Introduction

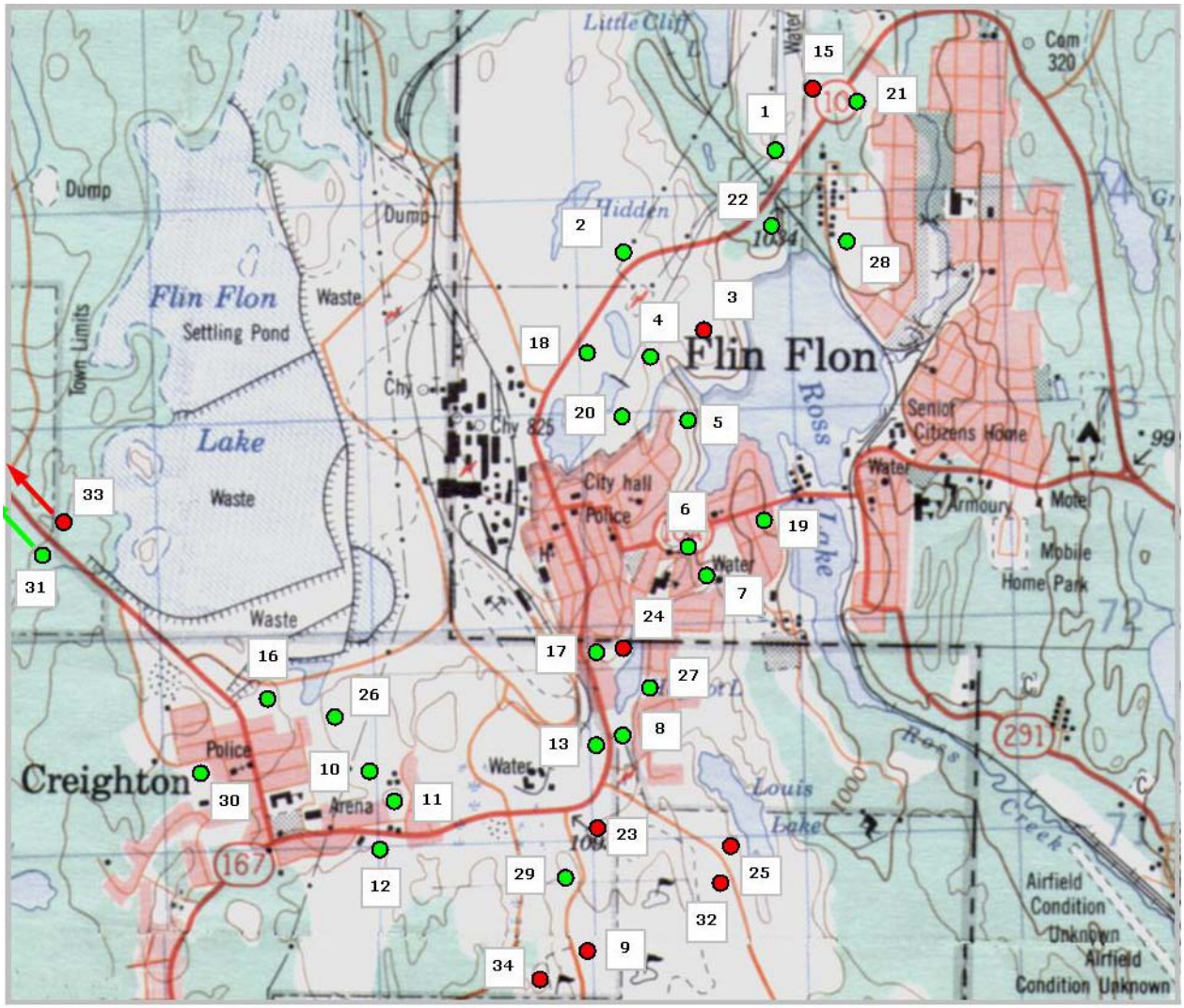
- 2009 was the tenth year for our community-based project.
- Our purpose is to accelerate the re-vegetation of barren areas in and around our communities by the application of crushed limestone.
- Because of the ruggedness of our terrain, it is not feasible to do the work by machine, so we use people-power, namely students from local schools and adult volunteers.
- Conditions were cooler than normal for the first eight months of the year – then turned abnormally mild through September. It was a damp summer with significant precipitation from mid-June through August. Vegetation growth in most treated areas was very satisfactory. Birch, poplar and other woody species are now commonly 3-4m. high – and locally approach 5m.
- The organizational and scientific backgrounds to our project are explained in Appendices 1 and 2 - below.

