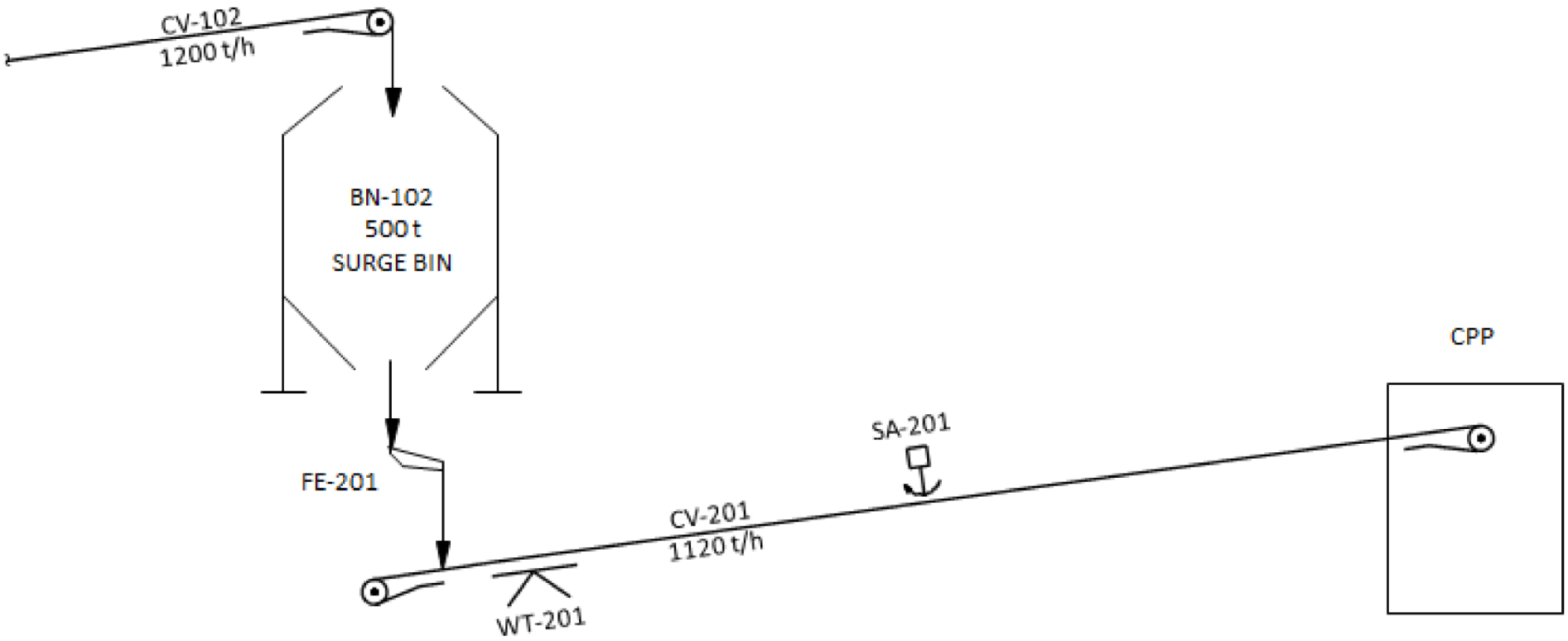
MEMS, 2015

SCALE BAR: N/A

FIGURE

C.2.6-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.6-3 Raw Coal Sizing Station.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

CPP FEED FLOWSHEET

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

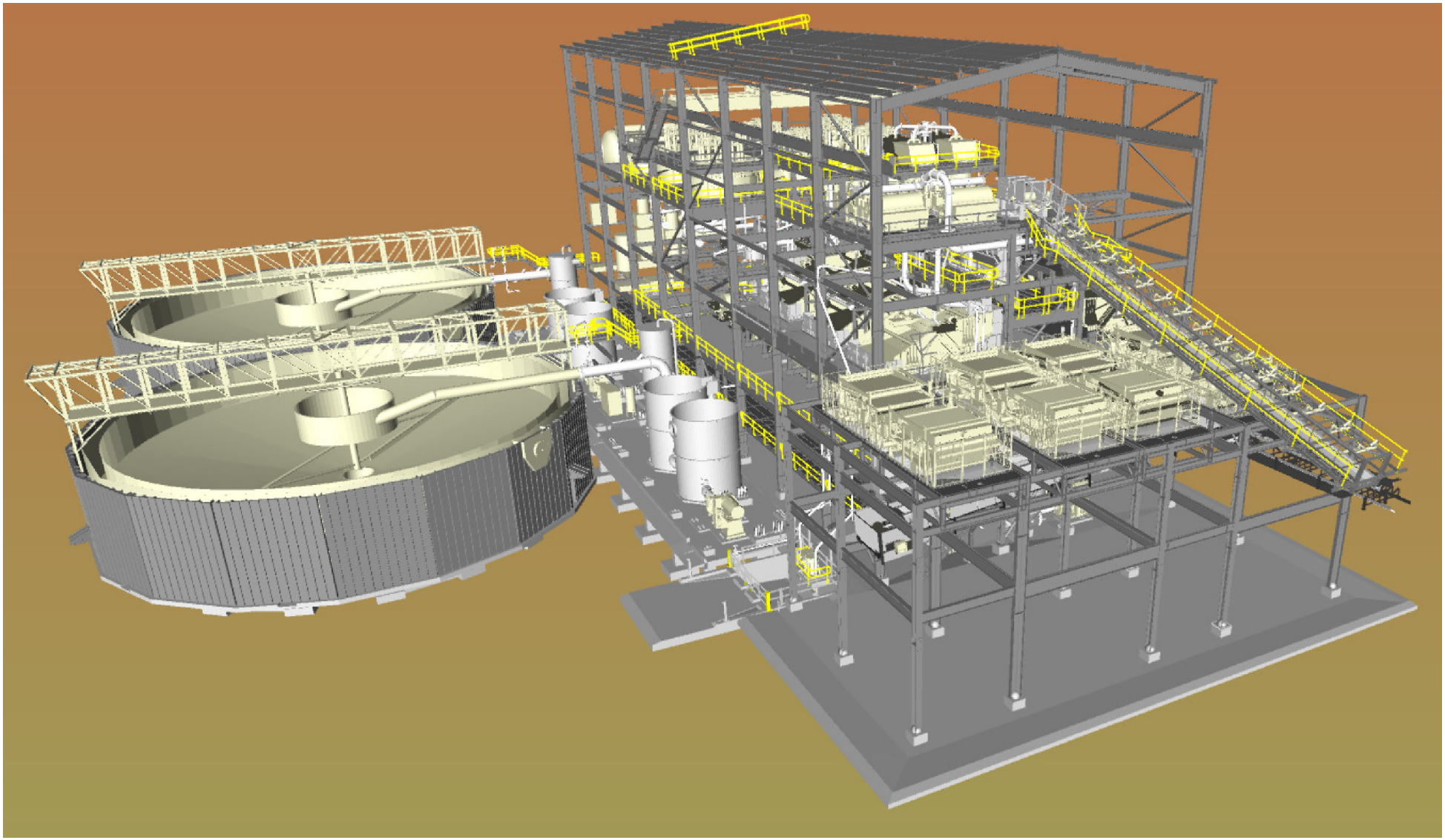
RIVERSDALE, 2015

SCALE BAR: N/A

FIGURE

C.2.6-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-4 CPP Feed Flowsheet.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

