Mount Polley Mining Corporation
August 2012

NEZ Dump Reclamation Assessment – Year 2

Background information

The NEZ Dump is an 80 ha area at Mount Polley Mine, just west of Polley Lake. In September 2010, re-vegetation reclamation research was initiated on 5 ha of this eastern aspect site. Three reclamation treatment units (refer to Figure 1) were established to determine the effectiveness of different soil treatments, seeding rates, and fertilizer rates for re-vegetation. The varying parameters of each treatment unit are described in Table 1.

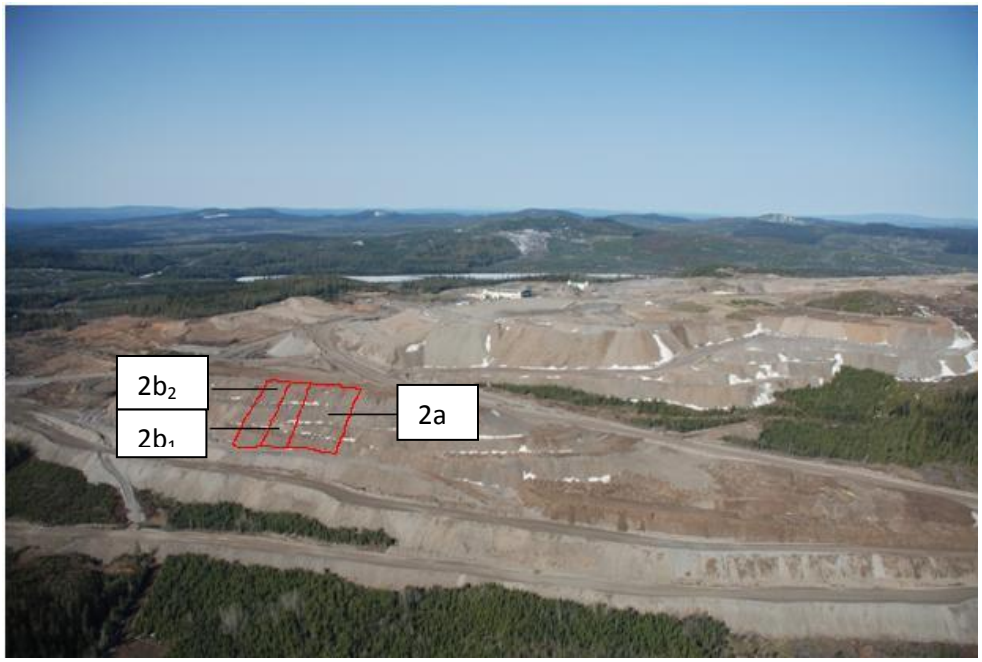

Figure 1. Mount Polley NEZ Dump (May 2008)

Table 1. NEZ Dump reclamation treatment unit parameters

Treatment Unit	Total Hectares	Seed Mixture	Seed Rate (kg/ha)	Fertilizer Rate (kg/ha)	Biosolid Application
2a	2.5	Native	45	283	No
$2b_1$	1.25	Native	34	0	Yes
$2b_2$	1.25	Native	34	71	Yes

Before seeding, biosolids were applied to $2b_1$ and $2b_2$, and then 0.4 m of till was spread on each treatment unit. Unfortunately the till cover was applied on top of the biosolids and not mixed in, so it is unlikely the biosolids will have had an immediate effect on plant growth.

Each treatment unit was hand-seeded with a native seed mixture containing eight (8) grasses (Mountain Brome, Native Red Fescue, Rocky Mountain Fescue, Wheat Grass-Blue Bunch, Blue Wild Rye, June Grass, and Tickle Grass) and two (2) forbs (Fireweed, and Lupins). Individual hand-seed trial plots of each of the nine (9) native seed types were also established in September 2010 on each treatment unit to investigate the re-vegetative success of each species (Figure 2).

It is also important to note that above average precipitation was recorded during spring and early summer in 2011 and 2012 at MPMC, which may have influenced plant growth on the site.

In 2012, fertilizer was applied to the portion of $2b_1$ that lacks soil coverage to increase performance of the vegetation there. A granular fertilizer was applied at a rate of 100 kg/ha to that area. While the vegetation is relatively sparse in this area, it is present and reasonably healthy.