Our Partners

We gratefully acknowledge that our project has been made possible through the generosity of our partners. Major funding for the work in 2009 came from Hudson Bay Mining and Smelting Company Ltd. (HBMS). The City of Flin Flon, the Town of Creighton and Reg Hiebert of Northern Bus Lines hauled the limestone to the areas to be treated. Flin Flon School Division and its Enviro-Mentor program, and Creighton School Division supplied the bulk of our workforce. Hudson Bay Exploration and Development Company Ltd. supplied us with air photographs. Home Hardware donated supplies. Edgar and Mary Wright provided us with seedlings of

various understory species, Kelly Gilmore supplied birch seeds, and Donna Lundquist of the Saskatchewan Ministry of Environment supplied us with pine and spruce seeds.

Areas Treated



Green circles indicate areas treated 2000 through 2008. Red circles indicate areas treated in 2009. *1: Balsam, 2: Rock Cut, 3: Second Valley North, 4: Second Valley West, 5: First Avenue, 6: Hiawatha, 7: Grandview, 8: Hapnot, 9: Phantom, 10: Knight North, 11: Knight, 12: Pizza, 13: South Main, 15: Esso, 16: Creighton North, 17: Super K, 8: Triple Seven, 19: Market, 20: Reservoir Hill, 21: Lancaster, 22: Railroad, 23: Phantom North, 24: Hapnot North, 25: Louis, 26: Creighton East, 27: South Hudson, 28: Roche, 29: Phantom Northwest, 30: Red Mountain, 31: Hilary, 32: Golf, 33: Sand Bar, 34: Driving Range.*

During a field season lasting from May 19 through September 17, we spread 80 yards of crushed (dolomitic) limestone in 9 areas to cover a total of 4.6 hectares (11.3 acres). The map above shows these areas. During the project period 2000-2009, we have treated 42.5 hectares (105.1 acres) with 929 yards of limestone (an application rate of 22 yards/hectare).

Volunteer Field Personnel

The work was carried out by 647 individuals during 35 sessions (488 school students – 22 sessions, 84 members of the general public - 10 evening sessions, 40 Manitoba Rangers – 2 sessions and 35 participants in the City of Flin Flon Recreation Department 'Summer-in-the-Parks' program – 1 session). It should be noted that 8 school sessions had to be cancelled in June due to poor weather conditions. At right below are kindergartners from McIsaac School at the Driving Range area in May, and at left are a group of community volunteers after an evening session at the Hapnot North area in August.

New Growth in Treated Areas

The areas we are treating are either totally barren, or have a few scattered tufts of the acid- and metal-tolerant grass Agrostis stolonifera, and a few stunted relict poplars, birches, and willows. Original organic topsoil is commonly entirely absent, or where present is thin. The ground surface is a combination of bare rock outcrop, and sandy or silty gravel with a variable content of pebbles and boulders. Areas treated in May and early June of each project year have generally shown some signs of life (typically Manitoba maple) within a month. By August, seedlings of birch, aspen, balsam poplar, and a variety of willows appear. Although the

maples tend not to over-winter well, the others flourish, and in the second season grow to about half-a-metre. Conifer seedlings tend not to appear until a year or two after the treatment.

Birches and poplars in several of our areas are now 3-4 metres high, and at our Knight, Knight North and Hapnot areas (treated in 2000 and 2001), some individuals are 4.5-5 metres high. As of the fall of 2008, self-seeded conifers were present in fourteen of our areas – they are now present in twenty. Pines – commonly associated with old relict parents – are locally up to 3.2 metres high, and a single tamarack at our Knight area is 2.9 metres high. Cones were noted on pines (self-seeded and transplanted) in several of our areas last year. This year, cones were noted on the tallest spruce in the plantation at our Knight North area, and on the single tamarack at the Knight area. Alders were not seen in any of our areas until 2005 – they have now been noted in twelve (four more than in 2008). In five of these areas, it appears that the seed came from individual alders planted in 2001. Individuals and small clusters of dwarf birch were first noted in one of our areas some years ago. Dwarf birch has now been recognized in three areas.

The pictures below show our first post-Greening spruce and tamarack cones – at left at the Knight North 'plantation', and at right at the Knight area.

Although understory species such as Bicknell's geranium, fireweed, raspberry and bearberry are quite widespread, they tend in general to be few and far between. The grass A. stolonifera tends to spread following treatment, and a few other grass and sedge species have appeared in some areas. Some of our best areas in terms of density of woody species – such as Creighton North - still have almost no understory vegetation.