CPP BUILDING - GENERAL ARRANGEMENT

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

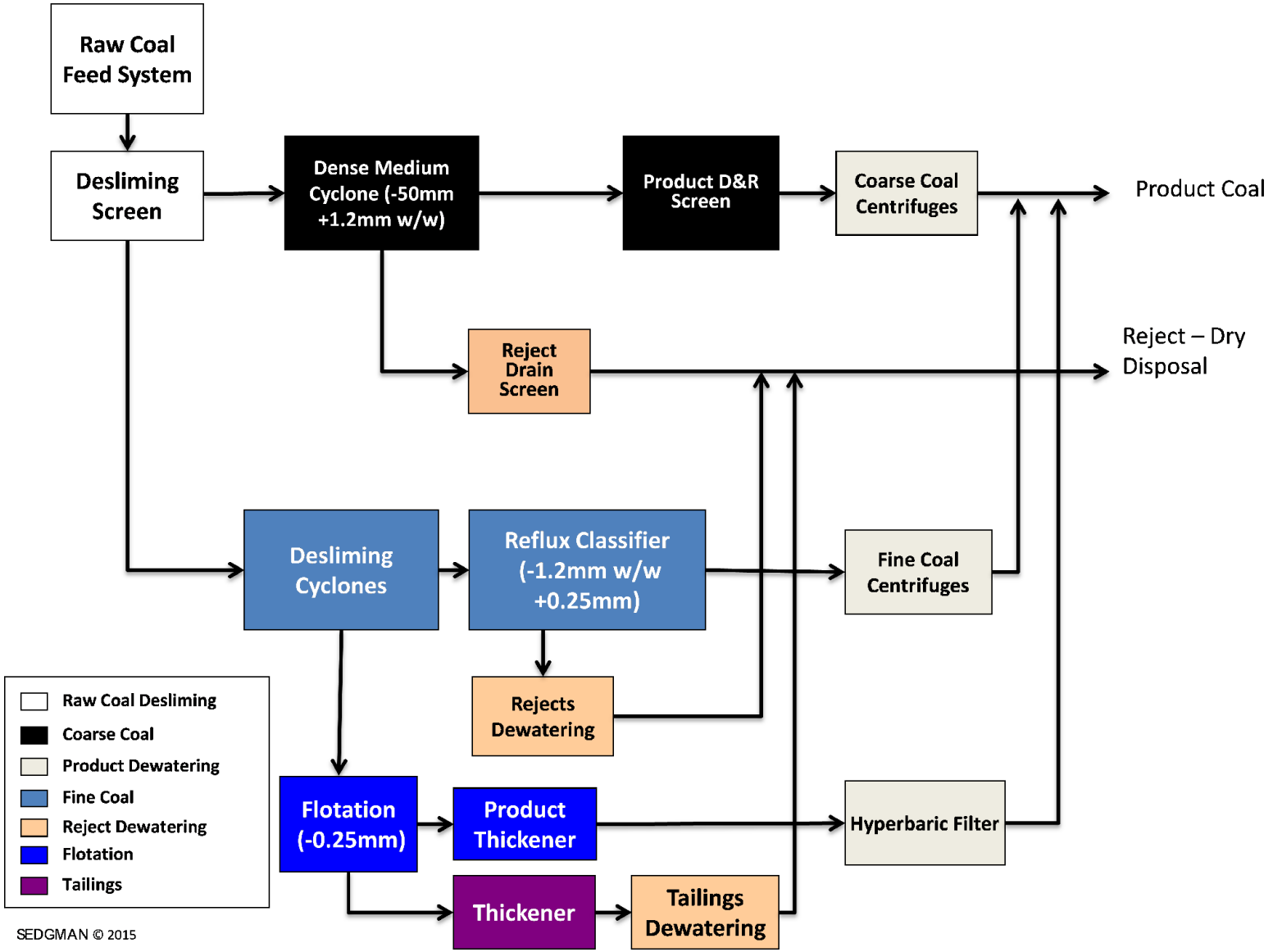
RIVERSDALE, 2015

SCALE BAR: N/A

FIGURE

C.2.6-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-5 CPP Building.mxd



Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-6 CPP Basic Flowsheet.mxd

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

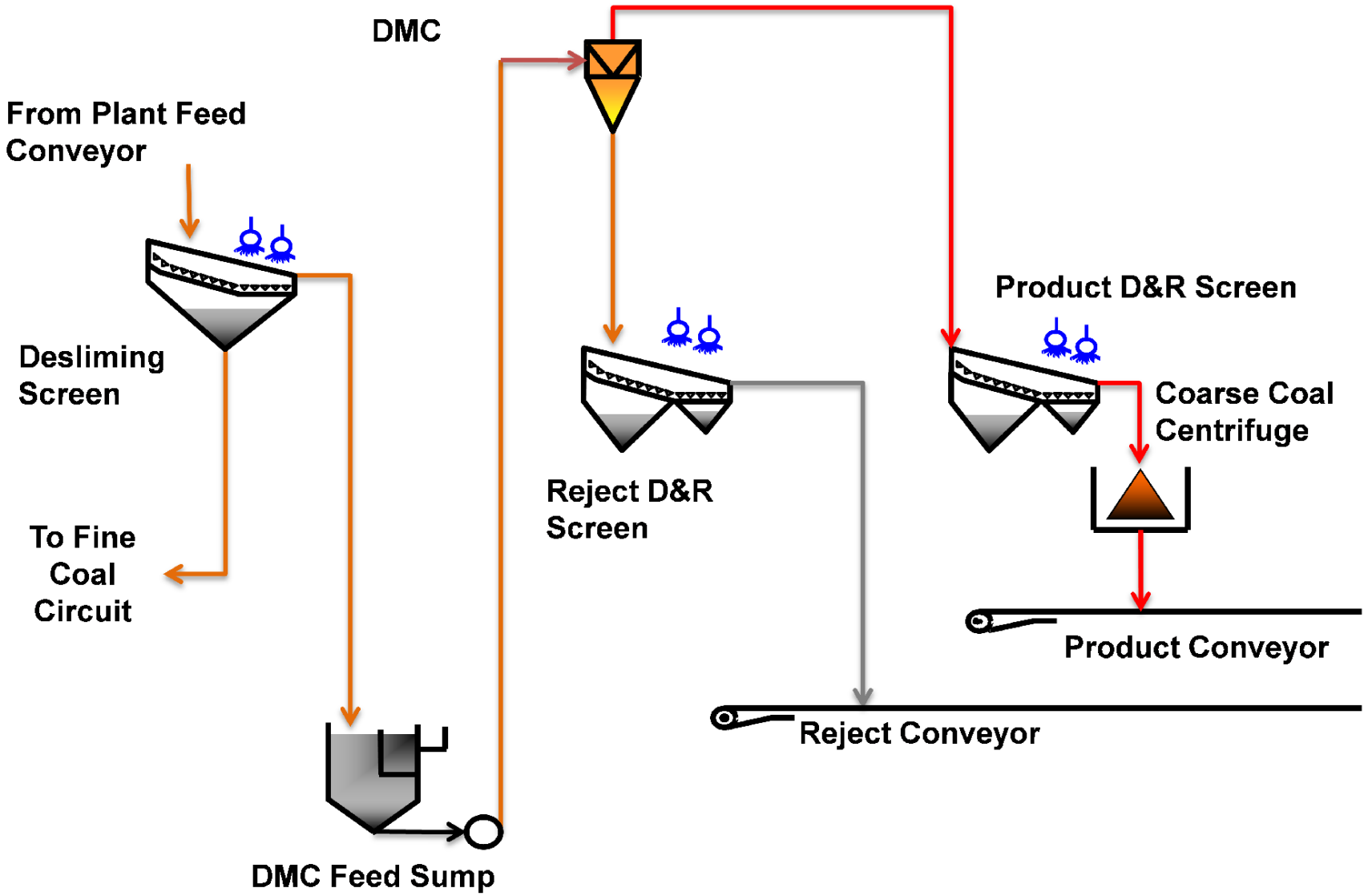
CPP BASIC FLOWSHEET

NOTES
MEMS, 2015

SCALE BAR: N/A

PROJECT: 14-00201-01
DRAWN BY: JL
CHECKED BY: JM
DATE: SEPTEMBER 21, 2015

FIGURE
C.2.6-6



SEDGMAN © 2013

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

COARSE COAL CIRCUIT FLOWSHEET

PROJECT: 14-00201-01

DRAWN BY: JL

CHECKED BY: JM

DATE: SEPTEMBER 21, 2015

NOTES

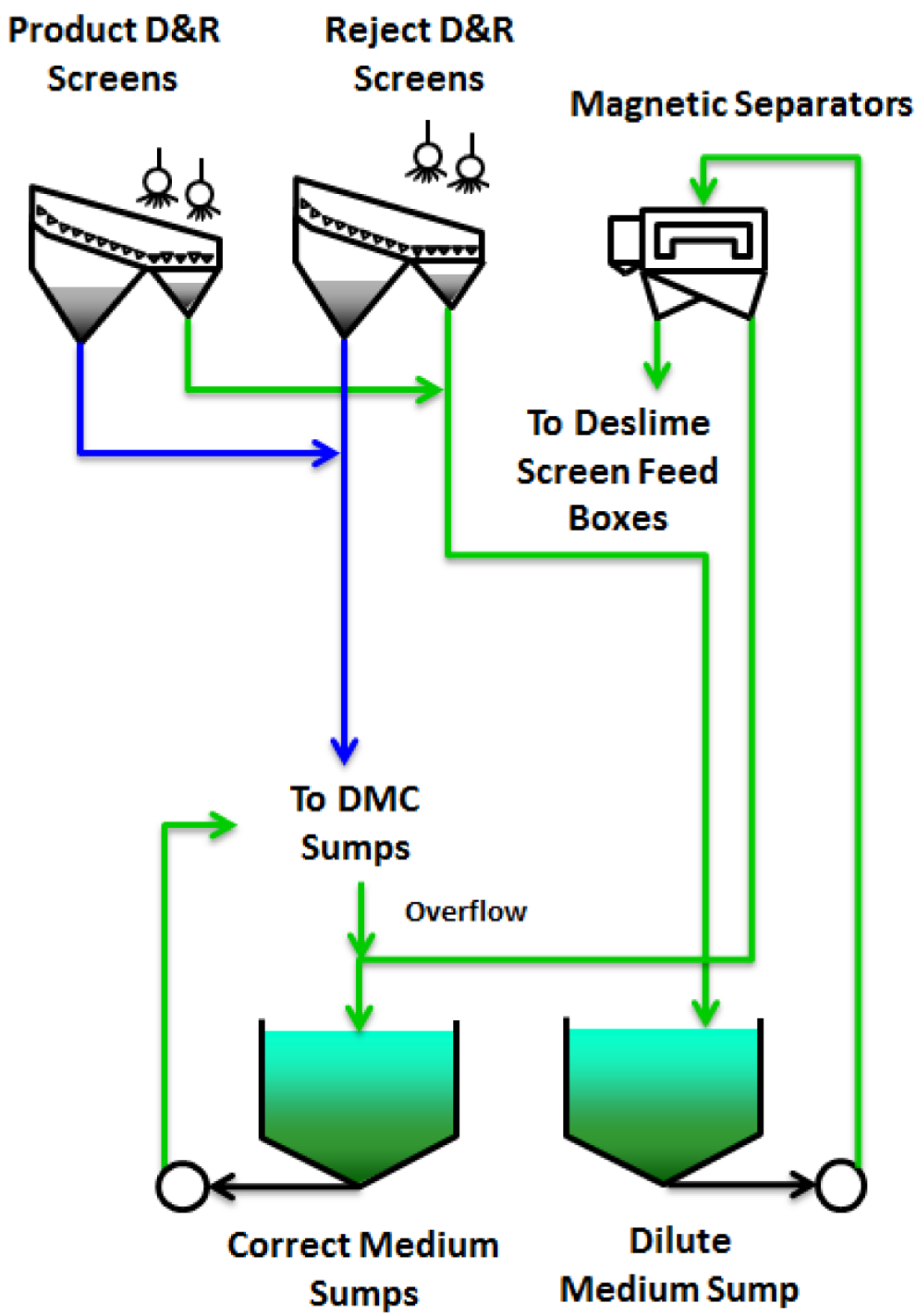
MEMS, 2015

SCALE BAR: N/A

FIGURE

C.2.6-7

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-7 Coarse Coal Circuit Flowsheet.mxd



SEDGMAN © 2013

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

MAGNETITE CONTROL AND RECOVERY CIRCUIT

NOTES

SEDGMAN, 2013

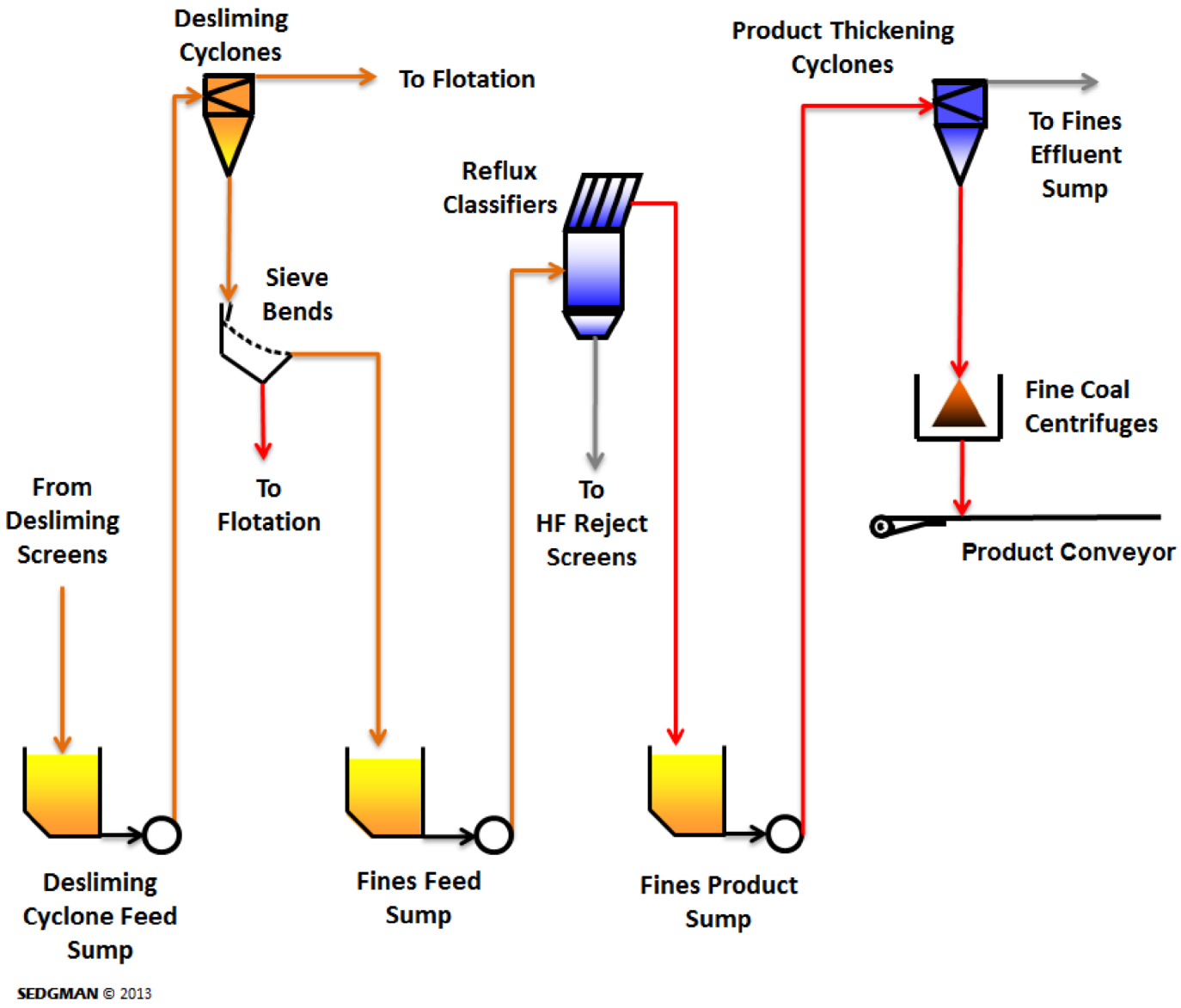
PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	JM
DATE:	JUNE 15, 2016

SCALE BAR: N/A

FIGURE

C.2.6-8

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-8 Magnetite Control and Recovery Circuit.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

FINE COAL CIRCUIT FLOWSHEET

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

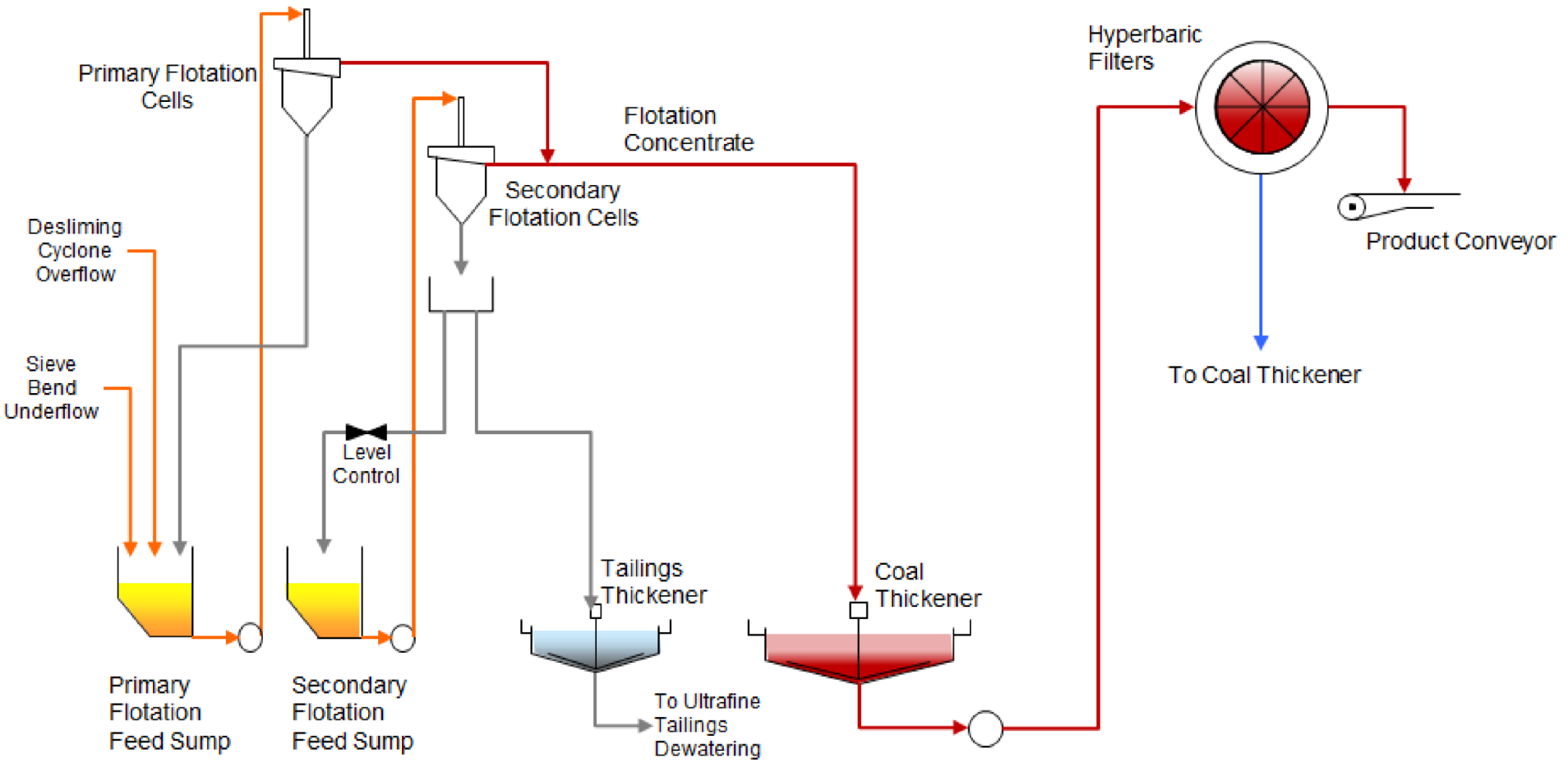
SEDGMAN, 2013

SCALE BAR: N/A

FIGURE

C.2.6-9

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-9 Fine Coal Circuit Flowsheet.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

