Introduction

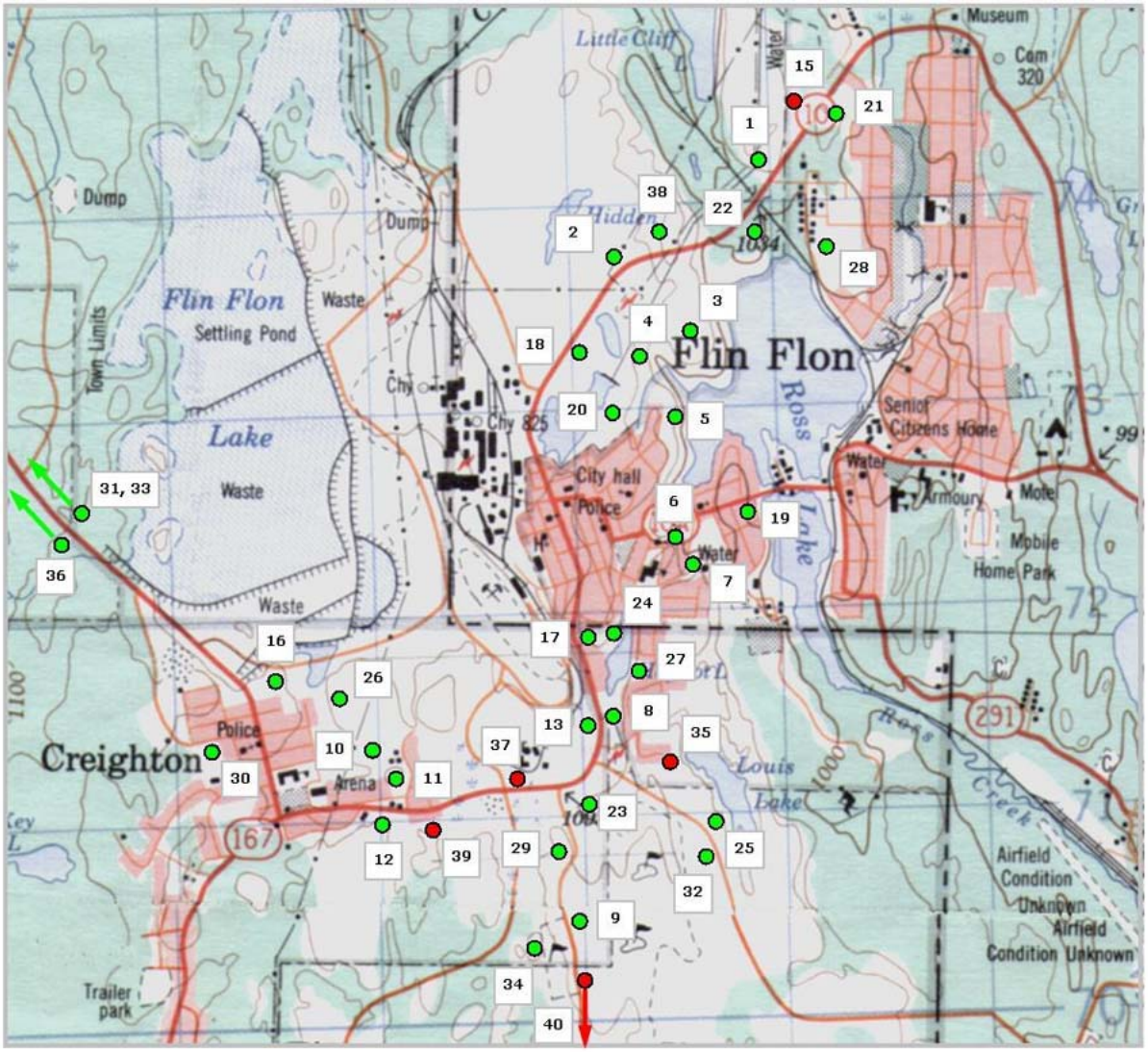
- 2012 was the thirteenth year for our community-based project.
- Our purpose is to accelerate the re-vegetation of barren areas in and around our communities by the application of crushed limestone.
- Because of the ruggedness of our terrain, it is not feasible to do the work by machine, so we use people-power, namely students from local schools and adult volunteers.
- The winter of 2011/2012 was milder than 'normal'. In spite of periods of rain in June through August, lake levels and the water table were low. Though there were pleasantly warm days through the summer, it was not notably hot. Some birch and aspen in two of our areas - treated in 2000 and 2001 - are now close to or a little over 6 metres high.
- The organizational and scientific backgrounds to our project are explained in Appendices 1 and 2.