Appendix 3 provides an indication as to how well each individual area is doing. It is notable that the four areas we characterize as 'poorest' are within about a kilometer of the stack. Our five 'best' areas are all south and southwest from Flin Flon. We have recognized since the early years of the project that some areas are 'slower' than others, that is, there is a variation in the rate of germination and growth and in vegetation density from one area to another. We hope that studies presently underway (see below) will provide an explanation and a remedy for this.

Planting and Seeding

Although we depend primarily on the natural 'seed rain' to do the re-vegetating for us, we have done some small-scale experimental planting and seeding.

In April 2009, Donna Lundquist of the Saskatchewan Ministry of Environment donated 14 kilograms of jack pine and white spruce seeds. These had been collected in 1995 and 1978 respectively, and were being removed from inventory because of their low (estimated 40%) viability. They were scattered in seven of our areas by Green Project staff on April 25 and by Creighton grade 6 students June 8. Good densities of seedlings were first noted at our Balsam, Esso, Railroad, Hilary and Sandbar areas between July 22 – September 12. A single small dense patch of seedlings was noted at the Reservoir Hill area September 12. No seedlings were noted at the Market area.

In September 2001, following advice from our consultant the late Professor Winterhalder, small 'plantations' were established in ten of the areas we had previously treated. In each we put four spruce seedlings, one alder (a nitrogen fixer) and one pine or tamarack. These were taken from the right-of-way along the Kisseynew Lake road during a very wet spell. To date, survival in the plantations has been close to 100%. It is of interest to note that growth and state of health in the plantations varies from area to area, and closely parallels the variation in area 'vegetation scores' in appendix 3. Plantation conifers in some areas categorized as 'best' (such as Knight and Knight North) are very healthy and up to 3.1m high, while those our 'poor' areas (such as Rock Cut and First Avenue) are more sickly-looking and are not a great deal bigger that when they were put in. Pines at the Balsam and Knight plantations produced cones for the first time in 2008. Cones appeared on the pines at the Second Valley, Hapnot and Pizza areas for the first time in 2009. The tallest spruce in our Knight North plantation

produced masses of cones in 2009 – these are the first spruce cones to have appeared in any of our treated areas (see picture on page 4).

Pine and spruce cones were scattered in seventeen of our areas in 2002 through 2004. Germination has taken place in eleven of these areas. Some of the pine seedlings from cones scattered by Saskatchewan Ministry of Environment personnel at our Knight North area in February 2002 are now up to 3.1m. high. Seedlings in the other areas are up to 1.65m. high. The pines at the Knight North area produced cones for the first time in 2008.

Spruce seedlings from SaskPower's Shand Greenhouse were supplied to us by Saskatchewan Ministry of Environment Creighton office personnel in 2005. They were put in by Green Project staff at three of our areas. Those at our Balsam and Railroad areas are doing quite well – some are 55-60cm. high. Most of our Triple Seven area was covered in topsoil and seeded by HBMS in the fall of 2008. Spruce planted at the north end of the area are now buried. Those planted at the south end remain unburied - several of these have died, the remainder barely survive.

In 2003 and 2005-2007, local Cubs and Beavers planted hundreds of spruce and pine seedlings – as well as several other species – at the Second Valley, Reservoir Hill, Phantom and Balsam/Esso areas. Survival rate for the conifers has been high – probably better than 90% in most areas – many individuals are now 50-60cm. high. Those planted at squares 1, 2 and 4 at Second Valley in 2003 are in general less healthy, with significant mortality - particularly among the pines.

Supplementary documentation on the above, and on some of our other planting and seeding projects is available on request, and will shortly be posted on our web site.

Scientific Studies

As noted above, many of our areas have responded very well to the limestone treatment, others are coming along more slowly, while in a few the response has been minimal. What accounts for this varying response? Might it be due to variations in the base-metal content of the soil? What treatment in addition to the application of crushed limestone might be needed to enhance germination and growth of woody species in our 'slow' and 'poor' areas – and to encourage growth of understory species? At the time of his death in October 2005, our consultant

Professor Keith Winterhalder had been conducting greenhouse experiments with a view to providing answers to these questions.

Following preliminary discussions with HBMS and Green Project coordinators in late 2007, members of the faculty at the University of Saskatchewan's Department of Soil Science drafted a proposal for a multi-year research project aimed at significantly expanding on the work initiated by Professor Winterhalder. Funding secured from HBMS and the Natural Sciences and Engineering Research Council of Canada will now allow the project to go ahead for an initial three-year period – with the possibility of an extension for a further two years. Site assessment – which included detailed soil mapping and collection of soil samples for laboratory characterization – was carried out in 2008 and continued in 2009. Other project components will include development of amendment strategies, metals characterization and speciation, and soil ecology and ecosystem sustainability.