FLOTATION CIRCUIT

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

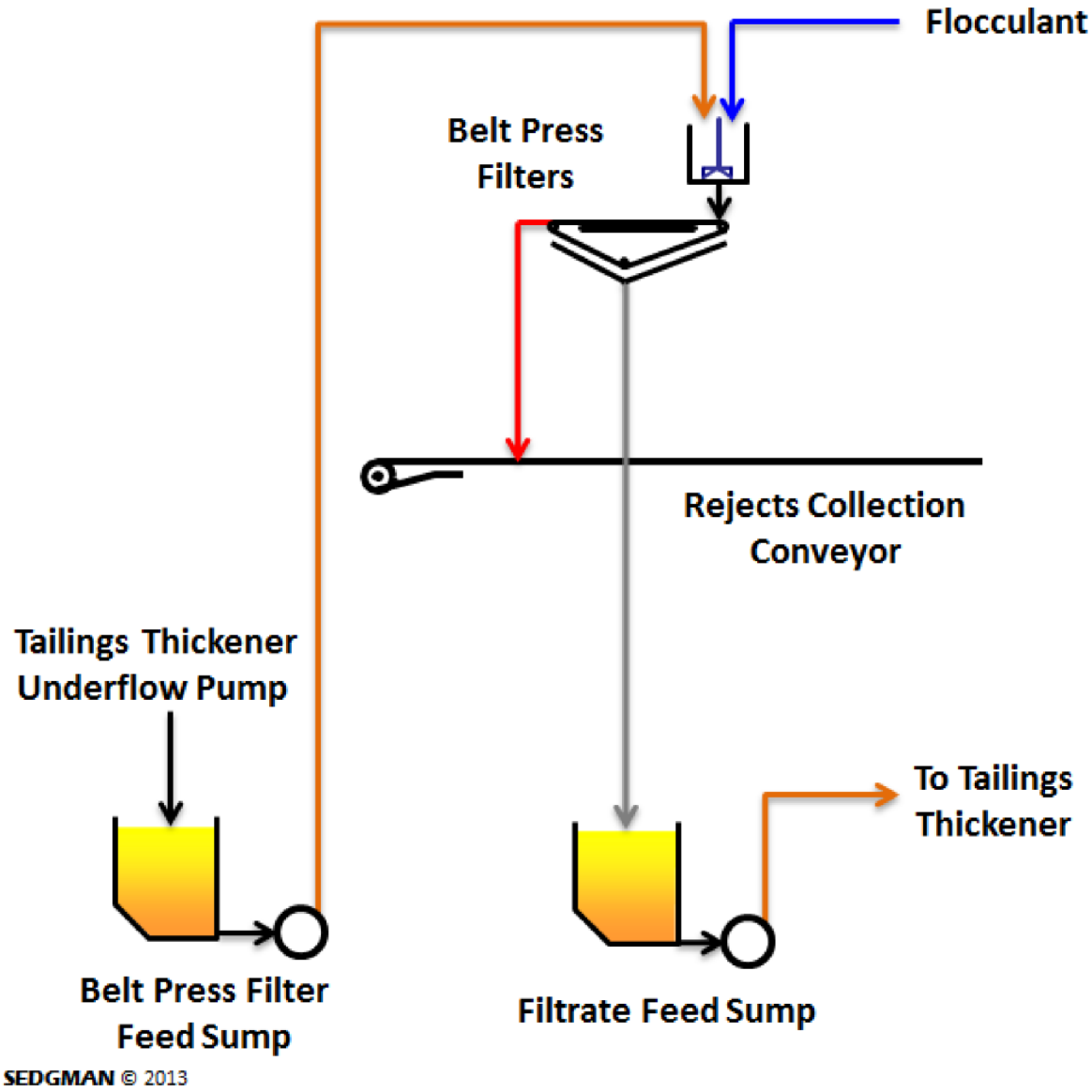
SEDGMAN, 2014

SCALE BAR: N/A

FIGURE

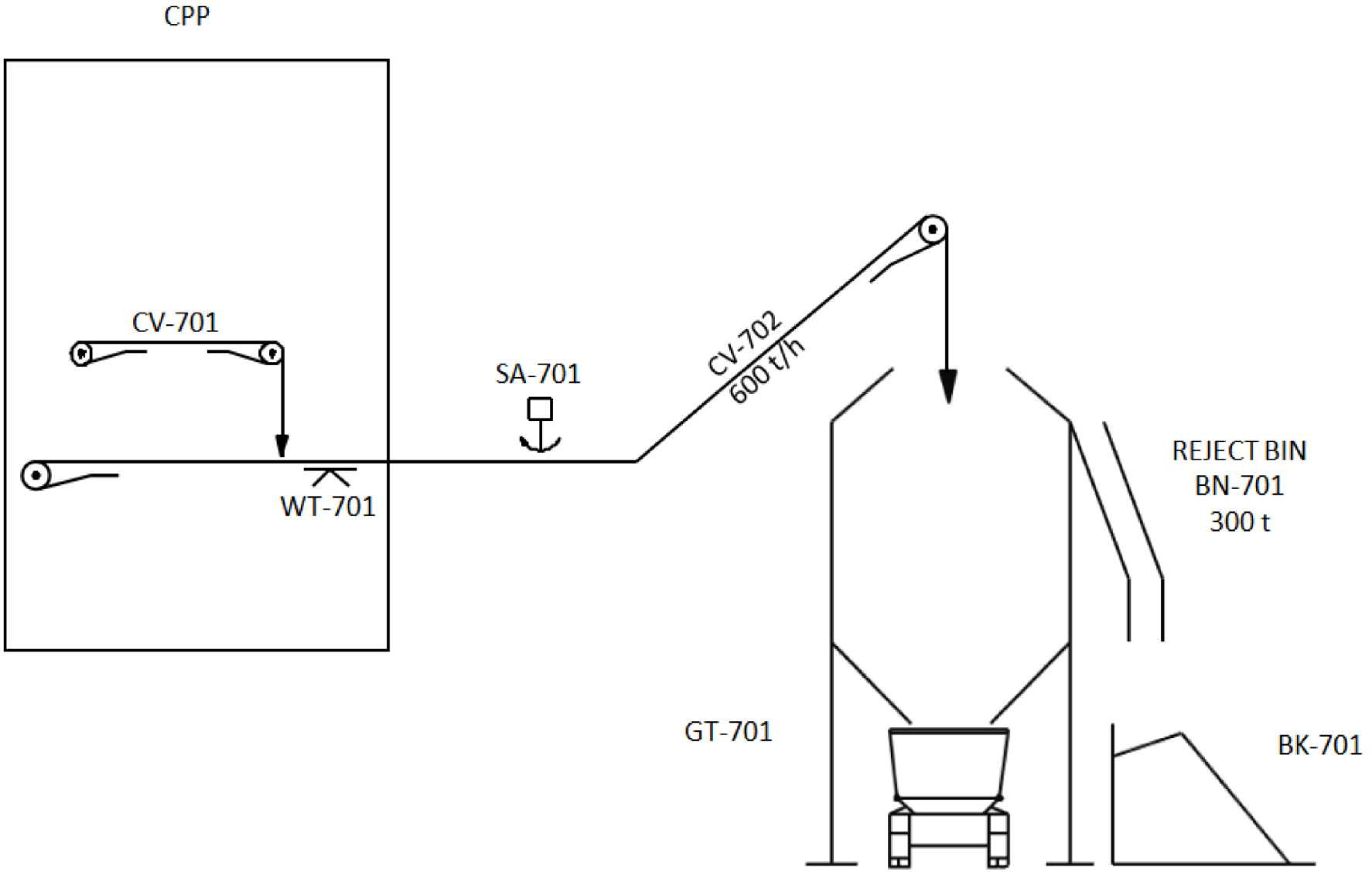
C.2.6-10

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-10 Flotation Circuit.mxd



LEGEND: N/A	PROJECT: RIVERSDALE RESOURCES — GRASSY MOUNTAIN COAL PROJECT	MILLENNIUM EMS Solutions Ltd.
	TITLE: REJECTS DEWATERING CIRCUIT	PROJECT: 14-00201-01 DRAWN BY: SL CHECKED BY: JM DATE: JUNE 15, 2016
	NOTES: SEDGMAN, 2013	SCALE BAR: N/A
		FIGURE: C.2.6-11

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-11 Rejects Dewatering Circuit.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

REJECTS HANDLING

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

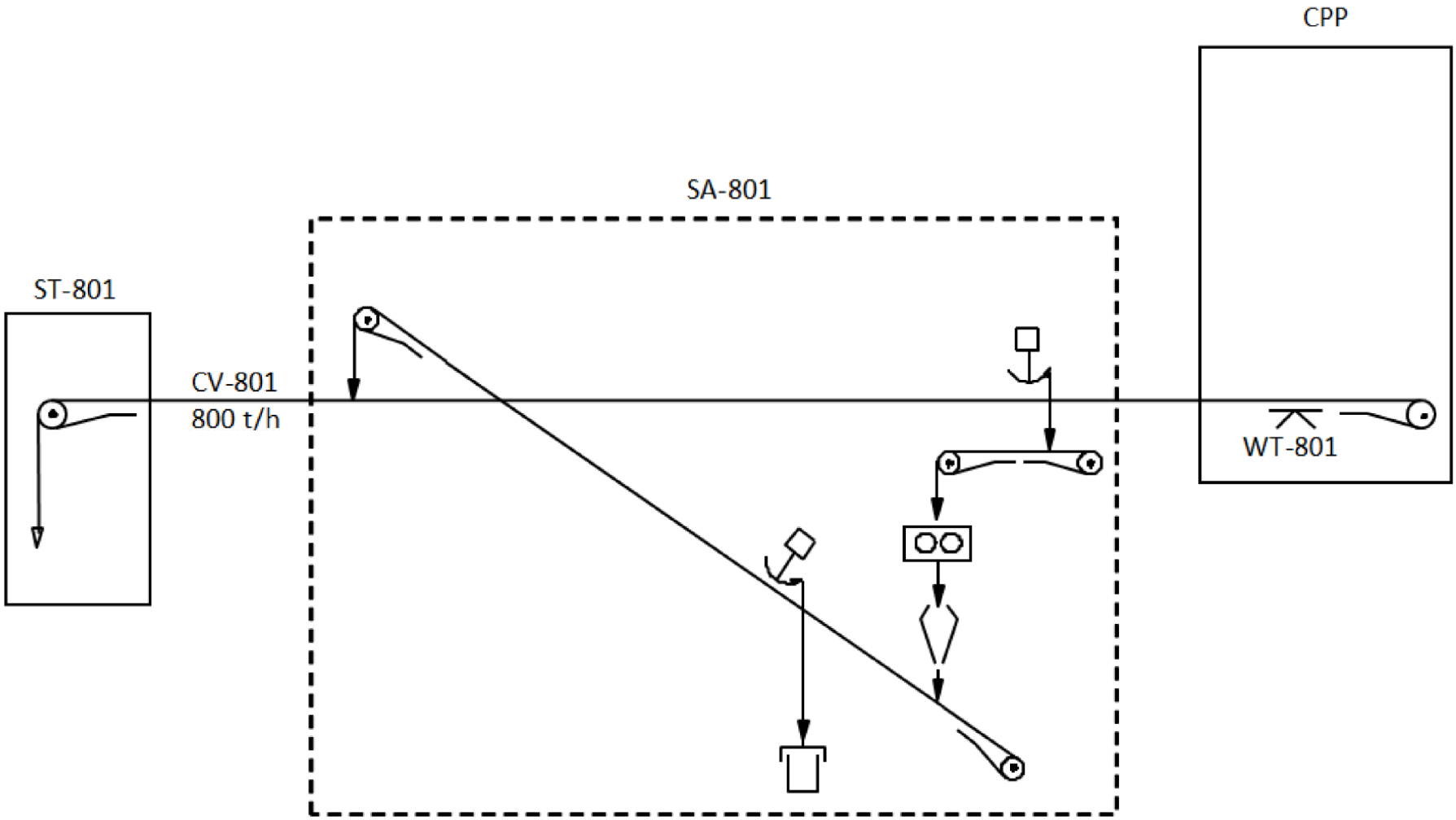
RIVERSDALE, 2015

SCALE BAR: N/A

FIGURE

C.2.6-12

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-12 Rejects Handling.mxd



LEGEND: N/A

PROJECT
RIVERSDALE RESOURCES
GRASSY MOUNTAIN COAL PROJECT

TITLE
PRODUCT HANDLING

NOTES
RIVERSDALE, 2015

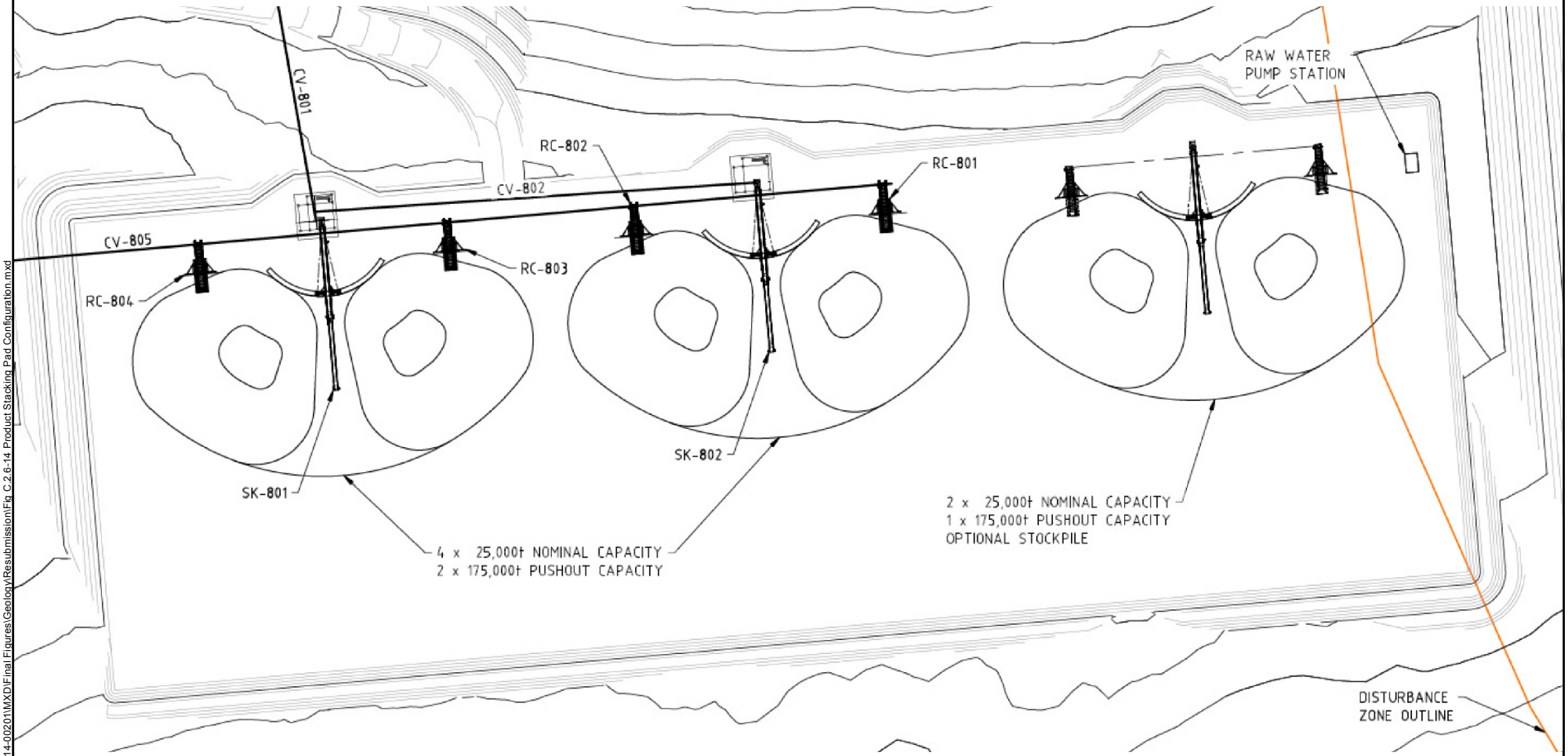
SCALE BAR: N/A

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: JM
DATE: JUNE 15, 2016

FIGURE
C.2.6-13

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-(



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

PRODUCT STACKING PAD CONFIGURATION

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

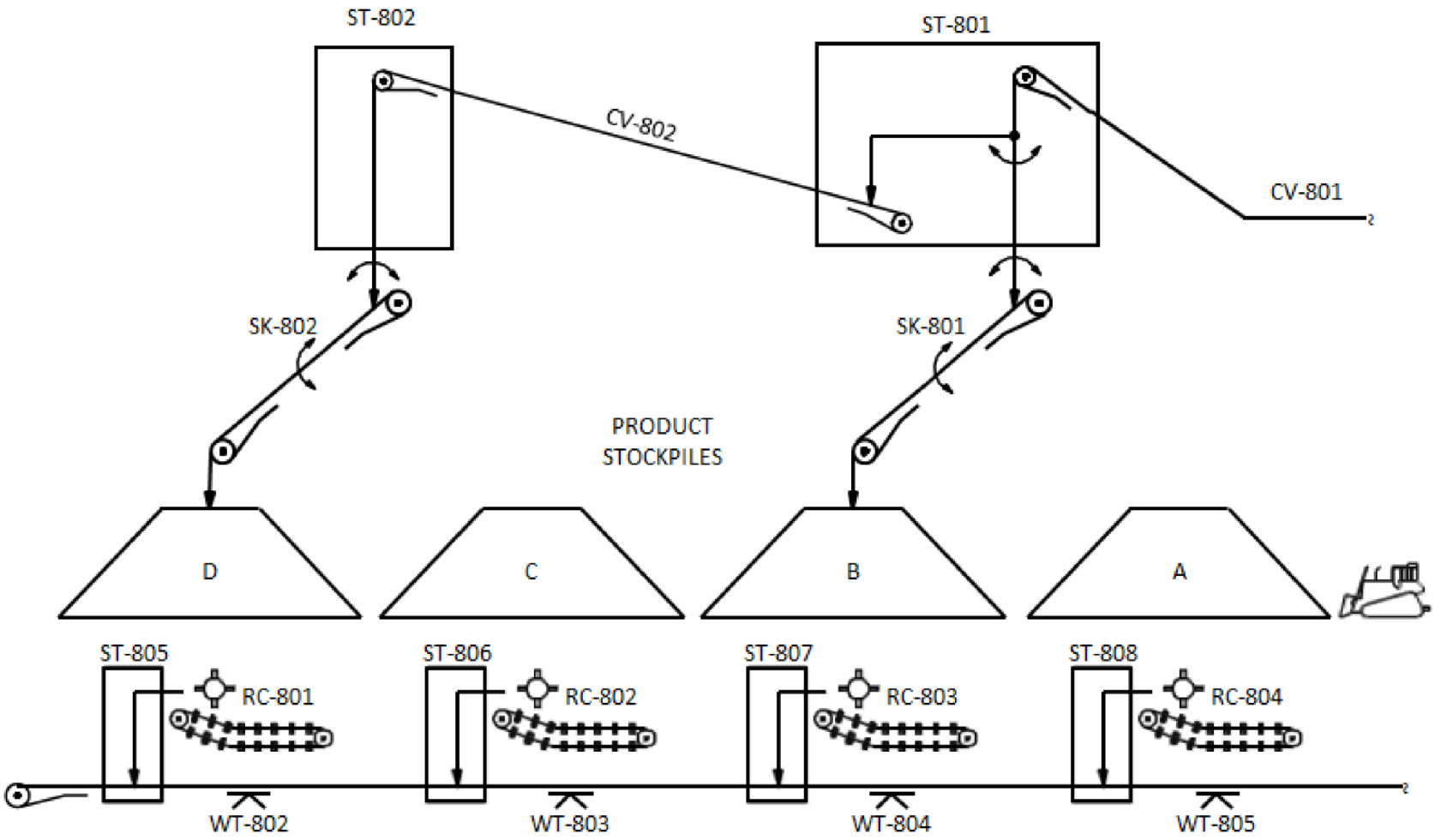
RIVERSDALE, 2015

SCALE BAR: N/A

FIGURE

C.2.6-14

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-14 Product Stacking Pad Configuration.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