Our Partners

We gratefully acknowledge that our project has been made possible through the generosity of our partners. Major funding for the work in 2012 came from HudBay Minerals Inc. (HMI). Flin Flon School Division and its Youth Mentor program and Creighton School Division supplied the bulk of our workforce. Hudson Bay Exploration and Development Company Ltd. supplied us with air photographs. Edgar and Mary Wright helped us with plant identification.

Areas Treated

In the map below, green circles indicate areas we treated in 2000 through 2011, red circles indicate those treated in 2012. Area names are as follows: 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, 18: 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, 35: Icehouse, 36: Creighton Creek, 37: Headframe, 38: Rock Cut North, 39: Larson, 40: Soccer.



During a field season lasting from May 31 through early September, we spread 47 yards of crushed limestone (dolostone) in 5 areas to cover a total of 1.8 hectares (4.4 acres). During the project period 2000-2012, we have treated 51.9 hectares (128.2 acres) with 1,123 yards of limestone (an application rate of 21.6 yards/hectare).

Volunteer Field Personnel

The work was carried out by 487 individuals during 28 sessions. These included 463 school students in 23 sessions. One session was handled by a group of 17 Resources Rangers (participants in a First Nations youth employment and training program). Interest in our Community Volunteer evening sessions has waned in recent years – this year we had one session only - however, one volunteer put in several sessions at our Esso area in September – good work Randy Bowman. Because Green Project co-coordinator Dave Price had temporary mobility issues to contend with this summer, we hired Hannah Fisher to supervise the school groups in the field – many thanks for a job well done Hannah. Details on personnel distribution are summarized in Appendix 3. At left below is a group of McIsaac grade 3s at work at our Soccer area in June. At right are some of the Resources Rangers after their session at the Soccer 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.

As of fall 2012, deciduous trees were more than two metres high in 30 of our treated areas, four or more metres high in 9 areas, five or more metres high in 5 areas (Knight, Knight North, Hapnot, Creighton North and Creighton East), and six metres high in 2 areas (Knight and Knight North). Our tallest self-seeded conifers are at the Hapnot, Phantom, Knight and Knight North areas. The tallest jack pines – commonly associated with old relict parents – are five metres high at the Phantom area. Our tallest spruce – at the Hapnot area – is three-point-four metres high. Below left is a view looking west over part of our Creighton East area. The area – which was formerly entirely barren – was treated in 2005 and 2006. The dense growth of birch – and the single spruce at left – are about two-and-a-half metres high. The view below right shows a promising start to growth at our Icehouse area – which was treated in 2011.

Until 2009, self-seeded tamarack (three individuals) had been noted only at our Knight area - the tallest is now three-point-one metres high. The small tamarack seedling first noted at our Creighton East area in 2010 is doing well. Individual Scots pines were noted for the first time at the Knight and Knight North areas in 2010. These were presumably seeded from imported trees planted in local yards – the individual at the Knight area is now three metres high. Alders were not seen in any of our areas until 2005 – they have now been noted in eighteen (three more than in 2011). In five of these areas, it appears that the seed came from individual alders put in at our 'plantations' – see 'Planting and Seeding' below - in 2001. Individuals and small clusters of dwarf birch were first noted at our Knight area some years ago. Dwarf birch has now been recognized in three areas.

Although understory species such as fireweed, rough cinquefoil, raspberry and bearberry are quite widespread, they tend in general to be few and far between. Our best areas in terms of variety and density of understory species are South Hudson and Roche. It is of interest to note that there is a greater variety and number of understory species coming through in areas we treated at our Louis and Esso areas in 2010 than in adjoining areas that were treated in earlier years. 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.