Two high-school student participants in a Manitoba Science Academy summer program spent some time on soil-science assignments in Green Project areas in mid-July. They were supervised by personnel from the University of Saskatchewan, and submitted reports on their work towards the end of the month.

Manitoba Conservation ecosystem monitoring specialist Geoff Jones visited Flin Flon in 2008 to resume monitoring vegetation on transect lines set up by Professor Winterhalder in a number of our areas. A detailed report on this work was submitted in June, 2009. A further five days of field work was carried out in July, 2009.

A study on the health implications of elevated levels of some metals and other elements in the soils of Flin Flon and Creighton, was referred to in the 2007 and 2008 Reports of Activities. The work is now nearing completion, and the final report is expected to be released in the summer of 2010. Information on this study – which is being carried out on behalf of HBMS by Intrinsik Environmental Sciences Inc. - is available at www.flinflonsoilsstudy.com.

Photography

During our first nine project years we took 1,618 pictures, and in 2009 we took an additional 229. These will serve as a permanent record of the project, and are being used for public relations purposes. Pairs of 'before-and-after' pictures

illustrate in a dramatic way, how effective the limestone treatment is proving to be. At left below is a view of part of our Hapnot area shortly after treatment in August, 2001. At right is the same area in September 2009.

Public Relations

There were 28 attendees at our annual informational meeting in early June. Articles in the Flin Flon 'Reminder' kept our project in the public eye again in 2009. Local radio station CFAR kept the public informed of our activities over the summer months. We put out a ninth issue of 'Green Project News'. Copies were distributed to interested parties, deposited at Flin Flon Public Library and made available for download on our web site – www.greenproject.ca . We made posters and brochures which were distributed to local schools. Presentations were made to the Flin Flon Rotary Club and to the Inner Wheel, and to several classes in Flin Flon and Creighton schools.

Future Plans

We aim to treat another five hectares in 2010. The main activity will be at our Esso, Pizza, Louis and Phantom Northwest areas - see the map on page 2.

Additional Information

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and check out our web site at: www.greenproject.ca

APPENDIX 1: Organizational Background and Procedures

In the late 1960s and early '70s, botanists at Laurentian University – among them our technical consultant, the late Professor Keith Winterhalder – found that the application of crushed limestone to the barren acidified and metal-contaminated soils around Sudbury led to the regeneration of vegetation. A major program of limestone application since then has led to a transformation of the Sudbury landscape.

In the early 1990s, Rena Gummerson and later Cathy Hynes of the Creighton /Denare Beach Economic Development Committee contacted Professor Winterhalder to see if he might be interested in helping to set up a re-vegetation program in our area. This resulted in his first visit up here in 1994. In 1999, Heather Acres and Clarence Pettersen of Flin Flon School Division thought that re-vegetation would be a good project for their Youth Mentor program and the Green Project was launched with the support of the School Division. Hudson Bay Mining and Smelting Company Ltd. and the Flin Flon Economic Development Commission generously provided funding to bring Professor Winterhalder up here in October 1999. He spoke to a number of groups and generated a high level of interest and enthusiasm. A community-based committee was formed, and planning meetings were held in March and April 2000. McKeen's Trucking generously donated 130 yards of crushed limestone, and this allowed us to put our first groups of students to work in the field in May of that year.

Present members of the committee are: Flin Flon School Division, Creighton School Division, City of Flin Flon, Town of Creighton, Flin Flon and District Environment Council, Hudson Bay Mining and Smelting Company Ltd., Saskatchewan Ministry of Environment and various community group leaders and members.

The first stage in planning our field operations involves checking out maps and air photographs. From these we get a general idea as to which areas might be suitable for treatment. We then ground-check the areas. Once their suitability has been confirmed, the crushed limestone is trucked in. Volunteers fill their pails at the dumps and spread the limestone as evenly as possible. The coordinator/supervisor makes sure no gaps are left. Work continues until the designated area is completely covered.

APPENDIX 2: Environment and Science

In and around the communities of Flin Flon and Creighton[1], there are large areas with little or no vegetation. Old tree stumps show that these areas were once forested.

In the 1920s and '30s when our communities and the smelter complex were first established, many trees were cut for fuel and lumber. Others were cut to make fire breaks, or were burned in forest fires. As production from the Flin Flon and other mines increased, so did the amount of sulphur dioxide smoke from the smelter. The smoke is harmful to vegetation, so the forest was not able to recover. The increasing acidity and metal content of the soil meant that only a very few hardy types of plant were able to survive. As the plants died, the thin topsoil washed away.