PRODUCT STACKING FLOWSHEET

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

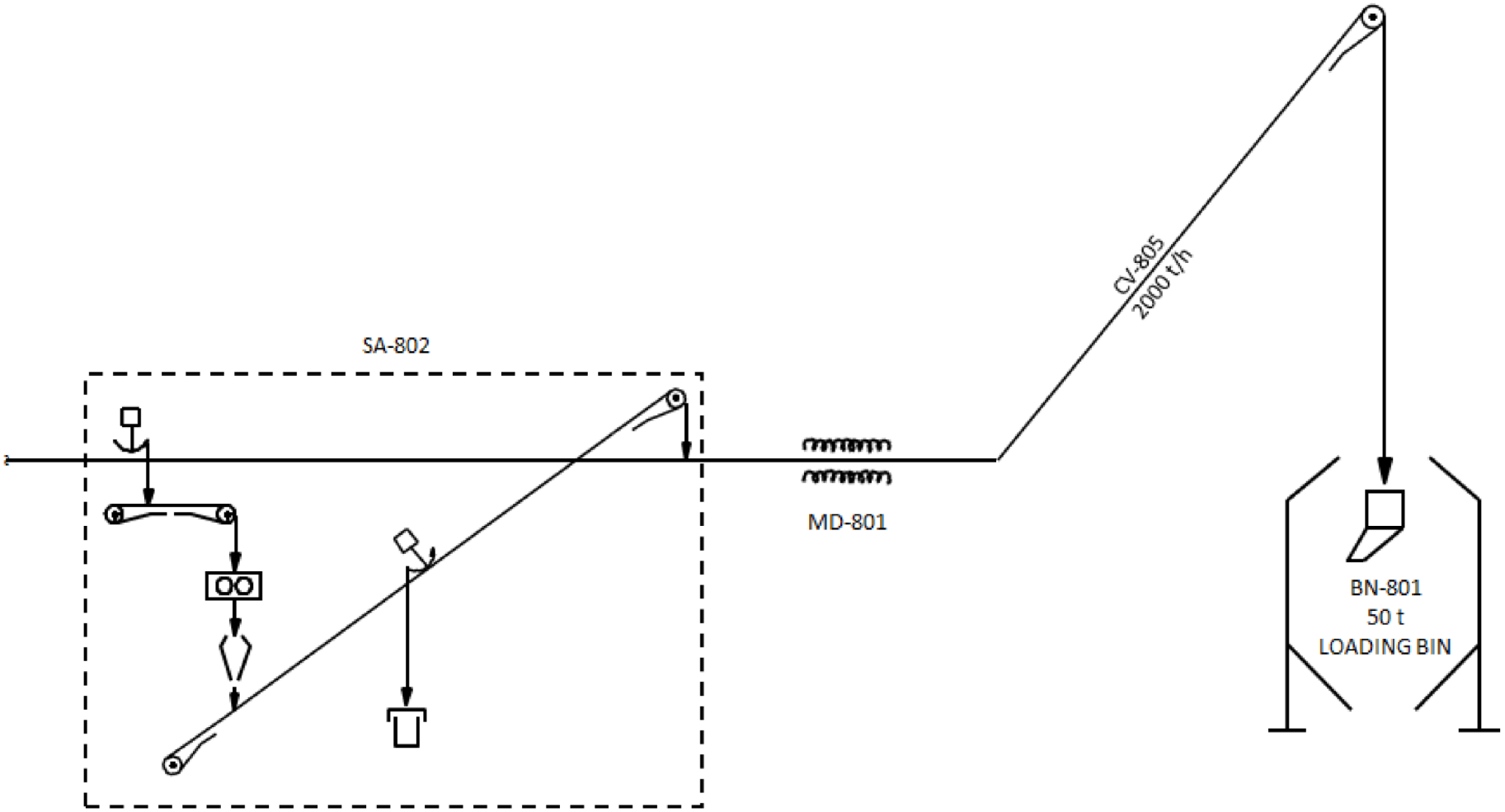
RIVERSDALE, 2015

SCALE BAR: N/A

FIGURE

C.2.6-15

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-15 Product Stacking Flowsheet.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAIM TRANSFER FLOWSHEET

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

DATE: JUNE 15, 2016

NOTES

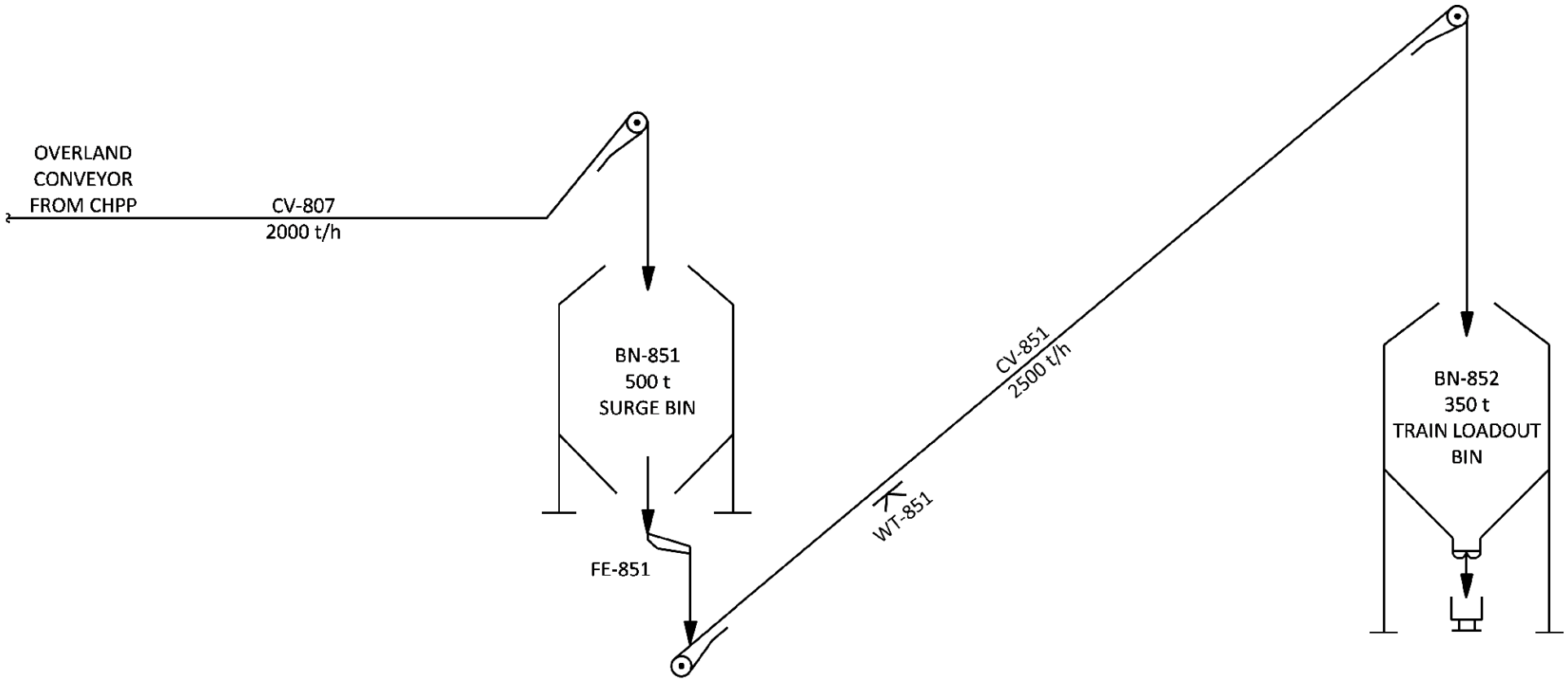
RIVERSDALE, 2015

SCALE BAR: N/A

FIGURE

C.2.6-16

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.2.6-16 Reclaim Transfer Flowsheet.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

TRAIN LOADOUT FLOWSHEET

PROJECT: 14-00201-01

DRAWN BY: JL

CHECKED BY: JM

DATE: SEPTEMBER 21, 2015

NOTES

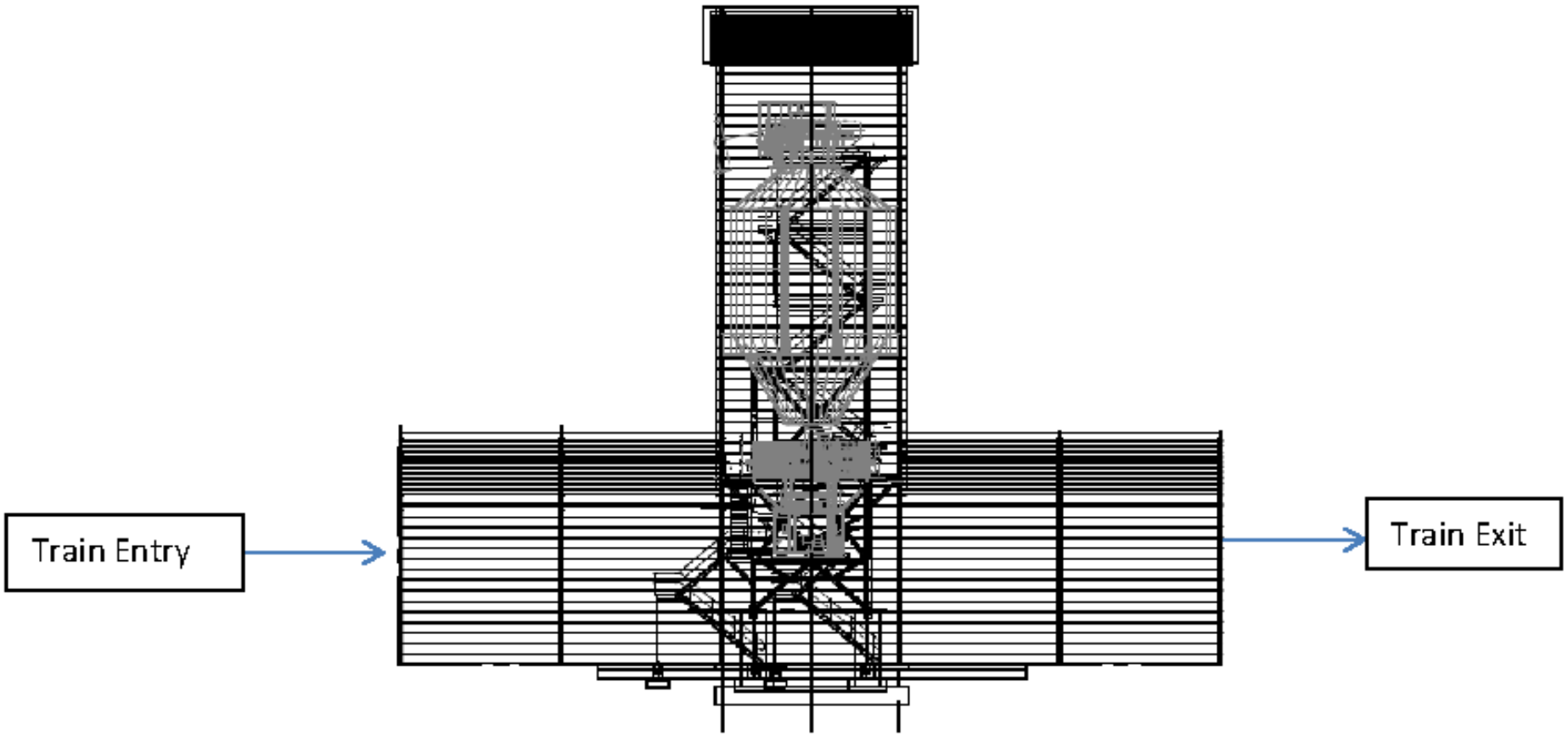
MEMS, 2015

SCALE BAR: N/A

FIGURE

C.2.7-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.7-1 Train Loadout Flowsheet.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

TLO CLADDING ARRANGEMENT

NOTES

MEMS, 2015

SCALE BAR: N/A

PROJECT: 14-00201-01

DRAWN BY: JL

CHECKED BY: JM

DATE: SEPTEMBER 21, 2015

FIGURE

C.2.12-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.2.11-1 TLO Cladding Arrangement.mxd

Temporary HWY 3 Diversion

Proposed Golf Course

Rail Underpass

Rg 4 W5M

Tp 8

Overland Conveyor

Proposed Helipad Access

Proposed Rail Loop

Road Access

Sediment Pond

Rail Loadout







LEGEND

- Existing Access Road
- Temporary HWY 3 Diversion
- Railway Loop
- Proposed Helipad Access
- Existing Railway
- Primary Highway
- Proposed Cut Area
- Proposed Fill Area
- Stormwater Detention Pond
- Covered Conveyor, Access Road and Powerline ROW
- Proposed Golf Course Area
- Proposed Mine Permit Boundary

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

PROPOSED RAIL LAYOUT

NOTES

AltaLIS, 2016; Hatch Mott MacDonald, 2016; MEMS, 2016
Datum/Projection: UTM NAD 83 Zone 11

0 150 300 600
Metres

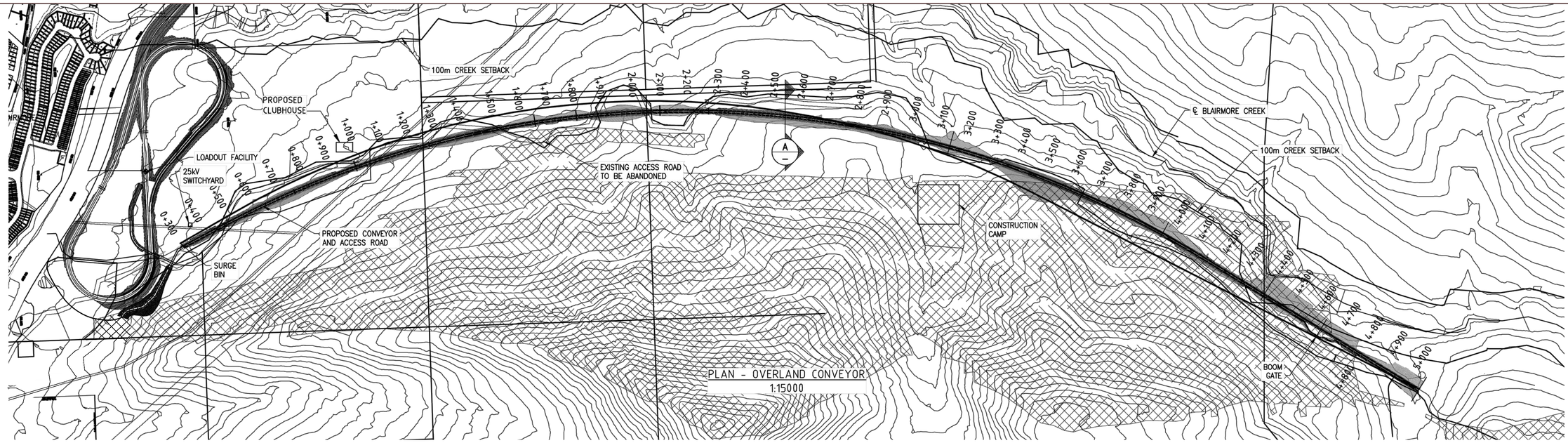
MILLENNIUM EMS Solutions Ltd.

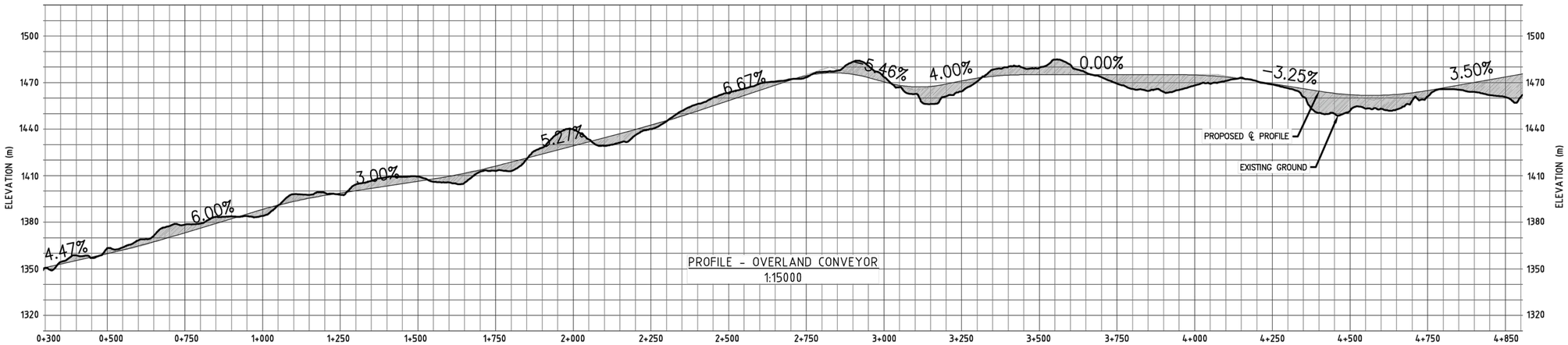
PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: JM
DATE: JUNE 17, 2016

FIGURE

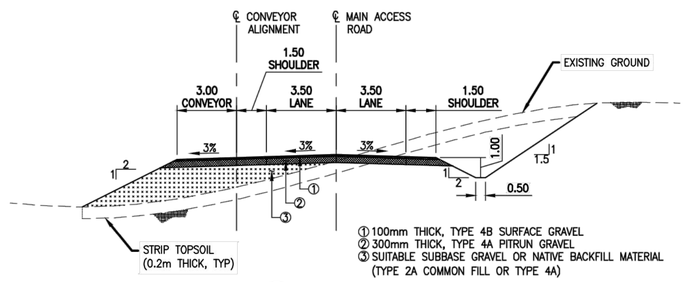
C.3.1-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.3.1-1 - Proposed Rail Layout.mxd