For the past several years, carpets of dead leaves have been accumulating in some of our most densely vegetated areas. These constitute the beginnings of a new organic topsoil. The mushroom Amanita muscaria was first noted in one of these shady and leaf-carpeted spots at our Knight North area in 2010. This year, Amanita has been noted in similar situations in six of our areas – see the picture taken at our Phantom North area below left. Our only other mushroom, the red-brown Laccaria laccata – seen at our Larson area, below right – is very common and has been noted at most of our areas since the early days.

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 'Scientific Studies' below - will provide an explanation and a remedy for this. The map - appendix 4 - provides an indication as to how well each individual area is progressing. Parameters used in constructing the map are: density of woody species, height of woody species, number of under-story species present, and presence or absence

of self-seeded conifers. It is notable that the four areas characterized as 'poorest' are within about a kilometer of the HMI stack. The six areas characterized as 'best', are all south and southwest from Flin Flon.

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 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 most 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 very good. A grass fire in June 2010, which reached the west end of the Balsam plantation, killed the pine and the alder and singed one of the spruce. Interestingly, this year five pine seedlings were noted in the immediate vicinity of the burned pine – presumably derived from its cones. Vandals broke off the main trunks of the two pines at the Hapnot plantation at knee-height in 2010, but growth of the lower branches continues. 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-cover status' (see appendix 4). Plantation conifers in some areas categorized as 'best' (such as Knight and Knight North) are very healthy and 4-5 metres 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. Since then, cones have appeared on the pines at the Second Valley, Hapnot, Pizza and Rock Cut plantations. The tallest spruce in our Knight North plantation produced masses of cones in 2009 – these were the first spruce cones to have appeared in any of our treated areas. In 2011, cones appeared on spruce at our Balsam, Knight and Pizza plantations.

Pine and spruce cones were scattered in sixteen 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 5 metres high. Seedlings in the other areas are up to 3.4 metres high. The pines at the Knight North area produced cones for the first time in 2008. Since then, cones have appeared on pines at our South Main, Phantom North and Creighton North areas.

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. Results to date are best at the Balsam/Esso area where some pines are up to 1.6 metres high. Since 2010, some have produced cones. Results are more patchy at the Second Valley area where mortality for both spruce and pines is high at square 1, but healthy spruce up to 95 centimetres high are quite widespread at squares 5, 6 and 8. It is no longer possible to distinguish the Cub and Beaver spruce and pines from the many self-seeded conifers that are coming through in the Phantom area. In May 2012, the Cubs and Beavers planted 500 white spruce seedlings at squares 182 and 184 at our Phantom North area. These survived a prolonged dry spell in June, and in late August most looked good and green and were up to about 30 centimetres high.

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 and are doing quite well and are up to a metre high. Some are healthily green and filling out (particularly at Balsam), while others are smaller, thinner and less regular, and tend to be a bit yellowish. Those put in at the Triple Seven area were buried during HMI landscaping activities in the fall of 2008.

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 six of our areas by Green Project staff on April 25, 2009 and by Creighton grade 4 students at the Sandbar area June 8. Scattered pine and spruce seedlings were noted for the first time at our Market area this year. Good densities of seedlings are present at all the other seeded areas. Dominant pines are associated with fewer and smaller spruce. Pines at the Reservoir Hill and Railroad area are up to 55 centimetres high, while some at the Hilary area are up to 85 centimetres.

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?

Our consultant Professor Keith Winterhalder made brief visits to Flin Flon in the summers of 2000 through 2003. He monitored vegetation growth and pH changes in the soil in areas we had treated – he also checked up on experimental plots he had established south of Creighton in 1994 and 1997. He submitted reports on his findings to the Green Project and to HMI in 2001 through 2004. At the time of his death in October 2005, he had been conducting greenhouse experiments on mixtures of Flin Flon soils with other additives. Manitoba Conservation ecosystem monitoring specialist Geoff Jones visited Flin Flon in 2008 to resume monitoring vegetation on the transect lines set up by Professor Winterhalder. A detailed report on this work was submitted in June, 2009. A further five days of field work was carried out in July, 2009. We were saddened to learn that Geoff passed away in January, 2010.