Figure 2. Newly planted NEZ Dump re-vegetation test plots

2012 Tree Planting

Trees and shrubs were planted May and June of 2012 in all 3 treatment units. Live stake willow trials were also completed. Planting targets involved uniform planting coverage with higher density "biodiversity islands" dispersed throughout the planting units. Conifers were planted at a uniform 1800 stems per hectare (SPH) with an additional 200 SPH planted in "biodiversity islands". The deciduous trees and shrubs were planted primarily in the "biodiversity islands" with a minor representation throughout the rest of the treatment units. Table 2 provides details on the quantities of each species planted.

Table 2. Quantities of each tree and shrub species planted on the NEZ Dump in Spring 2012

Species	Quantity	Stems per Ha	Status/Comments
Lodgepole Pine	6500	1300	Very good survival in all units
Douglas Fir	3500	700	Good survival in all units, minor sun scald
Paper Birch	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Trembling Aspen	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Black Cottonwood	1000	200	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Sitka Alder	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Saskatoon	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Wood Rose	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Willow (local, live staked)	200	40	Moderate survival in trials in Unit 2a, considerable sun scald on new growth

Grasses and Forbes Assessment: July 2012

For each of the nine plots on the three treatment units, the percentage of ground covered, the percentage of other unplanted species present, and the vigor of the planted species (0= poor, 5- very good) were documented. Photos were taken of each plot, and any additional observations were noted. General observations including growth success, invasive and non-planted species, and growth patterns were also made for the three treatment units. Results were compared with findings of 2011 Assessment.

Treatment Unit 2a

Treatment unit 2a (2.5 ha) had a seeding rate of 45 kg/ha and a fertilizer application rate of 283 kg/ha. Biosolids were not incorporated into the soil.

Ground coverage was roughly 70%, and grasses grew to a height of approximately 0.75 m (Figure 3). The plant species had a slight yellow hue, and were overall less vigorous than the other treatment units (Figure 4). Differences in growth success on this treatment unit may also be attributed to the lack of underlying biosolids, and/or the differences in soil observed in the 2011 assessment; soil in 2b appeared to be smoother and more till-like than in 2a. It is also possible that the higher seed rate may have stifled growth.

Invasive species observed include oxeye daisy, yellow hawkweed, Canadian thistle, and sow thistle. Native species present that were not originally planted include equisetum, aslike clover, and cow-parsnip.

Refer to Table 3 for the individual seed plot results. Since July 2011, in the native seed plots there have shown no specific trends for changes in % cover, % other species, and vigor.

Figure 3. Treatment unit 2a ground cover

Figure 4. Transition from treatment unit 2a to 2b

Treatment Unit $2b_1$

Treatment unit $2b_1$ (1.25 ha) had a seeding rate of 34 kg/ha and no fertilizer was applied. Biosolids were applied below the soil.

It is difficult to accurately assess the re-vegetative success of this treatment unit, as it appears that the till may have been pushed over the upper portion of the treatment unit, while the till intended for the lower portion was left in berms and not applied to the lower portion (Figure 5). The variable growth success may also be partially attributed to soil variability, as no fertilizer was applied to supplement available soil nutrients.

The soil berms and portion of the $2b_1$ with the native seed plots has full coverage and good vigour, with grasses reaching heights of greater than 1 m high. The portion "without till" had approximately 60% coverage and 0.5 m high growth and an average vigor of "3" on the 0 to 5 scale. For the purposes of comparison with other treatment units, the upper portion of the unit that received a till cover will be used.

Invasive species observed include Canadian thistle, sow thistle, yellow hawkweed. Native species present that were not originally planted include raspberries, a pink and yellow columbine, a yellow pea species, and aslike clover.

Refer to Table 4 for the individual seed plot results. Since July 2011, increases in % cover and vigor have been observed in the seed plots, while % other species shows no specific trend.