LEGEND



SECTION A – TYPICAL CONVEYOR/MAIN ACCESS ROAD

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

PROJECT SITE MINE ACCESS ROAD PLAN, PROFILE & SECTION

NOTES

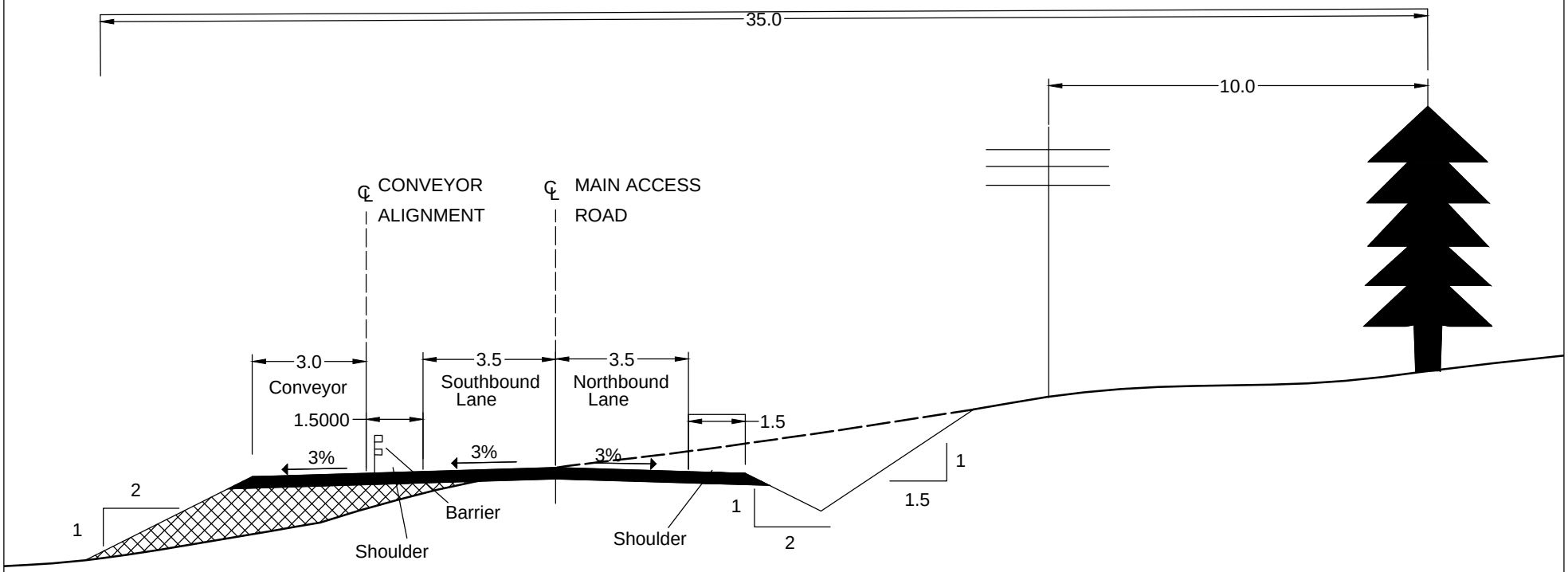
Reference 1, 2015; Reference 2, 2015; Reference 3, 2015
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: A258
DRAWN BY: MGM
CHECKED BY: -
DATE: AUG 14, 2015

0 150 450 750
Metres

FIGURE

C.4.1-1



PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

MAIN ACCESS CORRIDOR

NOTES

MEMS, 2016

PROJECT:	14-00201-01
DRAWN BY:	JM/SL
CHECKED BY:	JM
DATE:	JULY 13, 2016

0 2 4 8
Metres

FIGURE

C.4.1-2

NRDA

Rg 4

Rg 3 W5M

Tp 9

Tp 8

Pit Area

CRDA

SRDA

Southwest Surge Pond
Year 1

Phase 2 Dike (1450m)
Year 4

Phase 1 Dike (1440m)
Year 3

Plant Site
Sedimentation Pond
Year 0

Metals Treatment Plant

Dewatering Well

Raw Water Pond
Year 0

Southeast Surge Pond
Year 0

Bldrmore Creek

Caudron Creek

Gold Creek

Morin Creek

LEGEND

- Dewatering Well
- Release Point
- Existing Powerline
- CHPP Facilities
- Surface Water Drainage
- Water Transfer Pipeline
- Subsurface Flow
- Topographic Contour (20m interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Future Pond
- Undisturbed Area
- Release Pond
- Dam
- Surge Pond (No Release)
- Dike
- Saturated Fill Zone
- Rock Disposal Area
- Active Mining Area
- Topsoil Replacement
- Disturbed Area
- Legacy Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

WATER MANAGEMENT - EOY 2022 (YEAR 4)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder 2016; MEMS, 2016;
NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

0 0.5 1 2
Kilometres

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: DM
DATE: JULY 21, 2016

FIGURE

C.5.3-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.5.3-1 Water Management - EOY 4.mxd

NRDA

Northwest Surge Pond
Year 6

West Sedimentation Pond
Year 2

Pit Area

East
Sedimentation Pond
Year 6

CRDA

Southwest Surge Pond
Year 1

Phase 4 Dike (1465m)
Year 7

Southeast Surge Pond
Year 0

Phase 2&3 Dikes
(1450m, 1460m)
Year 4 & 5

Dewatering Well

Phase 1 Dike (1440m)
Year 3

SRDA

Plant Site
Sedimentation Pond
Year 0

Metals Treatment Plant

Raw Water Pond
Year 0

Rg 4

Rg 3 W5M

Tp 9

Tp 8

Caudron Creek

Blairmore Creek

Gold Creek

Morin Creek

LEGEND

- Dewatering Well
- Release Point
- Existing Powerline
- CHPP Facilities
- Surface Water Drainage
- Water Transfer Pipeline
- Subsurface Flow
- Topographic Contour (20m interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Future Pond
- Undisturbed Area
- Release Pond
- Dam
- Surge Pond (No Release)
- Dike
- Saturated Fill Zone
- Rock Disposal Area
- Active Mining Area
- Topsoil Replacement
- Disturbed Area
- Legacy Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

WATER MANAGEMENT - EOY 2027 (YEAR 9)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder 2016; MEMS, 2016;
NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

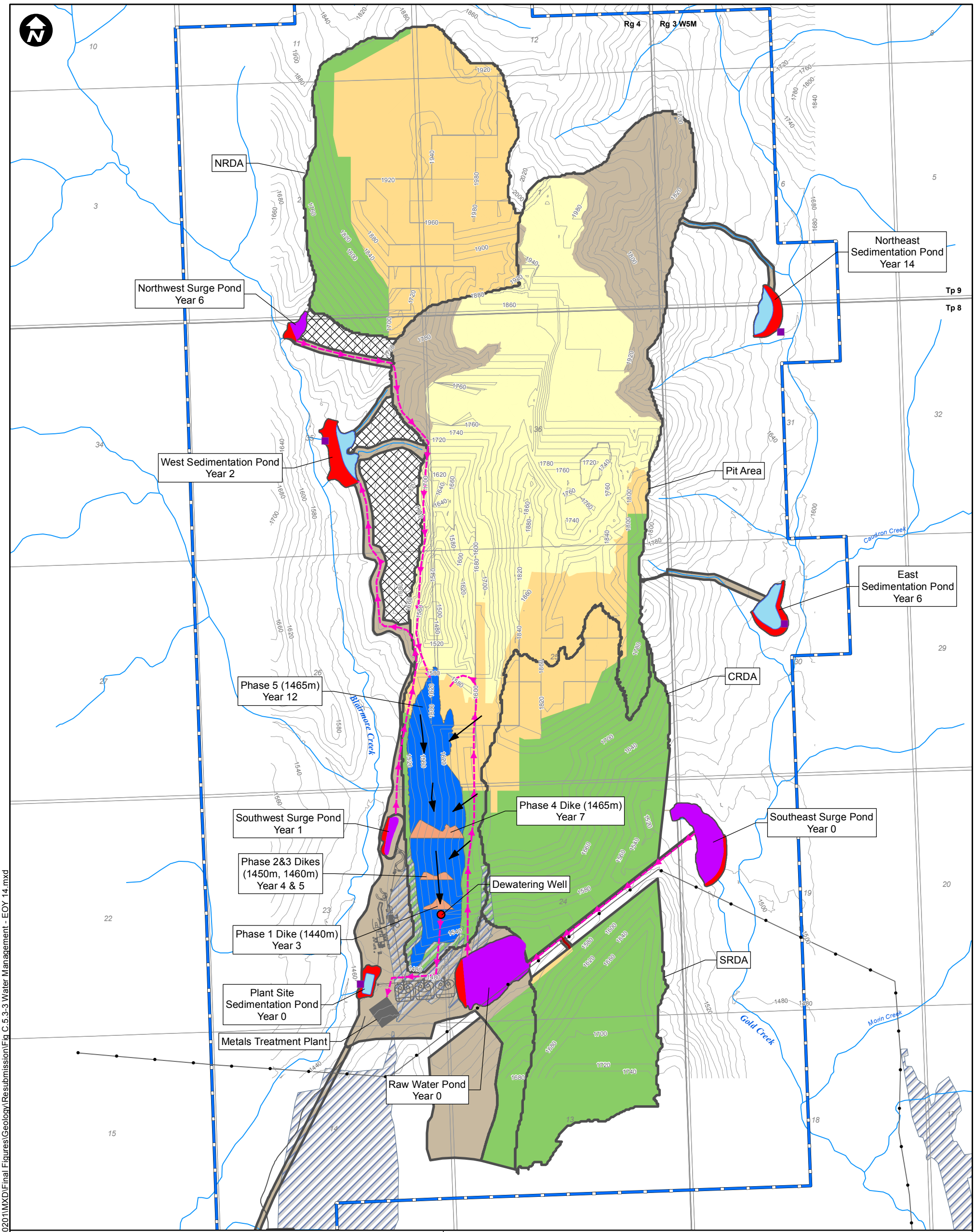
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Kilometres

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: DM
DATE: JULY 21, 2016

FIGURE

C.5.3-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.5.3-2 Water Management - EOY 9.mxd



LEGEND

- Dewatering Well
- Release Point
- Existing Powerline
- CHPP Facilities
- Surface Water Drainage
- Water Transfer Pipeline
- Subsurface Flow
- Topographic Contour (20m interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Release Pond
- Dam
- Surge Pond (No Release)
- Dike
- Saturated Fill Zone
- Rock Disposal Area
- Active Mining Area
- Topsoil Replacement
- Disturbed Area
- Legacy Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

WATER MANAGEMENT - EOY 2032 (YEAR 14)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder 2016; MEMS, 2016;
NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

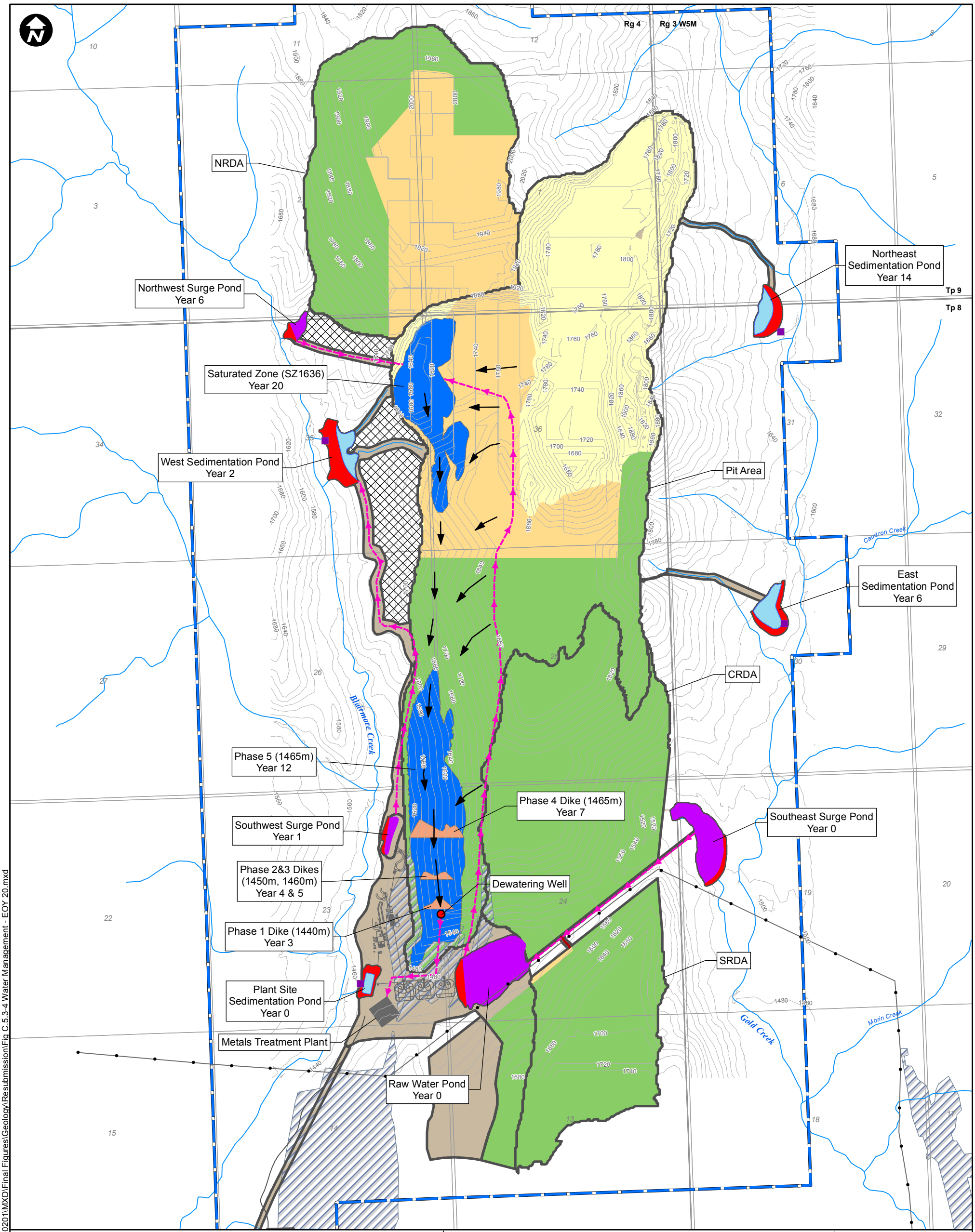
0 0.5 1 2
Kilometres

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: DM
DATE: JULY 21, 2016

FIGURE

C.5.3-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.5.3-3 Water Management - EOY 14.mxd



LEGEND

- Dewatering Well
- Release Point
- Existing Powerline
- CHPP Facilities
- Surface Water Drainage
- Water Transfer Pipeline
- Subsurface Flow
- Topographic Contour (20m interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Release Pond
- Dam
- Surge Pond (No Release)
- Dike
- Saturated Fill Zone
- Rock Disposal Area
- Active Mining Area
- Topsoil Replacement
- Disturbed Area
- Legacy Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

WATER MANAGEMENT - EOY 2038 (YEAR 20)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder 2016; MEMS, 2016;
NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

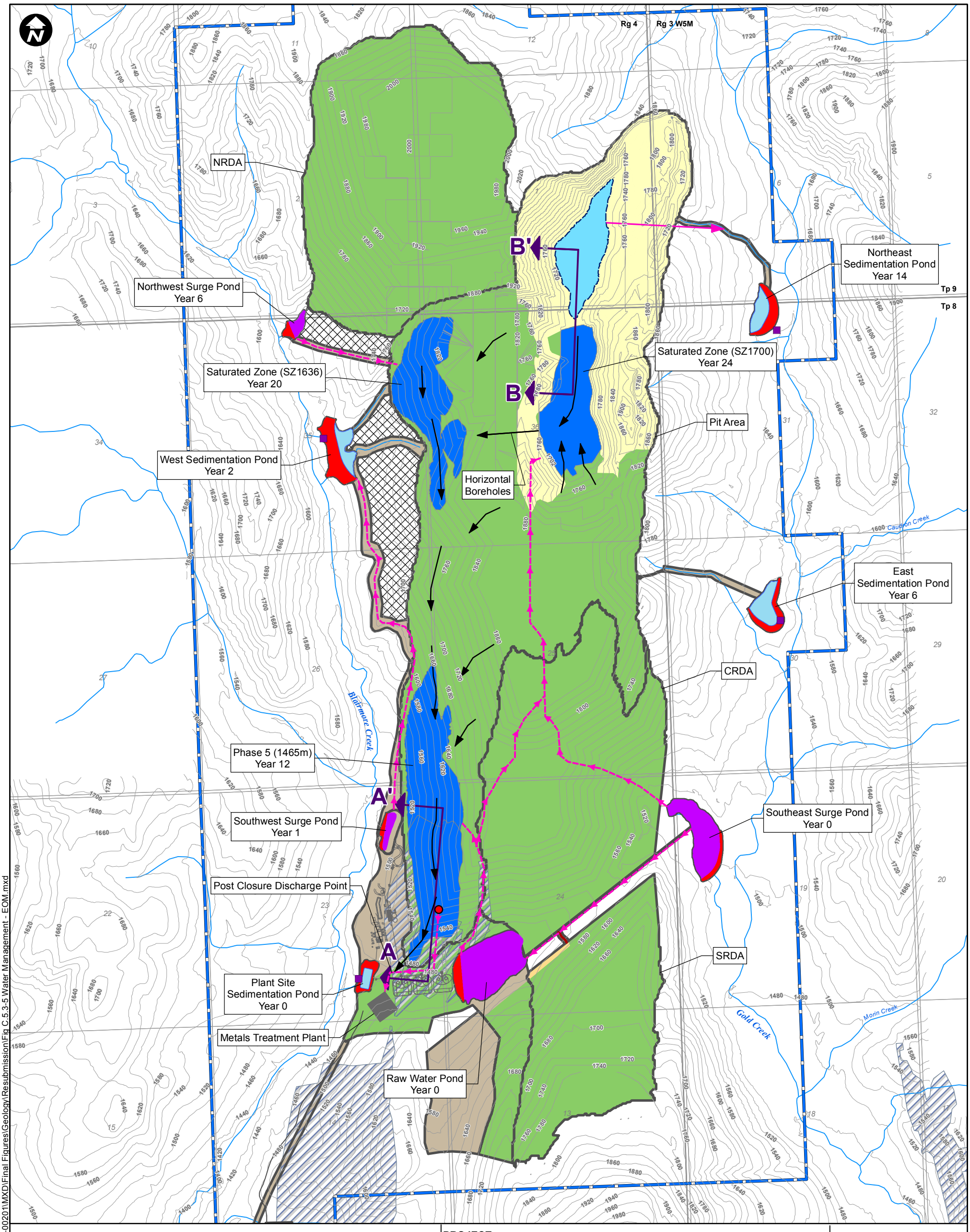
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Kilometres

