Footprints

The Evolution of Land Conservation and Reclamation in Alberta

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About this Book

Footprints: The Evolution of Land Conservation and Reclamation in Alberta is the story of how Alberta's land conservation and reclamation program came into being and how it has progressed over the past half century. Our goal is to provide an objective description for current and future generations. We believe it may be of interest and value to practitioners actively engaged in the numerous conservation and reclamation components, to landowners whose land is being disturbed, to industrial users responsible for the disturbance, to elected and appointed officials having a moral duty to see to the land's conservation and reclamation, and to college or university students considering a career in this or a related field. The book was initiated by several dozen retired or still-active land reclamation practitioners whose careers, in some instances, reach as far back as the 1960s. Some are still employed in public or private life, conserving and reclaiming our rich natural heritage. This is being written to help assess how effectively we have, or are, conserving our land base and providing the stewardship required to pass our legacy on to our progeny.

Those participating in the book's creation include professional writers, former and current government regulators, researchers, academics, and former to current industry reclamation managers or practitioners. Some have contributed text, memories of their actions and observations, photographs and documents, or simply fragmented recollections to help piece together this history.

Four former directors of the Land Reclamation Division at a land reclamation reunion, October 2, 2010. (L to R) Larry Brocke, 1993–98; John King, 1982–93; Doug Harrington, 1972–82; Henry Thiessen, 1971–72.

Dedication

This book is dedicated to Larry Brocke. Larry's impact on conservation and reclamation is evident throughout this document—from his early work as a soil surveyor, to his leadership as chair of the Development and Reclamation Review Committee, and later director of the Land Reclamation Division, and finally his role in establishing a growing consulting firm providing industry and government with conservation and reclamation advice and services.

His vision for this book was to provide an objective description of the progressive changes to Alberta's land conservation and reclamation program over the past 50 years.

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We also thank writers Graham Chandler, Peter McKenzie-Brown, and Henry Thiessen for their exceptional knowledge, insight, and commitment to this history project. Robert Bott, editor and writer, is commended for his inquisitive and comprehensive approach to all facets of the project.

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Abbreviations

ABMI	Alberta Biodiversity Monitoring Institute
AEMERA	Alberta Environmental Monitoring, Evaluation, and Reporting Agency
AENV	Alberta Environment
AER	Alberta Energy Regulator
AESRD	Alberta Environment and Sustainable Resource Development
AFS	Alberta Forest Service
AGTL	Alberta Gas Trunk Line
AITF	Alberta Innovates – Technology Futures
AOSERP	Alberta Oil Sands Environmental Research Program
AOSTRA	Alberta Oil Sands Technology and Research Authority
APESC	Alberta Pipeline Environmental Steering Committee
AR	Alberta Regulation
ARDA	Agricultural Rehabilitation and Development Act
ASGA	Alberta Sand and Gravel Association
AT	Alberta Transportation
AUC	Alberta Utilities Commission
bbl	barrel
B.Sc.	Bachelor of Science
BRRRP	Battle River Reclamation Research Project
CAC	Coal Association of Canada
CAPP	Canadian Association of Petroleum Producers
CEMA	Cumulative Environmental Management Association
CEPA	Canadian Energy Pipeline Association
CEO	Chief Executive Officer
CCREM	Canadian Council of Resource and Environment Ministers
CCRM	Canadian Council of Resource Ministers
CFB	Canadian Forces Base
CHOPS	Cold Heavy Oil Production with Sand
CLI	Canada Land Inventory
CLRA	Canadian Land Reclamation Association
CMDRC	Crown Mineral Disposition Review Committee
CNR	Canadian National Railways
CNRL	Canadian Natural Resources Limited
CONRAD	Canadian Oil Sands Network for Research and Development
COSIA	Canada's Oil Sands Innovation Alliance
CPR	Canadian Pacific Railway
CRR	Conservation and Reclamation Regulation
CSA	Canadian Standards Association
CSS	Cyclic Steam Stimulation
CT	Consolidated (or Composite) Tailings
CUC	Conservation and Utilization Committee
CWR	Central Western Railway
DC	Direct Current
DRRC	Development and Reclamation Review Committee
ECA	Environment Conservation Authority (renamed Environment Council of Alberta in 1977)
EIA	Environmental Impact Assessment
ELC	Equivalent Land Capability
ENR	(Alberta) Energy and Natural Resources
EPEA	Environmental Protection and Enhancement Act
EPO	Environmental Protection Order
ERCB	Energy Resources Conservation Board
ESRD	(Alberta) Environment and Sustainable Resource Development
EUB	(Alberta) Energy and Utilities Board
EVT	Environmental Technology
FMA	Forest Management Agreement
GCOS	Great Canadian Oil Sands (now Suncor)
GIS	Geographic Information Systems
GPS	Geographic Positioning Systems
HDD	Horizontal Directional Drilling
HSRP	Highvale Soil Reconstruction Project
IRD	Interdepartmental Relations Division
LAD	Land Assembly Division
LARP	Lower Athabasca Regional Plan
LCRC	Land Conservation and Reclamation Council
LCRD	Land Conservation and Reclamation Division
LFH	Litter – Fibric – Humic
LG/C	Lieutenant Governor in Council
LLR	Licensee Liability Rating
LOC	Licence of Occupation
LRIGS	Land Reclamation International Graduate School
LSCRA	Land Surface Conservation and Reclamation Act
LSCRC	Land Surface Conservation and Reclamation Council
MEA	Monoethanolamine
MLA	Member of the Legislative Assembly