Following preliminary discussions with HMI 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 HMI and the Natural Sciences and Engineering Research Council of Canada (NSERC) allowed the project to go ahead for an initial three-year period. Additional NSERC funding - in place as of June 2011 - will allow the project to continue for two more years. Site assessment – which included detailed soil mapping and collection of soil samples for laboratory characterization – was carried out in 2008 and continued through 2009. Other project components include development of amendment strategies, metals characterization and speciation, and soil ecology and ecosystem sustainability. See 'Public Relations' – below – for media reports on this project.

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 our 2007-2010 Reports of Activities. The final study report was released in June, 2010. This report, together with

other information on the study – which was carried out on behalf of HMI by Intrinsik Environmental Sciences Inc. - is available at www.flinflonsoilsstudy.com.

Photography

Pairs of 'before-and-after' pictures illustrate in a dramatic way how effective the limestone treatment is proving to be. At left is a view looking north at our Hiawatha area taken in April, 2003 – the area had been treated during the summer of 2002. At right is the same scene in September this year. During our first twelve project years we took 2,183 pictures, and in 2012 we took an additional 134. These will serve as a permanent record of the project, and are being used for public relations purposes.

Public Relations

Reports on aspects of the University of Saskatchewan's soil science study appeared in the Saskatoon 'StarPhoenix' (December 10, 2012) and in the Flin Flon 'Reminder' (January 9, 2013). These dealt with work being done at the Canadian Light Source synchrotron on base metal speciation. We made posters and brochures which were distributed to local schools. Our web-site – www.greenproject.ca – has been updated and can now be adjusted for viewing on desktop computers, tablets and on mobile phones.

Future Plans

We aim to treat another five hectares in 2013. We will continue work at our Phantom, Icehouse, Headframe and Soccer areas and start work at the new Rock Cut Middle area.

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 1970s, 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 consultation group 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 consultation group are: Flin Flon School Division, Creighton School Division, City of Flin Flon, Town of Creighton, Flin Flon and District Environment

Council, HMI, 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 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.

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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.*

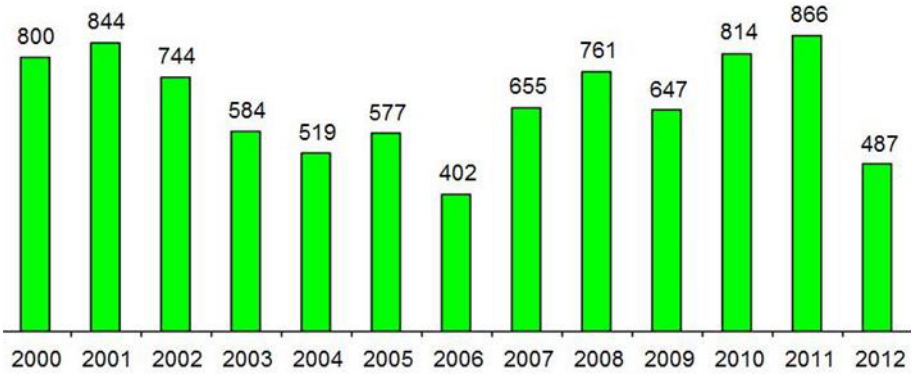
Since the early 1970s, Hudson Bay Mining and Smelting Company Ltd. spent hundreds of millions of dollars on improving technology at the smelter complex, with the result that emissions of sulphur dioxide and metal oxide dust were significantly reduced. The natural vegetation started to slowly recover. Our project is accelerating this recovery. In June 2010, the copper smelter was closed down, resulting in a complete cessation of gaseous and particulate emission from the stack.