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: DM
DATE: JULY 21, 2016

FIGURE

C.5.3-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.5.3-4 Water Management - EOY 20.mxd



LEGEND

- Dewatering Well
- Release Point
- Post Closure Discharge Point (1468m)
- Cross-Section Location
- CHPP Facilities
- Subsurface Flow
- Subsurface Lake Discharge
- Water Transfer Pipeline
- Surface Water Drainage
- Reclaimed Topographic Contour (20m interval)
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Release Pond
- Dam
- Surge Pond (No Release)
- Saturated Fill Zone
- End-Pit Lake
- Rock Disposal Area
- Active Mining Area
- Topsoil Replacement
- Disturbed Area
- Legacy Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

WATER MANAGEMENT - EOM (YEAR 24)

NOTES

AltaLIS, 2016; Deswik, 2016; Golder 2016; MEMS, 2016;
NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

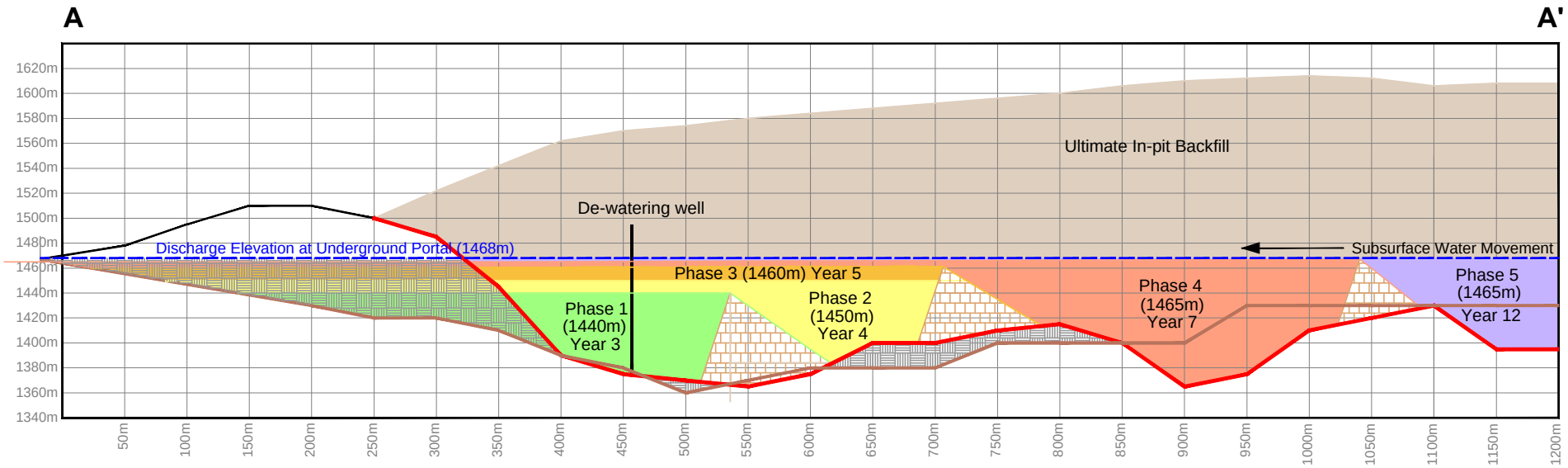
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Kilometres

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: DM
DATE: JULY 21, 2016

FIGURE

C.5.3-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.5.3-5 Water Management - EOM.mxd



LEGEND

- Original Ground
- Open Pit Limit
- Downdip Projection of Underground Mine
- Elevation at Underground Discharge Point
- Underground Workings
- Dike (Compacted Fill)
- Saturated Backfill Phases
- In-pit Backfill

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

SATURATED ZONE 1465m (SZ1465) - CROSS-SECTION A-A'

NOTES

MEMS, 2016

PROJECT: 14-00201-01

DRAWN BY: JM/SL

CHECKED BY: DM

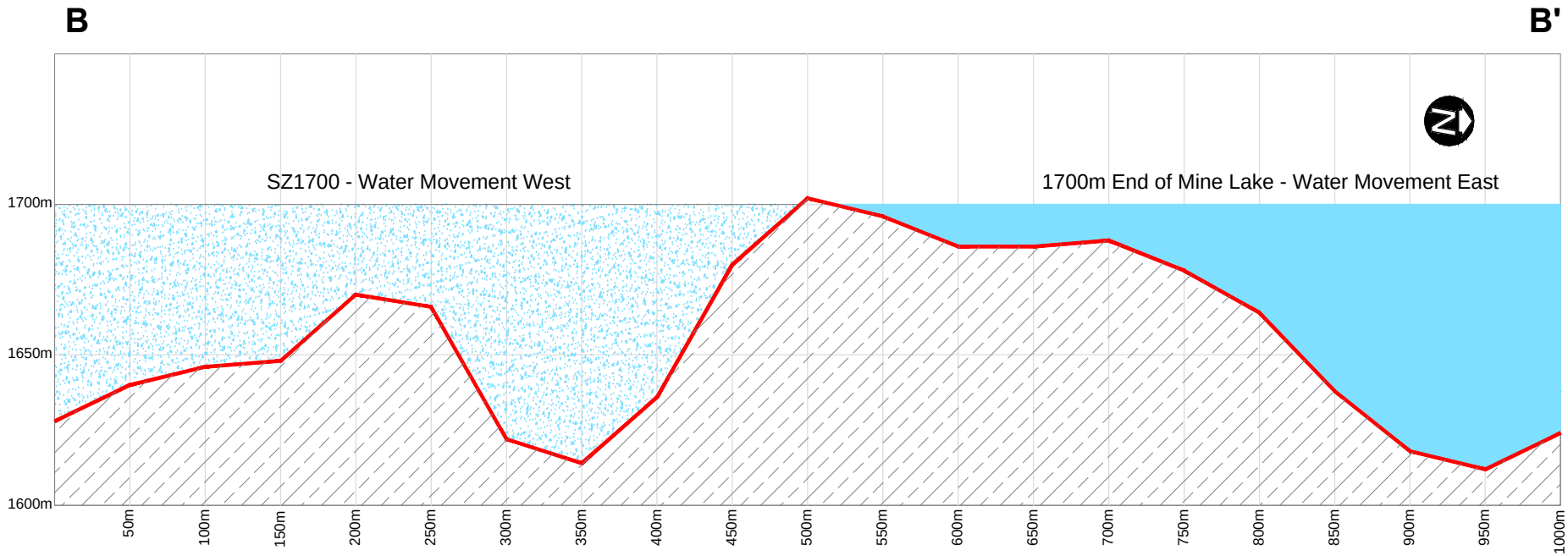
DATE: JULY 18, 2016

0 50 100 200

Metres

FIGURE

C.5.3-6



LEGEND

- Saturated Backfill
- Undisturbed Rock
- Open Water
- Pit Bottom

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

SZ1700 AND 1700m END-OF-MINE LAKE - CROSS-SECTION B-B'

NOTES

MEMS, 2016

PROJECT: 14-00201-01

DRAWN BY: JM/SL

CHECKED BY: DM

DATE: JULY 18, 2016

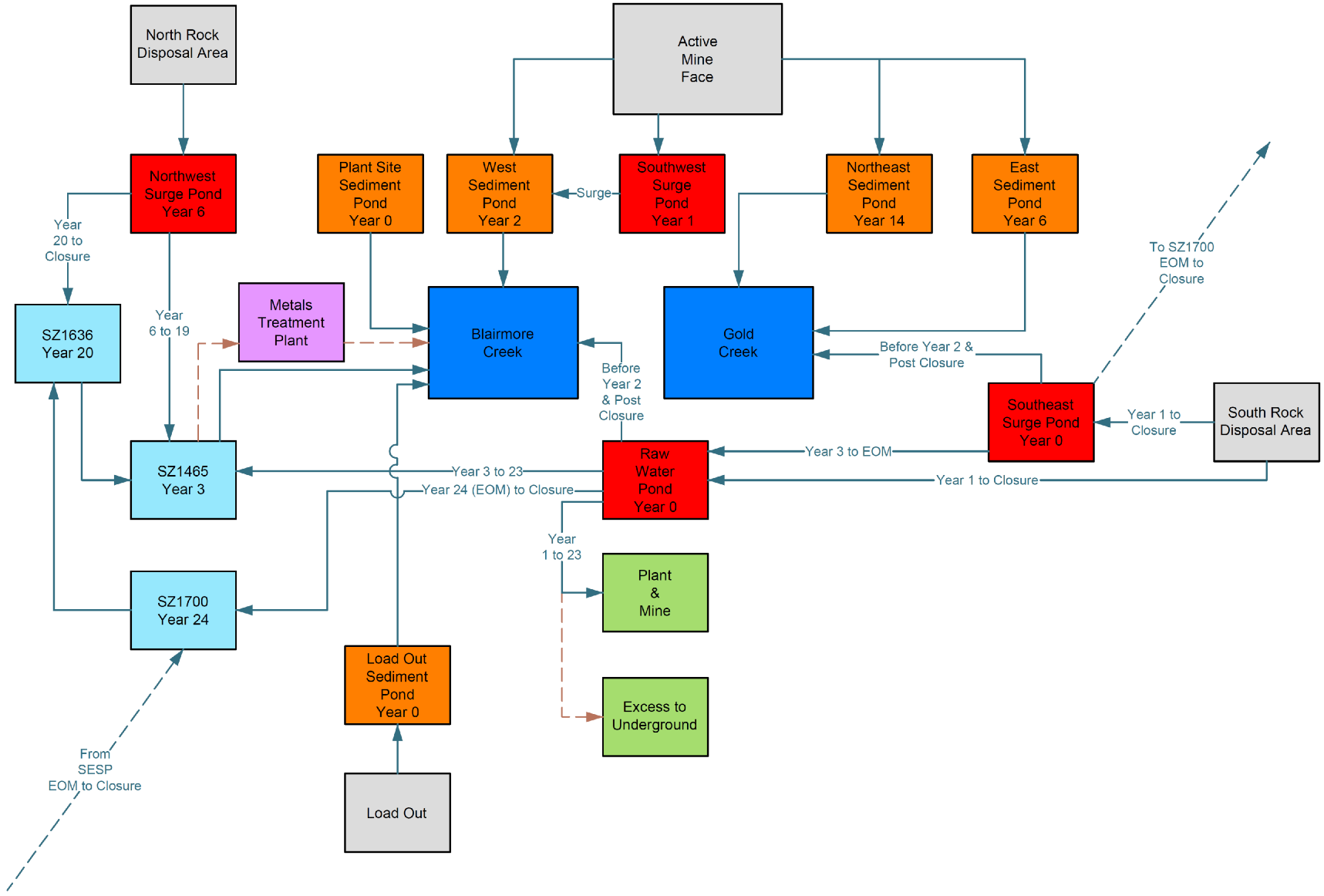
0 50 100 200

Metres

2X Vertical Exaggeration

FIGURE

C.5.3-7



LEGEND

- Surge Pond
- Release Pond
- Saturated Backfill Zone
- Water Use
- Metals Treatment Plant
- Contingency

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

WATER BALANCE AND MANAGEMENT

NOTES

MEMS, 2015

SCALE BAR: N/A

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201-01

DRAWN BY: SL

CHECKED BY: JM

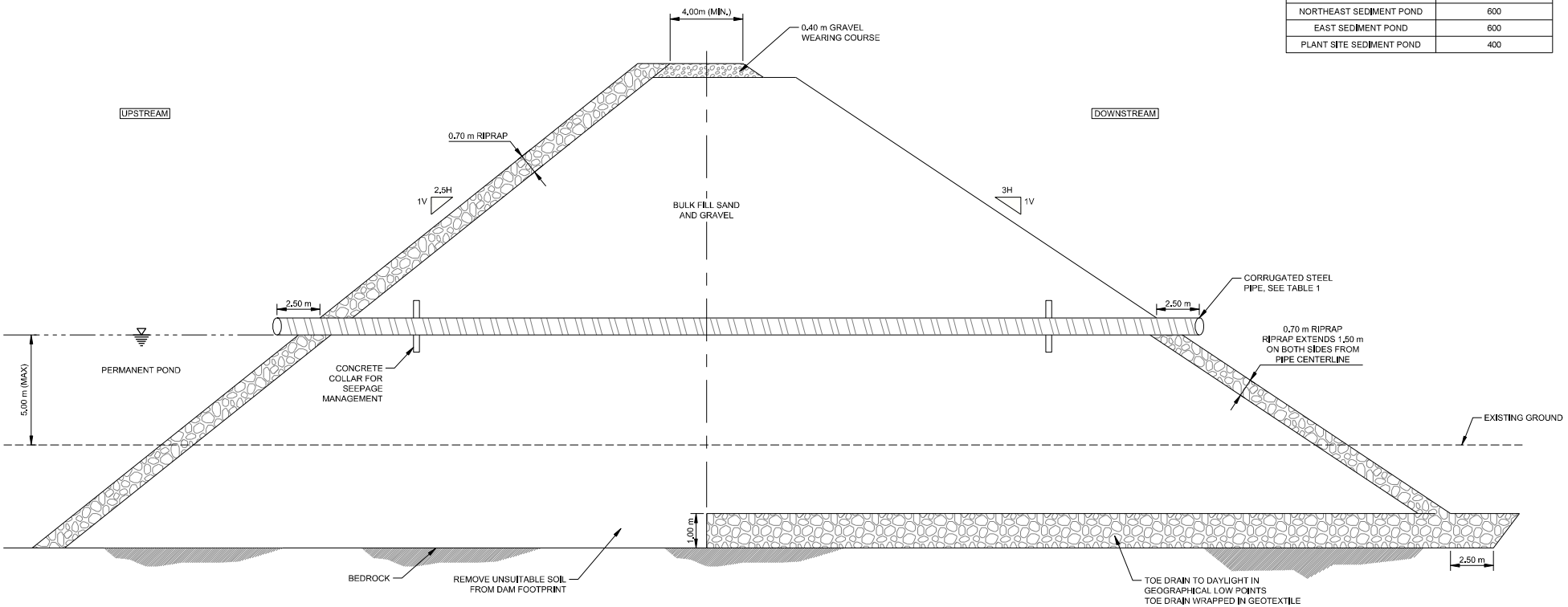
DATE: AUGUST 9, 2016

FIGURE

C.5.4-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.5.4-1 - Water Balance and Mgmt.mxd

TABLE 1	
SEDIMENT POND	CSP PIPE DIAMETER (mm)
WEST SEDIMENT POND	500
NORTHEAST SEDIMENT POND	600
EAST SEDIMENT POND	600
PLANT SITE SEDIMENT POND	400