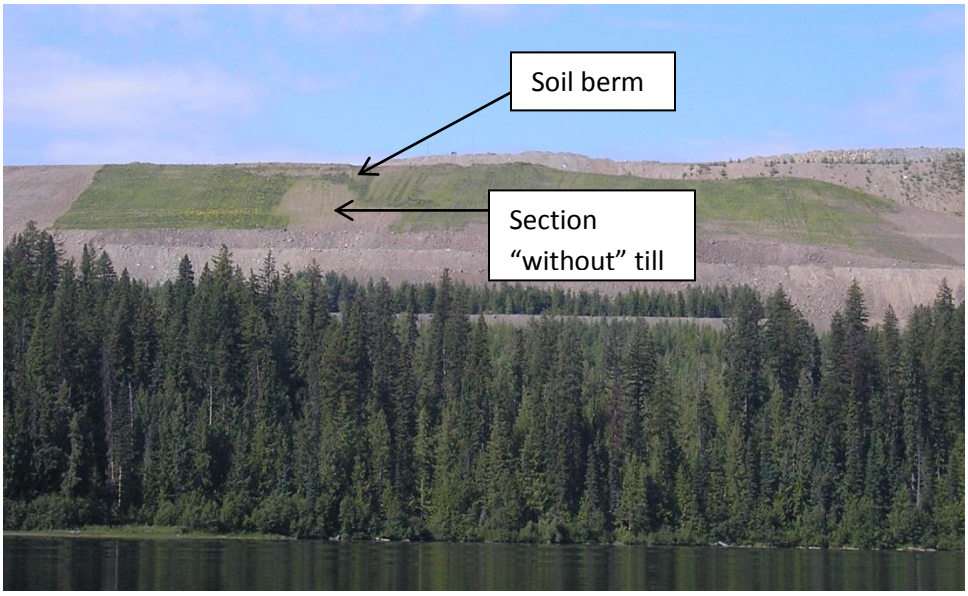

Figure 5. NEZ Dump reclamation $2b_1$ soil distribution (August 2011)

Treatment Unit $2b^2$

Treatment unit $2b^2$ (1.25 ha) had a seeding rate of 34 kg/ha and a fertilizer application rate of 71 kg/ha. Biosolids were applied beneath the soil.

This treatment unit shows impressive growth, with very good vigor, growth to greater than 1 m high, and more or less complete coverage (Figure 6). Moving forward, this may be a concern as there is potential that the thriving grasses and forbs may out-compete the recently planted tree and shrub species.

Invasive species observed include yellow hawkweed, Canadian thistle, sow thistle, and dandelions. Native species present that were not originally planted include aslike clover, raspberries, and cow parsnip.

Refer to Table 5 for the individual seed plot results. Since July 2011, increases and % cover and vigor have been observed in the seed plots, while % other species shows no specific trend.

Figure 6. Treatment unit $2b_2$ growth

Table 3. Treatment Unit 2a Individual Seed Plot Results

						Changes from 2011		
Plot	Species	% Cover	% Other Species	Vigor (0-5)	Notes	Cover	Other Species	Vigor
1	Mountain Brome	50	15	3		decrease	increase	decrease
2	Native Red Fescue	70	10	3		decrease	increase	decrease
3	Rocky Mountain Fescue	75	10	4		decrease	same	same
4	Wheat Grass - Blue Bunch	70	5	3.5		same	decrease	same
5	Blue Wild Rye	90	0	4	some seeded and dried out already	increase	decrease	same
6	June Grass	60	60	3	clover, fireweed, lupin, equisetum	increase	increase	increase
7	Tickle Grass	65	50	4	plot split down middle half clover, half grass	increase	increase	increase
8	Fireweed	50	80	3		increase	increase	increase
9	Lupin	90	<5	5	one fireweed	increase	decrease	increase

Table 4. Treatment Unit 2b[1] Individual Seed Plot Results

						Changes from 2011		
Plot	Species	% Cover	% Other Species	Vigor (0-5)	Notes	Cover	Other Species	Vigor
1	Mountain Brome	80	0	5	starting to flower (yellow)	same	decrease	increase
2	Native Red Fescue	90	10	4		increase	decrease	same
3	Rocky Mountain Fescue	100	15	5		increase	decrease	increase
4	Wheat Grass - Blue Bunch	90	20	5	pink and yellow columbine	increase	decrease	increase
5	Blue Wild Rye	85	35	4.5	lupin, raspberry	increase	increase	increase
6	June Grass	70	50	4	lots of fireweed	increase	increase	increase
7	Tickle Grass	70	80	4	raspberry, thistle (sow?)	same	increase	same
8	Fireweed	80	30	5		increase	same	increase
9	Lupin	80	30	5	grasses, fireweed, yellow hawkweed (invasive?)	increase	same	increase

