Executive Summary:

Approximately 130,000 hybrid poplar tree slips were planted on the 80 acres of cropland rented near Graceville, MN by Energy Performance Systems (EPS). Heavy rains in the area delayed the planned start of planting and the pre-emergence herbicide applications. The rains were sufficient enough to delay nearby corn and bean planting in the area by as much as 30 days. The planting was initiated on June 9, 2007 using the planter designed and built by EPS. During the main planting period from June 9 to June 29 approximately 76 acres were planted. The last few acres were planted by July 5. About half of the 80 acres was checked in a 5 x 5 foot spacing using the GPS guided EPS planter. The John Deere 8130 with Greenstar Pro, Auto Steer and the Starfire ITC receiver/transmitter was used. The John Deere Auto Steer and the ALMACO SkyTrip system were required to keep both the between-row spacing and the in-row spacing at 5 ft. Approximately 20 acres were planted with the EPS 6-row planter. Planting delays were due to very wet conditions, planter injection springs, undersized planting stock, and the GPS guidance system. Because of these difficulties on June 18th an experienced hand planting field crew was hired to complete the planting.

Commercial weed control approaches were used, including spraying the field with glyphosate (round-up) a few days prior to planting and applying a mixture of Pendulum and Scepter following planting on June 27, 2007. A few acres of the field were used to establish a nursery.
stool bed on July 5 & 6 for producing additional cuttings in the following years. The planting stock for the stool bed was from the undersized and unused material. Inspection of the site on July 17 and 18, 2007 showed that post-planting survival was excellent. Almost all mortality in the machine planted row was due to undersized planting stock as nearly 100% of the 3/8” and larger stock survived machine planting.

EPS performed the engineering and a design for modifying a 60-foot wide sprayer with a 4-foot underbelly to one with a 16-foot clearance to allow for second year control. However, following our experience in 2006 with weed control results, we came to the conclusion that mechanical control would produce better results than using herbicides which are very dependent on rain to be effective. On July 9 EPS purchased a 44 inch wide brush cutter that had an overall width of 60 inches. The unit was modified to an overall width of 46 inches to allow for the necessary driving tolerance of ± 8 inches. It is being used with a rented 4 X 4 ATV to provide control of weeds on the site. An alternate solution for weed control would be to develop round-up ready planting stock which is now the norm for corn and bean production.

Technical Progress:

12a – Completion of planting of hybrid poplar trees in commercial trial per project plans and specifications using no-till preparation.

As reported in Milestone 10, 150,000 tree slips were purchased from Hraymor Nursery for the 2007 planting. The first group of about 3000 slips (6 bags) were removed from storage on Saturday June 2, and carried in the back of a truck to the planting site to use in some trial planting tests with the new planter. After testing a few of the slips in the planter (discussed in Milestone 11 report), it was noted that several slips seemed to be smaller in diameter than specified. The remaining 440 slips in the opened bag were sorted and it was found that 62 or 14% did not meet specifications either because they were too small, bent, or had breaks in the skin (Fig. 1 &2). The major problem was small size, but otherwise they appeared to be in good condition from the standpoint of bud development and moisture content.

The project plan was to plant the cuttings into an untilled cropland site that was not drained. Both fields at the Graceville, MN site selected were in very good condition with relatively few

Fig. 1  All slips appeared to meet the 9 inch length specification.

Fig. 2. The diameter specification of 5/16 to 7/8 inch was exceeded on either the small end or large end in about 14% of the slips.
weeds and a thin layer of wheat straw residue remaining on both the west field and east fields in late May. Both fields were sprayed with round-up (glyphosate) on May 14 in preparation for initiation of planting on June 2, 2007. Pre-plant weed control appeared to be relatively effective as of June 2, when we arrived to begin planting, (Fig. 3 & 4) and no-till planting would have been a reasonable approach. Some portions of the fields not shown in photos below did have more weeds, but the majority of the field was as shown below.