SCALE 1:250 (A) SECTION - TYPICAL SEDIMENT POND DAM

0 5 10
1:250 METRES
2x VERT. EXAGGERATION

CLIENT
BENGA MINING LIMITED
RIVERSDALE RESOURCES

PROJECT
GRASSY MOUNTAIN COAL PROJECT
ALBERTA, CANADA

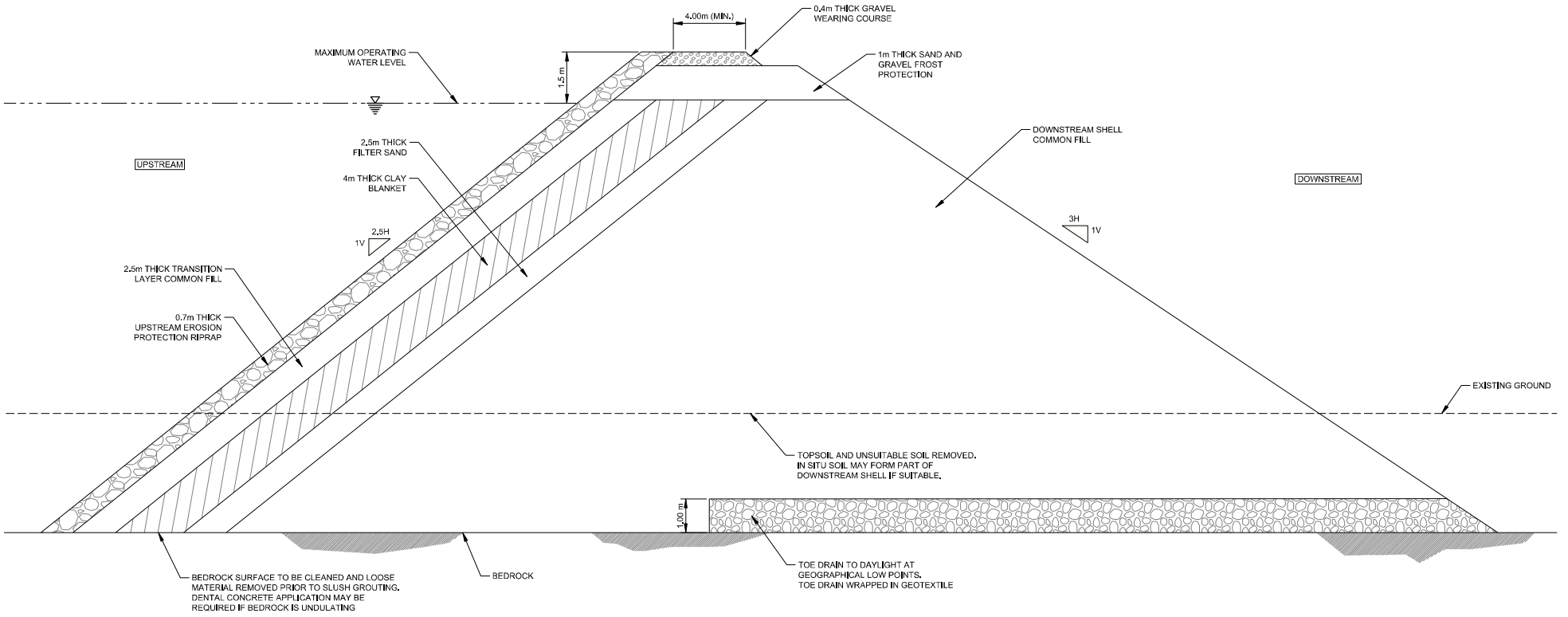
TITLE
SECTION - TYPICAL SEDIMENT POND DAM

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-08
PREPARED	CV
DESIGN	PA
REVIEW	RA
APPROVED	MF

PROJECT No. 1406422
Rev. A
Figure C.5.5-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25 mm
0
plan: \golder.gds\gal\burnaby\EDA\DATA\14\1406422_GMP\PRODUCTION\FIGURES | File name: 1406422GMP0925.dwg



SCALE 1:250 B SECTION - TYPICAL SURGE POND DAM

0 5 10
1:250 METRES
2x VERT. EXAGGERATION

CLIENT
BENGA MINING LIMITED
RIVERSDALE RESOURCES

PROJECT
GRASSY MOUNTAIN COAL PROJECT
ALBERTA, CANADA

TITLE
SECTION - TYPICAL SURGE POND DAM

CONSULTANT
Golder Associates

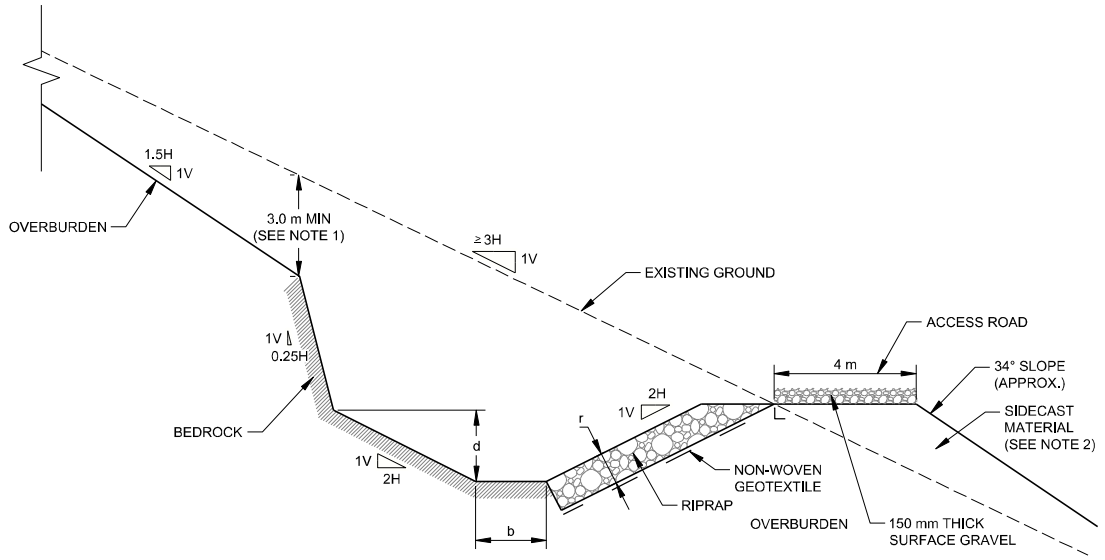
YYYY-MM-DD	2015-10-08
PREPARED	CV
DESIGN	PA
REVIEW	RA
APPROVED	MF

PROJECT No. 1406422
Rev. A
Figure C.5.5-2

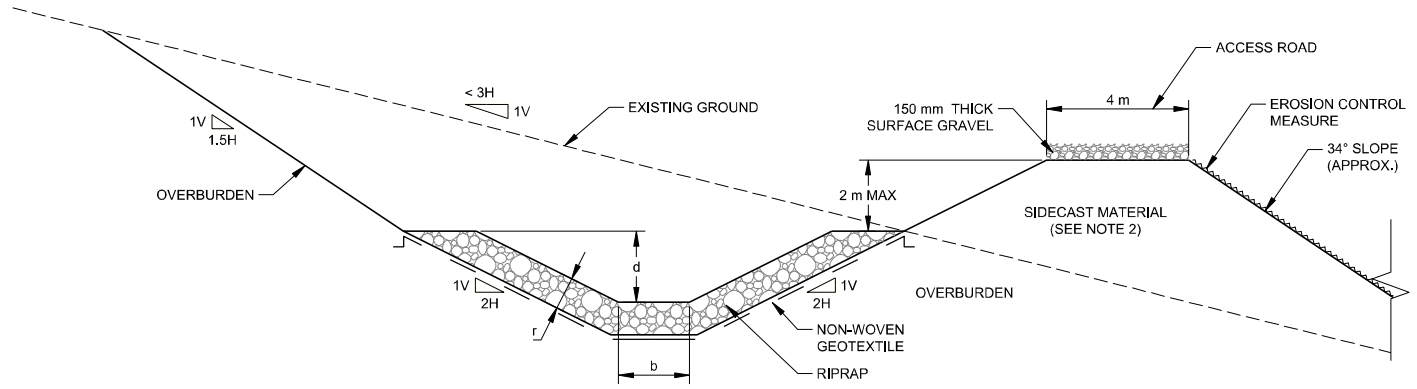
Plot by: rgallan, plotted on: FEDDADOSH1:HSHOS_PHASE_2_APPDOCUMENTS\FIGURES | File Name: 1406422SP2SF002.dwg
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25 mm
0

NOTES

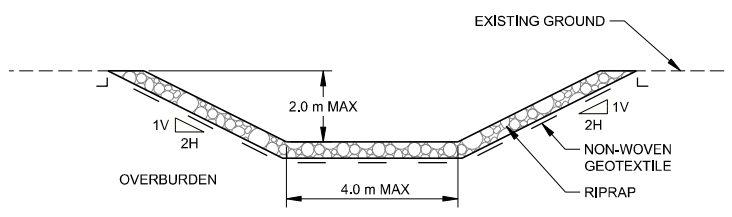
1. AVERAGE DEPTH TO BEDROCK ASSUMED TO BE 3 TO 4 m
2. SIDECAST MATERIAL TO BE USED TO CONSTRUCT ACCESS ROADS WHERE POSSIBLE.
3. RIPRAP LINING ONLY REQUIRED FOR CHANNEL SECTIONS CUT IN OVERBURDEN.



SCALE 1:200 A — TYPICAL SECTION - CHANNEL PARTIALLY EXCAVATED IN BEDROCK



SCALE 1:200 B — TYPICAL SECTION - CHANNEL EXCAVATED IN OVERBURDEN



SCALE 1:200 C — TYPICAL SECTION - CHANNEL TYPE C FOR FLAT NATURAL CROSS SLOPES

Channel Dimensions

Construction Year	Ditch ID	Length (m)	Base width, b (m)	Channel depth, d (m)	Riprap D50 (mm)	Riprap thickness, r (mm)
1	CL1-01	1020	2	2.0	150	300
1	CL1-02	800	1	1	150	300
1	CL1-03	3680	2	2	150	300
1	CL1-04-1	1820	2	2	305	610
1	CL1-04-2	310	2	2	rip rap or stepped chute	
1	DV1-01	2140	2	2	305	610
1	DV1-02-1	520	1	1	150	300
1	DV1-02-2	80	1	1	305	610
1	DV1-03	580	1	1	150	300
1	DV1-04	440	2	2	150	300
4	CL4-01-1	530	2	2	150	300
4	CL4-01-2	280	2	2	rip rap or stepped chute	
6	CL6-01	690	1	1	305	610
6	CL6-02	390	2	2	915	1830
7	DV7-01	1780	2	2	305	610
8	DV8-01-1	680	2	2	305	610
8	DV8-01-2	90	2	2	rip rap or stepped chute	
8	DV8-01-3	120	2	2		
8	DV8-02	1020	2	2	150	300
9	CL9-01	500	2	1.5	305	610
13	SZ1495	100	1	1	305	610
14	CL14-01	1130	2	2	150	300
14	CL14-02	210	2	2	305	610
14	DV14-01	390	1	1	150	300
19	CL19-01	640	1	1	150	300

0 5 10
1:200 METRES

CLIENT
BENGA MINING LIMITED
RIVERSDALE RESOURCES

RIVERSDALE RESOURCES

PROJECT
GRASSY MOUNTAIN COAL PROJECT
ALBERTA, CANADA

TITLE
SECTION - TYPICAL CHANNELS

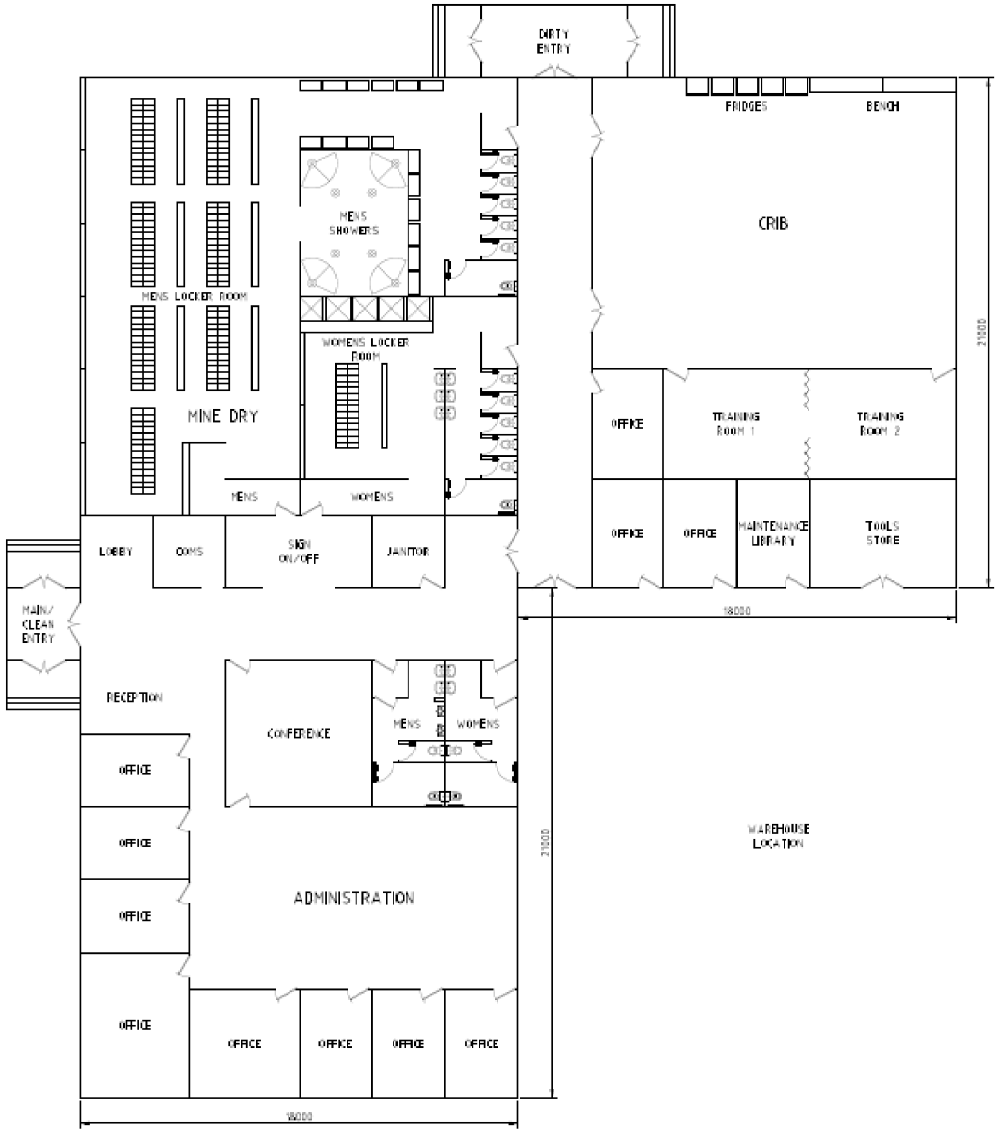
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-08
PREPARED	CV
DESIGN	PA
REVIEW	RA
APPROVED	MF

PROJECT No. 1406422
Rev. A
Figure C.5.5-3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm

Path: \\golder.gds\calgary\Active\EDC\D\2014\1406422\5_PHASE_2_&_PRODUCTION\FIGURES | File Name: 1406422PSF002.dwg



FLOOR PLAN

LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

OFFICE COMPLEX / MINE DRY

NOTES

MEMS, 2015

SCALE BAR: N/A

MILLENNIUM EMS Solutions Ltd.