Table 5. Treatment Unit 2b[2] Individual Seed Plot Results

						Changes from 2011		
Plot	**Species**	**% Cover**	**% Other Species**	**Vigor (0-5)**	**Notes**	**Cover**	**Other Species**	**Vigor**
1	Mountain Brome	90	0	4.5		increase	decrease	increase
2	Native Red Fescue	95	10	4.5	thistle, raspberry, fireweed, cow parsnip	increase	increase	increase
3	Rocky Mountain Fescue	90	20	5		increase	increase	increase
4	Wheat Grass - Blue Bunch	100	0	5		increase	decrease	increase
5	Blue Wild Rye	80	20	5		increase	decrease	increase
6	June Grass	70	50	4.5	raspberries, fireweed	increase	increase	increase
7	Tickle Grass	80	70	4.5	dandelions, lupins, fireweed	same	increase	increase
8	Fireweed	75	30	4	most not flowering yet	increase	increase	increase
9	Lupin	90	50	4	thistle, fireweed, grasses	increase	same	increase

Tree Survival Survey - August 17, 2012

A formal survival survey was completed on Aug. 17th focusing on the planted conifers. The survey was based on common methodologies found in the forest industry. 5 plots per treatment Unit were established. Detailed results are in Appendix A.

The overall success has been moderate/good with respect to survival on all species. Units 2a and $2b_1$ are performing very well. There is a noticeable difference in survival rates for the deciduous trees and shrubs in unit $2b_2$, specifically poorer survival. Unit $2b_2$ is characterized by rockier soils and heavy grass coverage. These trees and shrubs appear to have died as a result of drought. It is likely that the combined effects of the soils inability to retain moisture, heavy grass competition and hot dry weather contributed to these results. It is important to note that the conifers in this unit are doing well. There is a marginally higher rate of sun scald on the Douglas Fir, but overall survival has been good to date.

On Treatment Units 2a and $2b_1$, overall survival is very good with few problems observed. The planted Black Cottonwood, Paper Birch, Saskatoon, Alder and Rose appear to be performing moderately well overall. Each stratum is well stocked and no major stocking problems are foreseen. On 2b2 overall survival is poor to fair. Most of the Lodgepole Pine are doing well, but additional mortality should be expected over the short term due to rodent damage.

The live stake willow trials have been a moderate success. Stakes were planted from May 1st to June 25th. The initial success was impressive, with a survival rate of 89%. The onset of hot weather in mid-July dramatically affected the new foliage and branches though. Much of the new growth has been set back, though it appears that many viable buds still remain on the branches and a degree of recovery is expected. It is likely that the willow stakes' limited root development restricted the uptake of moisture and reduced their capacity for drought mitigation. Virtually all of the stakes planted after May 31 have not survived, likely as a result of drought/dehydration. The stakes that were planted the earliest in the season are performing the best.

Discussion

Successful plant growth was observed at all sites, as were wildlife (including ladybugs, butterflies, mice, and various insects); indicating that re-vegetation is proceeding and habitats are developing. Plant growth was denser and more vigorous on contoured and ridged areas, indicating that such areas provide improved microsites.

Overall, ground coverage, vigor, and vegetation height appeared to be the greatest on $2b_2$, and poorest on 2a (with the exception of the lower portion of $2b_1$ that did not receive a till cover). The 2b treatment units showed improved coverage and vigor from 2011, which is potentially because the plant roots have

extended into the layer of biosolids, while 2a (which did not have biosolids applied), has not shown these trends. Lower growth success at 2a may also be a function of variability of soil applied across the slope.

By combining results from the three groups of native seed plots, and analyzing results by species, each species can be ranked in its ability to provide ground coverage, out-compete non-planted species, and its vigor. Table 5 shows these results and combines them into overall rankings based on the sum of the species rankings in all three categories.