M.Sc.	Master of Science
NAIT	Northern Alberta Institute of Technology
NBRI	NAIT Boreal Research Institute
NEB	National Energy Board
NPS	Nominal Pipe Size
NRCB	Natural Resources Conservation Board
NRCC	Natural Resources Coordinating Council
NRDA	Natural Resources Development Authority
OC	Order in Council
OGCB	Oil and Gas Conservation Board
OGRRAC	Oil and Gas Remediation and Reclamation Advisory Committee
OPEC	Organization of Petroleum Exporting Countries
OSE	Oil Sands Exploration
OSESG	Oil Sands Environmental Study Group
OWA	Orphan Well Association
P.Ag.	Professional Agrologist
PCA	Parsons Creek Aggregates
PCRRP	Plains Coal Reclamation Research Program
Ph.D.	Doctor of Philosophy
PHRP	Plains Hydrology and Reclamation Project
PITS	Petroleum Industry Training Service
PNGCB	Petroleum and Natural Gas Conservation Board
PSRP	Plains Soil Reconstruction Project
RAP	Reclaimed Asphalt Pavement
RBW	Rheinische Braunkohlenwerke
RCAG	Reclamation Criteria Advisory Group
RDA	Restricted Development Area
RFD	Request for Decision
RFP	Request for Proposal
RRTAC	Reclamation Research Technical Advisory Committee
RSA	Revised Statutes of Alberta
SA	Statutes of Alberta
SAGD	Steam-Assisted Gravity Drainage
SAIT	Southern Alberta Institute of Technology
SRC	Surface Reclamation Council
SREM	Sustainable Resource and Environmental Management
TDS	Total Dissolved Solids
TUC	Transportation and Utility Corridor
UK	United Kingdom
US	United States
USGS	US Geological Survey
WTI	West Texas Intermediate

PART ONE

OVERVIEW

Land reclamation students revegetating a former waste disposal site in Waterton Lakes National Park. ***M. Anne Naeth***

Introduction

We are prosperous now, but we must not forget that it is just as important that our descendants should be prosperous in their turn.