PROJECT: 14-00201-01

DRAWN BY: CP

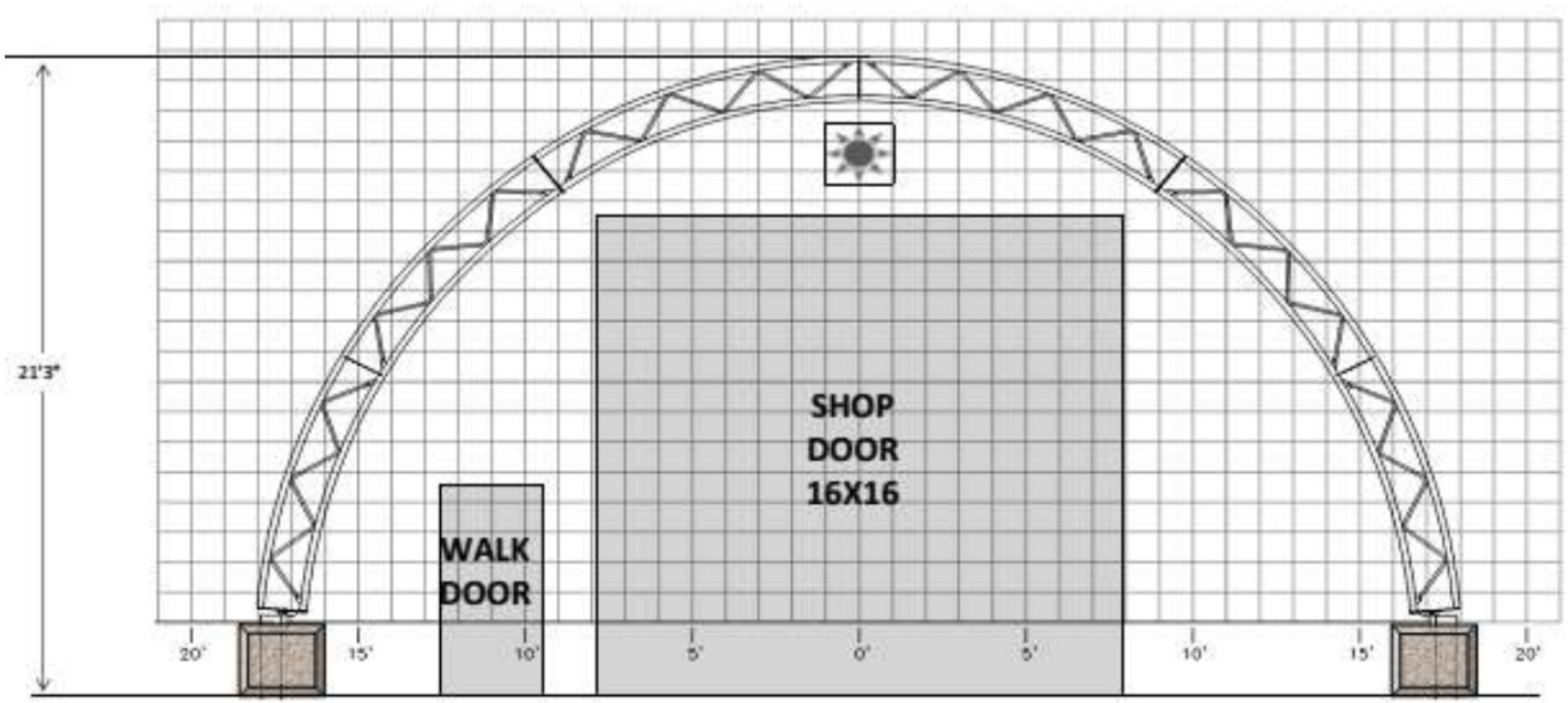
CHECKED BY: JM

DATE: OCTOBER 19, 2015

FIGURE

C.6.1-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.6.1-1 Office Complex - Mine Dry.mxd



LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

COVERED COLD STORAGE

PROJECT: 14-00201-01

DRAWN BY: CP

CHECKED BY: JM

DATE: OCTOBER 19, 2015

NOTES

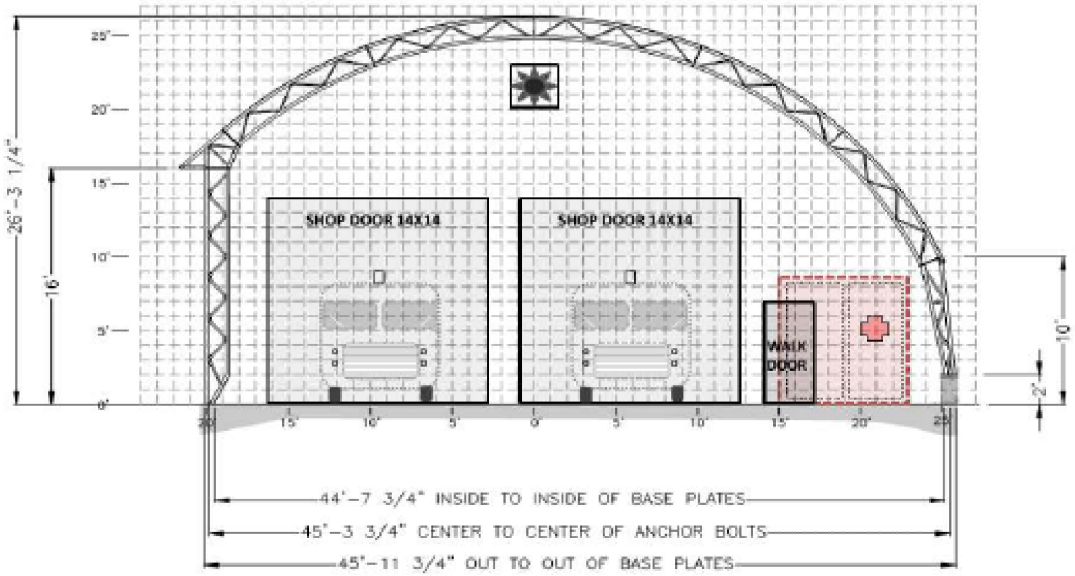
MEMS, 2015

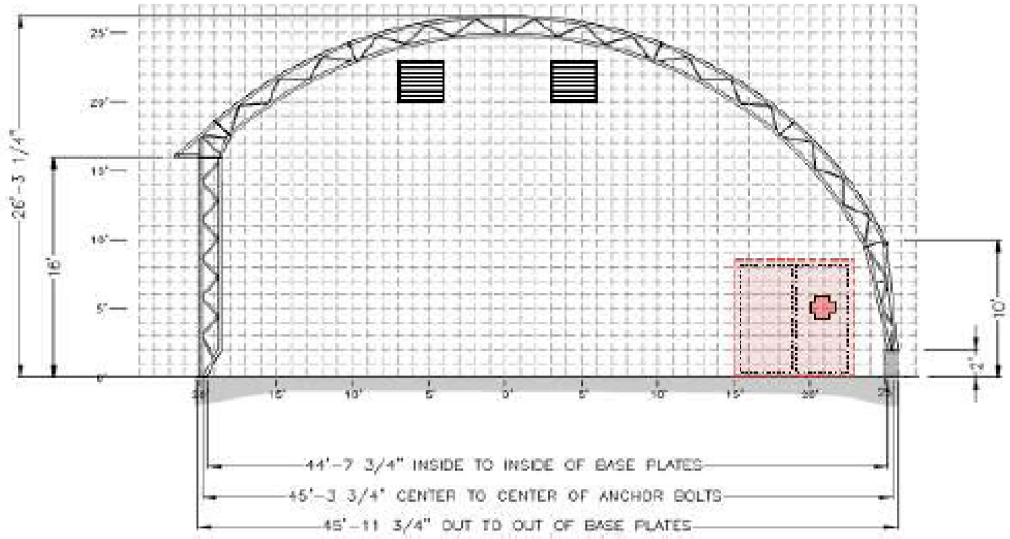
SCALE BAR: N/A

FIGURE

C.6.8-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.6.8-1 Covered Cold Storage.mxd





LEGEND: N/A

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

EMERGENCY RESPONSE BUILDING

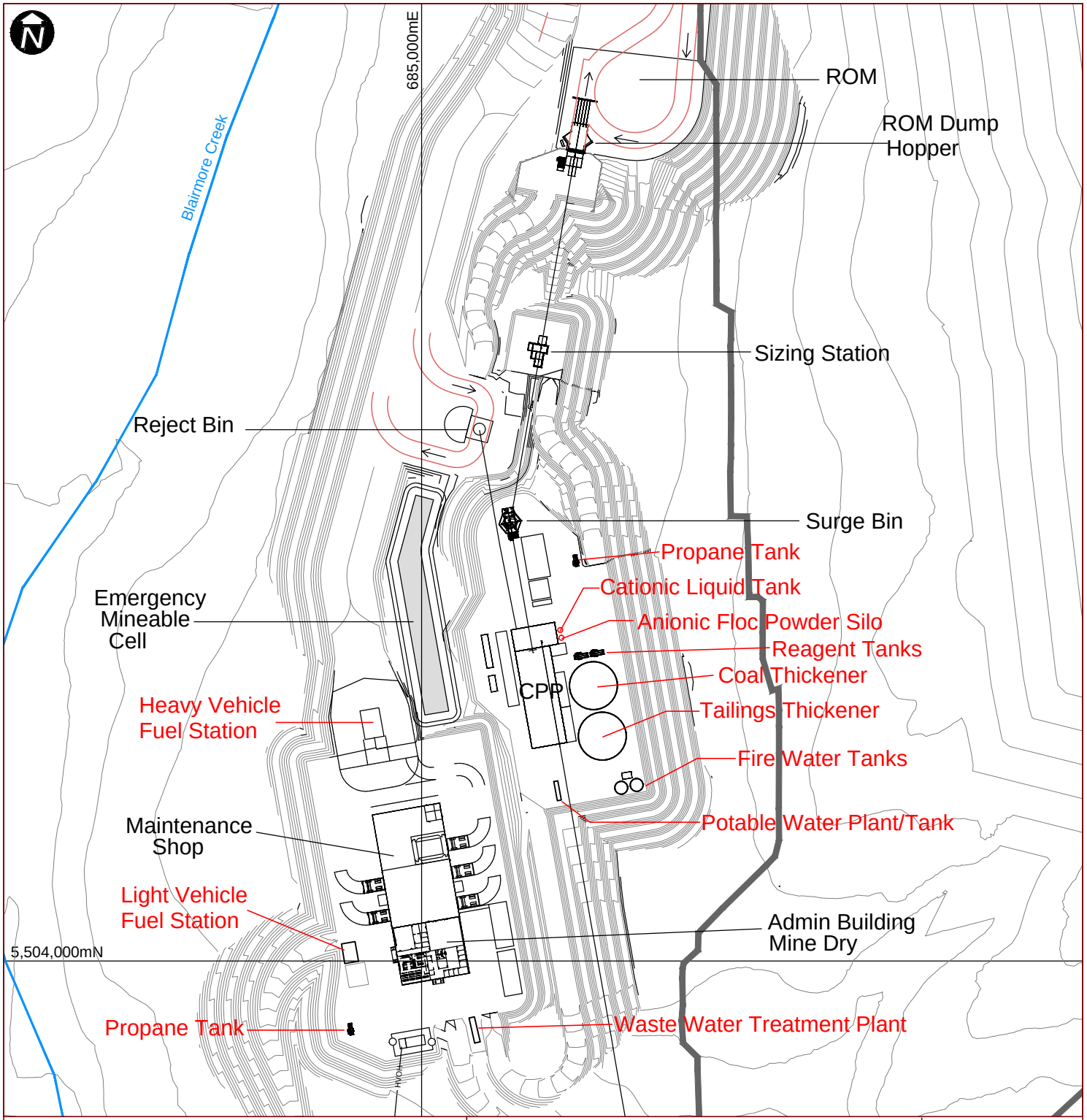
PROJECT: 14-00201-01
DRAWN BY: CP
CHECKED BY: JM
DATE: OCTOBER 19, 2015

NOTES
MEMS, 2015

SCALE BAR: N/A

FIGURE
C.6.11-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Fig C.6.11-1 Emergency Response Building.mxd



PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

SITE STORAGE TANKS

NOTES

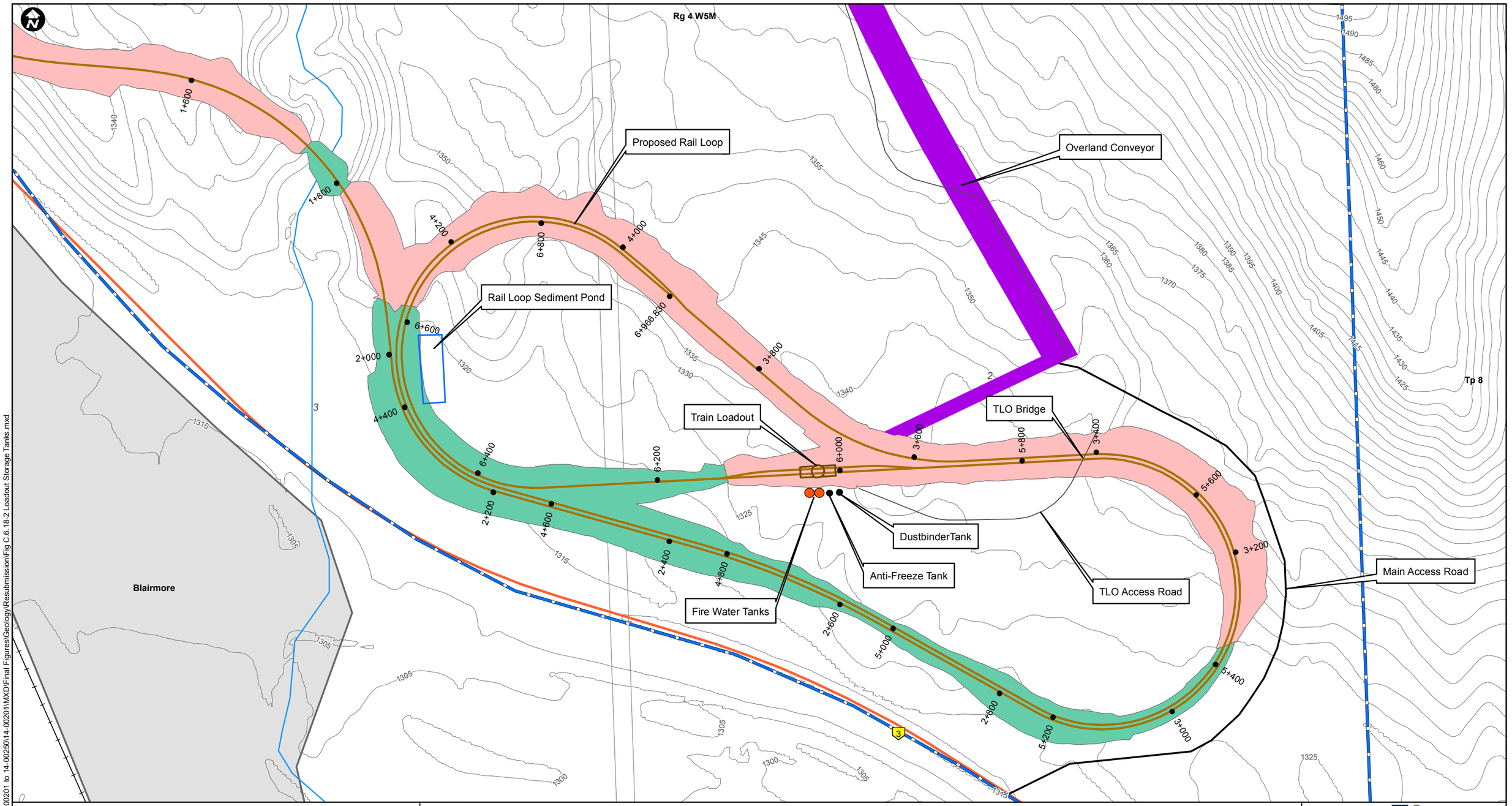
MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: JM/SL
CHECKED BY: DM
DATE: AUGUST 10, 2016

0 50 100 200
Metres

FIGURE

C.6.18-1



Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.6.18-2 Loadout Storage Tanks.mxd

LEGEND

- Existing Access Road
- Railway Loop
- Existing Railway
- Primary Highway
- Topographic Contour (5m interval)
- Proposed Cut Area
- Proposed Fill Area
- Stormwater Detention Pond
- Covered Conveyor, Access Road and Powerline ROW
- Proposed Mine Permit Boundary

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

LOADOUT STORAGE TANKS

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: JM
DATE: AUGUST 10, 2016

NOTES
AltaLIS, 2016; Hatch Mott MacDonald, 2016; MEMS, 2016; Sedgman, 2016
Datum/Projection: UTM NAD 83 Zone 11

0 75 150 300
Metres

FIGURE
C.6.18-2

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Caudron Creek
Blairmore Creek
Gold Creek
Morin Creek
Green Creek
Nez Perce Creek
Pelletier Creek
Crowsnest River
York Creek
Lyons Creek
Coleman
Blairmore
40
3
RGSC0010
TP-01
TP-02
TP-04
TP-03
RGSC0009
TP-16
TP-15
TP-14
TP-05
TP-06
TP-07
RGSC0008
TP-08
TP-09
TP-18
TP-13
TP-21
RGSC0006
TP-12
TP-17
TP-20
TP-11
TP-19
TP-10
RGOH3003
Seep-01
Seep-02
TP-26
RGOH3001
TP-23
TP-25
TP-22
TP-24
RGOH3002
Seep-03

LEGEND

- Drill Holes
- Legacy Waste
- Seeps
- Surface Water Drainage
- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Access Road
- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Railway Loop
- Proposed Helipad Access
- Proposed Mine Permit Boundary
- Ultimate Pit Extent
- Ultimate Rock Disposal Area Extent
- Topsoil Storage
- Construction Camp
- Ponds and Ditches
- Coal Handling Processing Plant and Infrastructure
- Covered Conveyor, Access Road and Powerline ROW
- Proposed Golf Course Area
- Undisturbed Area
- Legacy Mine Disturbance
- Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

GEOCHEMISTRY SAMPLE SITES

NOTES

AltaLIS, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: CP/SL
CHECKED BY: JM
DATE: JULY 22, 2016

0 0.75 1.5 3
Kilometres

FIGURE

C.8.1-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Geology\Resubmission\Fig C.8.1-1 Geochemistry Sample Sites.mxd