Table 5. Native species rankings

	Species Ranking				
Species	**Cover**	**% Planted**	**Vigor**	**Rankings Sum**	**Overall Rank**
Mountain Brome	6	1	5	12	4
Native Red Fescue	4	3	8	15	6
Rocky Mountain Fescue	1	4	1	6	1
Wheat Grass - Blue Bunch	2	2	3	7	2
Blue Wild Rye	4	5	3	12	4
June Grass	9	8	8	25	9
Tickle Grass	7	9	5	21	7
Fireweed	8	7	7	22	8
Lupin	2	6	1	9	3

The tall grasses, in particular Rocky Mountain Fescue and Wheat Grass – Blue Bunch were the most successful species, which agrees with field observations. Tickle Grass and June Grass were the least successful grasses. Forbe growth (fireweed and lupins) cannot necessarily be compared with that of the grasses, and while lupins were successful in the plots, fireweed was observed to be prominent species across the treatment units.

With regards to tree planting, limiting factors on 2a and $2b_1$ appeared to be minor sun scald and drought on Douglas Fir and Alder, minor planting errors, and considerable drought damage on the Trembling Aspen. On $2b_2$, there was major drought damage on the Fdi, and very few planted deciduous shrubs were observed. This is likely due to competition from the heavy grass cover, and this treatment unit may be rockier, with less moisture holding capacity. Considerable rodent damage was observed on the Lodgepole Pine, likely due to the heavy grass cover which increases rodent habitat.

Recommendations

For New Reclamation Sites

For soil application, 0.4 m of till appears sufficient. Reclamation sites with a rougher surface, contours and debris will exhibit more successful plant growth. Soil variability plays a key factor in re-vegetative success, so it is recommended that a tracking system be devised so that soil is either used immediately for reclamation (ensuring soil microbes, bacteria, and viable seeds remain in the soil), or it is stockpiled and seeded. Minimal disturbance and re-handling of soil is recommended, to prevent compaction

(which decreases pore space and increases bulk density). Additionally, prior to soil use, in situ physical tests and/or soil samples can help prevent application of till that is not appropriate for growth.

Based on these results a seeding rate of 34 kg/ha is plentiful. A lower seeding rate may be advantageous, as it would provide coverage and erosion control without competing with tree and shrub growth. 71 kg/ha of fertilizer appears to provide a good nutrient supply for the first year of growth for situations when biosolids are not incorporated into the soil, while biosolids may provide a longer term nutrient source.

For maximum growth, the native seed mix should be adjusted, and June Grass and Tickle Grass should be removed, however, for general reclamation use, these species provide biodiversity and will be less likely to exclude young trees and shrubs.

For the NEZ Dump

Due to the grass and forb growth success on the NEZ Dump, chemical or repeated mechanical treatment around trees and shrubs may be necessary so that they are not out-competed by the grasses (particularly on treatment unit $2b_2$).

A second formal survival survey should be completed in 2013 survival survey for all Treatment Units, and $2b_2$ survival should be closely monitored to see if fill planting is required to meet the stocking standards.

Appendix A

Treatment Unit 2a

MPMC Survival Survey Summary

Location/Block: NEZ	**Date:** Aug. 17, 2012	**Surveyor:** GH (201102), KM
Area (Ha): 5	**History:** Waste Rock Dump. Sloped 2010, soil 2010, grass seeded 2010, planted 2012	

Stratum Information:

Stratum: 2a		**Area (Ha):** 2.5
BGC Zone and Sub Zone: ICH mk3		**Site Series:** 02
Site Index, Method and Species: 18/BEC/Pli		**Slope and Aspect:** +/- 50% -E-
Inventory Label: Pli70Fdi30-1/1-0.1/0.2-18/E-1-2120(12)		**Silviculture Label:** Pli70Fdi30-1-0.1-18/E-1200(12)
Total Trees: 2120	**Total Conifers:** 2080	**Total Well Spaced:** 1200/1480 with no max.

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Fdi	52	29	14	5
Pli	51	47	1	1
Sx	-	-	-	-

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height	Leader	Age
Fdi	17	17	1
Pli	11	11	1
Sx	-	-	-

Limiting Factors (e.g. forest health, planting errors):

-Minor sun scald and drought on Fdi and planted Alder.
- Minor planting errors.
- Considerable drought damage is evident on the planted At.