Frank Adams

Aboriginal people lived for about 10,000 years in the area that would become Alberta. They left few footprints on the land. Wind, water, fire, seasonal and climatic variations, the life cycles of plants, the comings and goings of animals, and the actions of micro-organisms continually shaped and altered the landscapes these people knew. Their use of fire and their hunting and gathering practices may have altered some landscapes and ecosystems.[1]

The human footprints on the land became far more obvious and numerous after the arrival of the Canadian Pacific Railway in 1883. The grasslands, forests, and mountains drew farmers, coal miners, loggers, builders, tourists, explorers and developers of oil and natural gas, and all the people needed to provide the newcomers with goods and services. The population was about 185,000[2] when Alberta became a province in 1905; today it is more than 4 million. There are now few landscapes without some evidence of our presence:

- About 40 per cent of the land area is settled—farms, ranches, towns, cities, and commercial and industrial developments. Much of the remaining area is affected by energy, forestry, transportation, and recreation activities.
- There are more than 226,000 kilometres of public roads, including more than 61,000 kilometres of paved roads, and about 9,700 kilometres of railway.[3] Many thousands of kilometres of buried pipes carry water and sewage; fibre optic telecommunication lines are increasingly extending their reach.
- Approximately 450,000 oil and gas wells have been drilled in the province, nearly half of which are still in various stages of production, and in recent years an average of more than 10,000 wells have been drilled annually.[4] About 450,000 kilometres of pipeline of varying sizes and lengths serve the energy industry, with as much as 10,000 kilometres added each year.[5]
- Five large oil sands mining operations, some with multiple sites, are located north of Fort McMurray.[6] In situ oil sands operations, largely concentrated in the area south of Fort McMurray down to Cold Lake, include central processing facilities, steam-generating plants, water treatment facilities, roads, pipelines, and well pads. There are also in situ bitumen operations in the Peace River area.
- Currently nine coal mines operate in Alberta.[7] Since the 1870s more than 2,000 underground and surface mines have exploited the province's vast coal resources and produced more than 1 billion tonnes of coal.[8]
- Electricity reaches consumers and industries through 21,000 kilometres of high-voltage transmission lines.[9]
- Twenty-one industrial mineral quarries produce limestone, sandstone, shale, salt, silica sand, and dolomitic siltstone.[10] There are also at least 3,000 sand and gravel pits and numerous borrow excavations used for construction of roadways. About 20 operations harvest peat.

As these land uses expanded and multiplied, the importance of land conservation and reclamation became evident to landowners, politicians, scientists, bureaucrats, industries, workers, and the general public. They concluded that temporary, non-renewable land uses should not diminish the inherent value of the land—even if "temporary" might mean a time span of decades. Developing systems and practices to achieve this goal has been an evolutionary process, and it is still evolving.

Land Capability

A simple definition of landscape is "as far as the eye can see." This once meant the panorama from the highest point in an area; now it can also mean the view from an airplane or even a satellite. Likewise, our understanding of land capability has expanded beyond crops, forage, and trees to include values such as biological diversity, wildlife habitat, traditional land use, culture, recreation, and aesthetics.

Four interdependent factors influence land capability and determine the success of conservation and reclamation over time:

Topography – the contours and aspects of the landscape shaped by geology, glaciation, wind, water, and human interventions

Hydrology – how the land holds precipitation and transmits water internally and surficially, both greatly influenced by the climate and its hydrological cycle

Soil – the naturally occurring, unconsolidated, mineral or organic material at the Earth's surface that is capable of supporting plant growth. It extends from the surface to 15 centimetres below the depth at which properties produced by soil-forming processes can be detected

Biota – the living things on and under the surface, which can range from micro-organisms to grasses to trees

Each of these components plays a role in the re-establishment of land capability after disturbance. The intended land use resulting from these interactions depends on factors such as climate, water resources, proximity to urban development, transportation infrastructure, prevailing economic conditions, and social values.

As well, each of these components and concepts is a science in itself. Applying the sciences in the real world may involve a complex balancing of economic, social, and environmental considerations. Determining success is often a judgment call. There is no single solution for every site, region, or intended land use. Urban land areas pose special challenges and at the same time offer unique opportunities for creative reclamation solutions. Many sites also require remediation—removal or treatment of contaminants. Those responsible for land disturbance receive a reclamation certificate when government is satisfied that capability has been returned, ultimately ending the temporary user's reclamation liability for the site.