High levels of metals such as copper and zinc in the soil are toxic to plants[3]. This toxicity is accentuated by acidity, which makes the metals more soluble, and therefore more accessible. When seeds germinate in metal-contaminated soil, growth stops immediately on contact with the toxic soil solutions. The carbonate ion in the limestone tends to neutralize soil acidity, thus making the metals less

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[1] *Flin Flon and Creighton are situated on either side of the Manitoba/Saskatchewan boundary about 600 kilometres north of the Canada/US border. A large copper-zinc ore body was discovered at Flin Flon in 1915, and production – which started in 1930 – continues to the present day.*

[3] *This paragraph is from information supplied by the late Professor Winterhalder.*

soluble, and less toxic. Another component of the limestone, calcium, contributes to reducing soil toxicity by competing with zinc ions for uptake by plant roots. Calcium ions also have a strengthening effect on the plasma membranes in the root cells. This membrane is responsible for determining what is absorbed by the roots.

Since the early 1970s, Hudson Bay Mining and Smelting Company Ltd. has spent hundreds of millions of dollars to improve technology at the smelter complex, with the result that emissions of sulphur dioxide and metal oxide dust are now significantly reduced. The natural vegetation is slowly starting to recover. Our project is accelerating this recovery.

APPENDIX 3: Area Vegetation-Cover Scores at Fall, 2009

Area (& Distance)*	Years Treated	A	B	C	D	Total Score
1 - Balsam (1.9km)	'01	2	3	2	2	9
2 - RkCut (1.1km)	'01	1	1	2	0	4
3 - SecV-N (1.1km)	'00-'02,'08,'09	2	3	2	0	7
4 - SecV-W (0.9km)	'00,'01	0	0	0	0	0
5 - FirstA (1.0km)	'00	1	2	0	0	3
6 - Hiawa (1.1km)	'02,'04	3	3*	2	0	8*
7 - Grandv (1.3km)	'01,'05-'07	2	3*	2	0	7*
8 - Hapnot (1.6km)	'00-'02	3	3	2	2	10
9 - Phant (2.5km)	'01-'03,'07,'08,'09	3	3	2	2	10
10 - KtNor (1.7km)	'01	3	3	2	2	10
11 - Knight (1.8km)	'00	3	3	2	2	10
12 - Pizza (2.0km)	'01,'03,'04	3	3	2	2	10
13 - SoMain (1.6km)	'02,'03,'04	3	3	2	2	10
15 - Esso (2.2km)	'02,'03,'04,'08,'09	2	3	2	2	9
16 - CrtNor (1.6km)	'02,'03,'04	3	3	0	2	8
17 - Sup-K (1.2km)	'02	3	3	0	2*	8*
18 - TripSevn (0.6km)	'02	1	2	0	0	3
19 - Markt (1.4km)	'02	1	3	0	0	4
20 - ResHill (0.7km)	'02,'03',05,'08	1	2	0	0	3
21 - Lanc (2.3km)	'03',06	2	2	0	2	6
22 - RailRd (1.7km)	'03	2	2	0	2	6
23 - PhantN (1.9km)	'03,'05,'06,'09	3	3	2	2	10

24 – HapNor (1.5km)	'06,'07,'08,'09	2	2	2	2*	8*
25 - Louis (2.3km)	'04,'09	3	3	2	2*	10*
26 - CrtEast (1.4Km)	'04-'08	3	3	2	2	10
27 - SoHud (1.5km)	'05	3	3*	2	0	8*
28 - Roche (1.9km)	'05,'06	2	2	2	0	6
29 - PhantNW (2.1km)	'05	2	2	2	2	8
30 – RedMtn (2.1km)	'06	2	2	2	0	6
31 – Hilary (2.4km)	'06	2	2	2	2*	8*
32 – Golf (2.7km)	'07,'08,'09	1	2*	2*	0	5*
33 – Sand Bar (2.5km)	'07',08,'09	1	1	0	2*	4*
34 – DrivgRge (2.8km)	'08,'09	2*	1*	2*	2*	7*

A: Vegetation density - low/medium/high, score 1/2/3.
B: Maximum bushy seedling height - <0.5m/0.5-1.5m/>1.5m, score 1/2/3.
C: Two or more understory varieties present – score 2.
D: Self-seeded spruce/pine seedlings present – score 2.

* Approximate distance of area from HBMS Co. stack.
* Score improved since 2008.