Comments:

Overall survival appears to be very good in this TU. Very few problems were observed.
The planted Act, Ep, Saskatoon, Alder and Rose appear to be performing moderately well overall.
This stratum is well stocked and no major stocking problems are foreseen.

Recommendations:

1) Survival Survey summer/ Fall 2013.

Figures 2. Overview of Treatment Unit 2a

Figure 3. Overview of Treatment Unit 2a

Figure 4. Typical planted Pine

Figure 5. Typical planted Fir

Treatment Unit $2b_1$

MPMC Survival Survey Summary

Location/Block: NEZ	**Date:** Aug. 17, 2012	**Surveyor:** GH (201102), KM
Area (Ha): 5	**History:** Waste Rock Dump. Sloped 2010, soil 2010, grass seeded 2010, planted 2012	

Stratum Information:

Stratum: 2b1		**Area (Ha):** 1.25
BGC Zone and Sub Zone: ICH mk3		**Site Series:** 02
Site Index, Method and Species: 18/BEC/Pli		**Slope and Aspect:** +/- 50% –E-
Inventory Label: Pli70Fdi30-1/1-0.1/0.2-18/E-1-2000(12)		**Silviculture Label:** Pli73Fdi27-1-0.1-18/E-1200(12)
Total Trees: 2000	**Total Conifers:** 1880	**Total Well Spaced:** 1200/1320 with no max.

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Fdi	67	16	6	11
Pli	48	49	2	1
Sx	-	-	-	-

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height	Leader	Age
Fdi	16	13	1
Pli	13	13	1
Sx	-	-	-

Limiting Factors (e.g. forest health, planting errors):

-Minor sun scald and drought on Fdi and planted Alder.
- Minor planting errors.
- Considerable drought damage is evident on the planted At.

Comments:

Overall survival appears to be very good in this TU, much the same as 2a. Very few problems were observed.
The planted Act, Ep, Saskatoon, Alder and Rose appear to be performing moderately well overall.
This stratum is well stocked and no major stocking problems are foreseen.

Recommendations:

1) Survival Survey summer/ Fall 2013.

Figure 6. Overview of 2b1

Figure 5. Overview of 2b1

Figure 7. Typical planted Pine

Figure 8. Typical planted Fir

Treatment Unit 2b²

MPMC Survival Survey Summary

Location/Block: NEZ	**Date:** Aug. 17, 2012.	**Surveyor:** GH (201102), KM
Area: 5	**History:** Waste Rock Dump. Sloped 2010, soil and bio-solids 2010, grass seeded 2010, planted 2012	

Stratum Information:

Stratum: 2b2		**Area:** 1.25
BGC Zone and Sub Zone: ICH mk		**Site Series:** 02
Site Index, Method and Species: 18/BEC/Pli		**Slope and Aspect:** +/- 50/ -E-
Inventory Label: Pli90Fdi10-1/1-0.1/0.2-18/E-1-1040(12)		**Silviculture Label:** Pli96Fdi4-1-0.1-18/E-880(12)
Total Trees: 1040	**Total Conifers:** 1040	**Total Well Spaced:** 880/920 with no max.

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Fdi	19	3	3	75
Pli	45	29	3	23
Sx	-	-	-	-

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height	Leader	Age
Fdi	18	18	1
Pli	12	12	1
Sx	-	-	-

Limiting Factors (e.g. forest health, planting errors):

- Major drought damage on the Fdi. Likely due to very coarse soils and considerable grass coverage.

- Very few planted deciduous and shrubs were observed. It is expected that these components have suffered major drought damage as well. The visibility was poor due to heavy grass cover and there is a possibility that more of these components survived but were not observed during the survey.

- Considerable rodent damage was observed on the Pli.

Comments:

Overall survival is not that great. Most of the Pli are doing well. More mortality should be expected over the short term due to rodent damage.

Recommendations:

1) Fill plant with 100% Pine Spring/Summer 2013. Target 2000 SPH. 880 WS x 1.25 Ha =1100, 2000-1100= 900 Total Trees required.
2) Survival Survey 2013.

Figure 9. Overview of $2b_2$

Figure 10. Overview of $2b_2$

Figure 11. Typical Pine

Figure 12. Rodent damage

Figure 13. Rodent damage