Because of major rainstorms on May 30 and 31, all crop planting in the area had ceased due to wetness of the fields. Since the tree planting site was not drained and very flat, and the sky was still overcast, it did not dry out quickly. Some areas of the field still had surface water ponding on June 5 and 6 (Fig. 5&6). The decision was made to shallow cultivate “dig” the majority of the field with a track type 4-wheel drive tractor to facilitate drying out of the soil. Two strips (enough for 12 rows) were left untilled on both the west and east fields for comparison purposes and to meet the obligations of the proposal to evaluate growth under untilled conditions.

Anticipating that the field would be sufficiently dry for planting by June 9, 2007, all of the remaining hybrid poplar slips were moved from the freezer in Minneapolis to refrigerated storage in Wheaton, MN on June 9. Fortunately the field had sufficiently dried and the tractor and planter combination was able to operate in the field without getting stuck and damaging the site. The major focus of work on June 9 was getting the position control system, purchased from ALMACO, set up and properly working. This is more fully described in Milestone 11.
A total of about 20 acres were machine planted. An area of about 13 acres located on the eastern portion of the west was planted first, between June 9 and June 20, 2007. It consisted of 48 rows of trees or 8 passes with the planter over most of the length of the field. The lengthy time involved in machine planting was caused by the need to mold several new sets of rubber springs and get them from Minneapolis to Graceville, and install them on the planter. The second area of about 7 acres, located in the curved section of the west field, was planted by machine on June 25 & 26. Videos and pictures were taken of the planter in operation (Fig. 7). During this substantial test of the new machine planter, EPS was greatly assisted by the landowner in finding crews to load the feed hoppers during operation and in assisting with making in-field planter modifications.

Because of these operational difficulties, on June 18th an experienced hand planting field crew, who were in Minnesota planting other commercial hybrid poplars plantings, was hired and began planting on June 22. Hand planting of approximately 54 acres was completed in about 2 1/2 days.

Following planting, the pre-emergent herbicide sprays Pendulum and Scepter were applied as a mixture to the site on June 27, 2007. Wind delayed the spraying five days. To avoid herbicide damage, the portion of the west field machine planted on June 9 & 10 was not sprayed since trees had already begun leaf out. Another small part of the west field was not sprayed due to the limited amount of spray available. Mowing was the weed control method used in those areas. The rate of herbicide application was 1.5 quarts/acre of Pendulum and 2.1 oz/acre of Scepter. Based on observations in mid-July, the relative amounts of broadleaved plants in the tilled and untilled portions of the field indicated that relatively good broadleaf control had occurred (Fig. 8). However, there appeared to be very little herbicide control of grass in the untilled area of both the east and west fields (Fig 9). Thus it is apparent that tillage facilitated the incorporation of the herbicides into the soil even though rainfall has been very minimal after spraying.
To obtain preliminary data on the effects of hand-planting versus machine planting on survival and early leaf flush, comparisons were made between an adjacent hand planted and machine planted row along an equivalent N-S length of each row on July 18, 2007. Because this sample represents a very small portion of both the hand planted and machine planted sections of the field, and because the machine planter is still in an early development stage, this data should be understood to be limited in value. The two adjacent rows were chosen to minimize the effects of soil and planting timing differences. By making the comparison in mid-July, the complication of weather effects, and weed control variation were also avoided.

The comparison showed that within a distance of 1895 ft, the two rows contained a differing number of trees. The spacing intervals in the hand planted row were not accurate, averaging closer to 5.3 ft between trees, rather than 5 ft. While spacing in the machine planted row did appear to be accurate, some planting locations in the row were missing trees. There were 356 planted trees in the hand planted row and 336 planted trees in the machine planted row. A complete planting at 5 ft intervals would have contained 379 trees. “Missing” trees in the hand planted row were due to inaccurate spacing estimates by the hand planters. “Missing” trees in the machine planted row were likely due to a combination of inaccuracies caused by the many stops and starts of the planter as operational problems were dealt with and the inexperience of some of the planting crew.