Conservation and Sustainability

The concept of "conservation" has been evolving since US President Theodore Roosevelt[12] and Gifford Pinchot, the first head of the US Forest Service,[13] popularized it in the early 20th century. In 1909, former Interior Minister Sir Clifford Sifton founded Canada's Commission of Conservation, modelled on the US body established a year earlier by Roosevelt. The influential commission, led by Sifton, reported annually to Parliament and produced numerous publications before it was dissolved in 1921; by then many of its recommendations had become government policy.[14] Frank Adams, dean of Applied Science at McGill University, chaired the commission's Minerals Committee. In 1914, he told the Royal Society:

> Our forests, our lands, and our fisheries will, if properly worked, not only yield this generation a larger profit, but they will be handed on to our successors in a more highly productive condition than that in which we received them. We are prosperous now, but we must not forget that it is just as important that our descendants should be prosperous in their turn. Each generation is entitled to the interest on the natural capital, but the principal should be handed on unimpaired.[15]

Sometimes called "wise use," the term has had a spectrum of meanings. These have ranged from protection and preservation to "highest and best use" of natural resources—that is, maximizing their utility and avoiding waste. Emphasizing the latter meanings, most of the predecessors of the Alberta Energy Regulator (see Chapter 3) since 1938 have had "conservation" in their titles, and the province still has a Natural Resources Conservation Board to assess non-energy developments. Since the 1987 report of the World Commission on Environment and Development (the Brundtland Commission[16]), "sustainable development" has become a somewhat less ambiguous alternate term for conservation. Essentially, sustainable development means meeting today's needs without impairing the ability of future generations to meet their needs. Knowledge, technology, and wealth, passed on to future generations, are often considered components of sustainability.

Key Definitions from the 2002 Alberta Environment *Reclamation Glossary*

compiled by Chris Powter[11]

Conservation (sustainability)

- the planning, management, and implementation of an activity with the objective of protecting the essential physical, chemical, and biological characteristics of the environment against degradation
- a policy that seeks to sustain future useable supplies of a natural resource by present actions
- the protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits

Conservation (soil)

- (1) protection of the soil against physical loss by erosion or against chemical deterioration; that is, excessive loss of fertility by either natural or artificial means
- (2) a combination of all methods of management and land use that safeguard the soil against depletion or deterioration by natural or man-induced factors
- (3) the division of soil science dealing with soil conservation and (1) and (2)

Larkspur blooming on reclaimed land. *Bob Logan*

Reclamation

- the process of reconverting disturbed land to its former or other productive uses
- all practicable and reasonable methods of designing and conducting an activity to ensure: (1) stable, non-hazardous, non-erodible, favourably drained soil conditions, and (2) equivalent land capability
- Regulatory definition:
  - the removal of equipment or buildings or other structures and appurtenances
  - the decontamination of buildings or other structures or other appurtenances, or land or water
  - the stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land
  - any other procedure, operation, or requirement specified in the regulations

Seedling. *Suncor Energy Inc.*

Presumably representing the will of the people, federal and Alberta governments decided in the 19th and early 20th century that farming and ranching were the best uses for the vast prairie grasslands vacated after extirpation of the bison herds and the signing of Aboriginal treaties. Total occupied farmland in Alberta soared from 1.1 million hectares in 1901 to 7.0 million hectares in 1911 and 11.9 million hectares in 1920; since then farmland has gradually expanded to the post-1961 total of about 20 million hectares.[17]

That land-use decision led to others. Agriculture on the arid plains depended crucially on adequate water, so the governments set aside forest reserves and barred most settlement and clearing in the forested foothills watersheds. The water flowed into Alberta's irrigation district system that now includes 50 impoundments and 8,000 kilometres of channels.

Governments also deemed that the development of towns and cities, and supporting infrastructure such as railways and roads, were desirable and sustainable land uses.

Logging in the forest reserves provided railway ties, mine timbers, and lumber for homes and buildings on the treeless prairies. As forestry became more extensive and industrialized after the 1950s, provincial regulators made the sector more sustainable through requirements to reforest harvested lands and placed restrictions on logging near waterbodies. The annual forest harvest in Alberta had grown to about 1 million cubic metres by 1940, and by the mid-1970s it had reached about 5 million cubic metres; since the mid-1990s the total has averaged more than 20 million cubic metres.[18]

The need for active land conservation became evident during the 1930s when drought and farming practices led to widespread degradation of soils. The governments used laws, education, and applied research to limit the damage. The "Dirty Thirties" finally ended after changes in farming practices, renewed rainfall, increased irrigation, and the end of the Great Depression. Since then, the provincial Agriculture Department has continued to assist and educate—and intervene when necessary—to ensure the sustainability of farming and ranching. Government departments (currently Environment and Parks as well as Agriculture and Forestry) have likewise overseen activities such as forestry and recreation on public lands.