APPENDIX 3:

Personnel Summary Tabulation ~ 2012

Group	Sessions	Number*
McIsaac School	9	169
Ruth Betts School	4	86
Creighton School	4	110
Hapnot Collegiate	6	98
Many Faces E.C.	-	-
Resources Rangers	1	17
Community Volunteers	4	7
Total	**28**	**487**

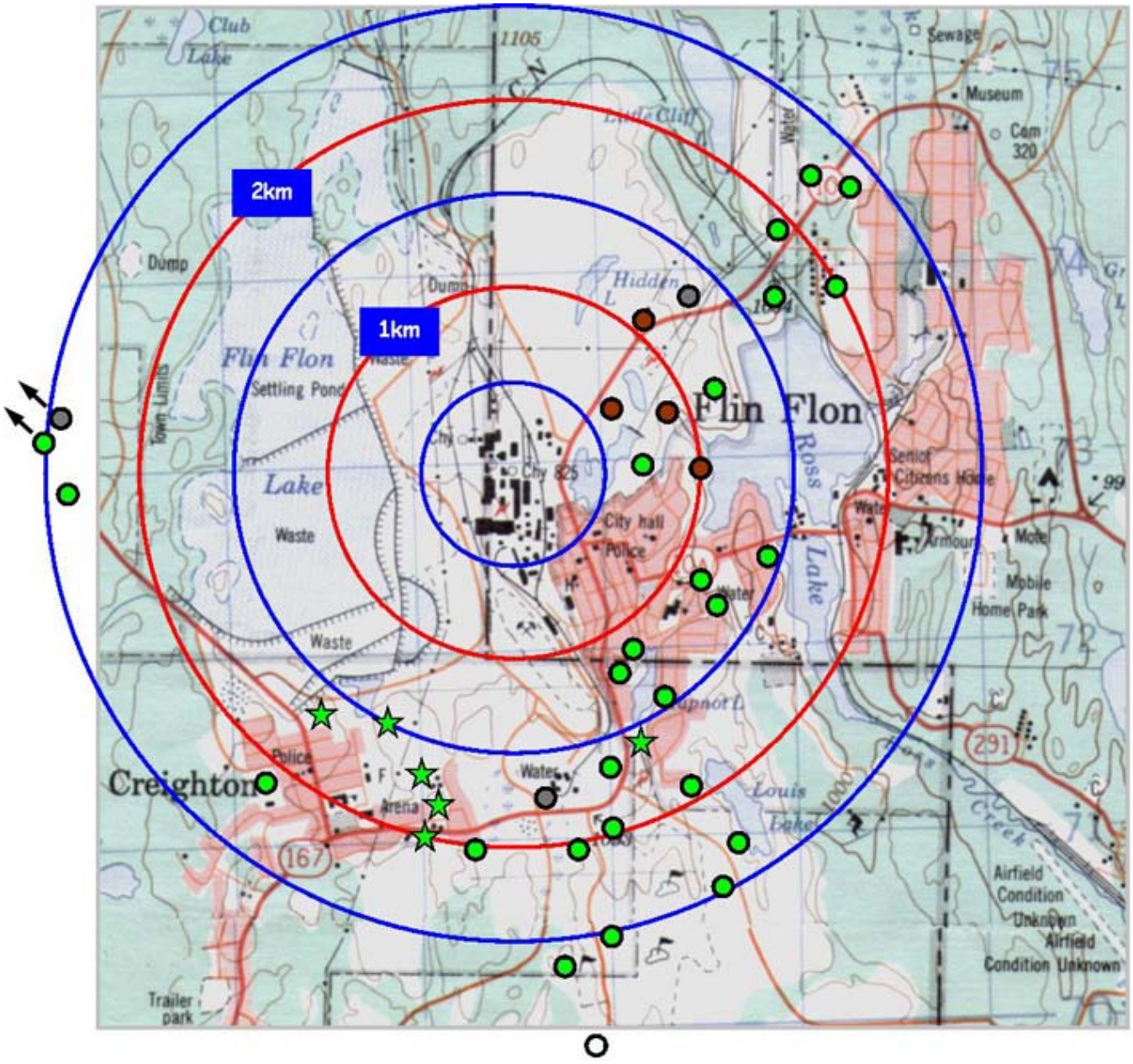
Personnel Distribution ~ 2000-2012



Total to date ~ 8,700*

* *Because some individuals worked in more than one session, the actual number of participants in the Green Project is less than this.*

APPENDIX 4: Vegetation-Cover Status by Area at Fall, 2012



Green stars – best, green circles – good, gray circles – promising, brown circles – poorest, open circles – awaiting results.

Large circles are centred on HMI's stack (half-kilometre intervals).