Mid-July survival of trees, based on actual planted trees, was excellent in both rows. A tree was counted as surviving if there was any evidence of leaf-out. The majority of the trees were leafing out nicely with tree heights in the range of 8 inches to 2 feet (Fig. 10) on July 18, 2007.

It was observed that 10 % of the machine planted slips were damaged but still producing leaves as of July 18. Since most of the damaged slips not producing leaves were less than 3/8 inch, survival can be improved by changing the slip specification. Only 1.3% of the slips had “smashed” tops and all of those appeared to be producing healthy leaf-out. Damage to the slips is very preventable and will be corrected once changes are made to the planter.
12b. Commercial Spray Rig Modification

EPS proceeded with engineering and a design for modifying a 60-foot wide sprayer with a 4-foot underbelly to one with a 16-foot clearance to allow for second year control. However, when examining damage caused by various spray’s, and the fact that 5 x 5 feet is a very tight spacing, and crown closure takes place in the second year, we came to the conclusion that mechanical control would produce better results. On July 9 EPS purchased a 44 inch wide brush cutter that had an overall width of 60 inches. The unit was taken into our shop and modified to an overall width of 46 inches to allow for the necessary driving tolerance of ± 8 inches. On July 16 the unit was transported to the site with a rented 4 X 4 ATV and set up for weed control. The unit did an acceptable job of control. Maintenance, however, on the belt drive for the swing blades has been excessive and would have to be upgraded for large commercial applications. Considering the costs for both the ATV and its operator, the system compares favorably to the herbicide application and is much more controllable and less weather dependant. The overall cost of a single application of glyphosate was $1200 and the Labor and rental cost of the brush cutter was approximately $550 and $600 respectively. The mechanical control advantages include the ability to traverse much wetter ground and greater flexibility deciding when to control the weeds.
The accomplishment of Milestone 12 requires observation of the planting area by a RDF representative. Mark Ritter, the contract manager for Xcel on this project, visited the planting site on June 21, 2007.

**Additional Milestones Completed:**

- **M1 – Annual Land Rental (first year);** report submitted April 2006, payment made.
- **M2 – Design & Test Planter Injection system;** report submitted July 2006, payment made.
- **M3 – Tree Slip Purchase & Tractor Purchase;** report submitted April 2006, payment made based on lease assumption.
- **M4 – Basic Planter Design and Fabrication;** report submitted 12/6/06, payment made.
- **M5 – Test Planter;** report submitted 12/7/06, payment made.
- **M6 – First 80 acre Planting;** revised report submitted 12/6/06, payment made.
- **M8 – Post Planting Tending and Monitoring;** report submitted March 2007, payment made.
- **M9 - Annual Land Rental (second year),** report submitted July 2007, payment made.
- **M10-Tree Slip Purchase for Second Year and Tractor Rental;** report submitted March 2007, payment made.
- **M11 – Completion of Purchase of Automatic Position Control for Planter and Completion of Update of design drawings, installation and testing:** report submitted.

**Milestones In Progress:**

- **M7 - Tree Harvester Testing;** work on the harvester is in progress but has been delayed.
- **M13 – Harvester Testing and Modifications;** work on the harvester is being delayed due to lack of availability of labor manpower at the fabricators shop.
M14 – Annual Tending and Monitoring of Trees: Tending of the trees was started on July 17, 2007 using a modified mower pulled behind a 4-wheeler. A local labor, has been hired to mow between the rows in the both fields at least twice during the growing season in order to keep weeds under control and to check for insect or other problems. Planning for data collection in the fall is underway. The date has already been agreed upon and travel arrangements made for collection of growth data in mid-October. The University of Minnesota foresters who assisted with data collection in 2006 will again be recruited to assist with collection of survival and tree height measurements in fall 2007. A more extensive stratified random sampling technique will be used to obtain overall survival data and to compare differences between machine and hand-planting and between the tilled and untilled sections of the east and west fields.

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