Governments and the Alberta public generally have supported sustainable land uses such as farming, ranching, human settlement, forestry, recreation, and tourism. Yet conservation requires continued vigilance as land uses intensify and increasingly overlap. At a 2014 conference, for example, Alberta agrologists expressed concern about the loss of agricultural land to urban and industrial develop-

On February 13, 1947, oil flowing from a well in a farmer's field near Leduc prompted the biggest oil boom in Canadian history. Imperial Leduc #1 signalled the beginning of Alberta's reliance on non-renewable resources for the majority of revenues and employment. Within a few years, oil and gas replaced agriculture as the province's dominant industry. *Provincial Archives of Alberta P2719* ment at a time when climate change and population growth could lead to much greater demand for food production.[19] Compliance with regulations is necessary, but optimal success and progress have involved cooperation and collaboration among companies, landowners, educational institutions, researchers, consultants, farmers, ranchers, land managers, and foresters.

Reclamation and Remediation

Until the Leduc oil discovery in 1947, agriculture dominated the Alberta economy, and the "footprint" of transient, non-renewable, extractive industries was very small. More than 1,000 coal mines had been excavated; most were underground or relatively small excavations on the surface.[20] There had been scattered exploration drilling and modest oil and gas development, mainly around Turner Valley and in the Medicine Hat and Viking areas. Leduc changed all that, and by the mid-1950s oil and gas revenues exceeded those from agriculture. Most farmers and ranchers did not own the mineral rights under their property, and they became increasingly concerned about the condition of their land after the drilling rigs departed. Regulations said "abandonment" of a wellsite was supposed to leave the site in a safe and clean condition, but this was not always the case, and many landowners were not satisfied with the result.

Concerns from farmers, landowners, outdoors enthusiasts, and municipalities led to Alberta's first land reclamation legislation in 1963—the first such law in Canada dedicated solely to reclamation. Under this law, inspectors from the provincial and municipal governments had to be satisfied that the site was sufficiently cleaned up and recontoured to prevent erosion. The company remained liable for the site until it received a reclamation certificate, and the inspectors could order additional work if needed. Similar standards were applied on public lands after 1969. Conservation of topsoil became a legislated requirement in 1983, as did cleanup of contamination.

Two kinds of large-scale land disturbance, surface coal mining and oil sands mining, emerged in the 1960s. To

This photo shows construction of a large natural gas pipeline beside Highway 22 south of Longview in September 2002. Pipeline reclamation requirements include provisions for soil handling, revegetation, and protection of water resources.
Robert Bott

A wellsite landscape after reclamation. *OWA*

Reclamation operations underway. *OWA*

address concerns about the eventual reclamation of these excavations, legislation in 1973 required major projects to submit environmental impact assessments (EIAs). The assessments had to address issues that could arise before, during, and after construction and operation. The assessments, which could be subject to public hearings, had to include information about soils and landscapes before disturbance and plans for reclamation after operations. In addition to mines, the requirement for EIAs eventually extended to other large-scale disturbances such as quarries, major pipelines, and industrial plants. The government later issued reclamation guidelines and criteria for disturbances such as wells, pipelines, and batteries.

Until the mid-1980s, the objective of reclamation was "equal or better productivity" compared to the pre-disturbance condition. In other words, if the land grew a given amount of wheat before disturbance, it should grow at least as much after reclamation. This standard proved difficult to assess; weather conditions and land management practices such as applying fertilizer, for example, could alter productivity from year to year. In addition, reclamation of larger disturbances such as mines and pits could result in new features that were not directly comparable with the pre-existing condition—lakes, for example, where there had been prairie.

The goal gradually shifted to "equivalent land capability," which was formally adopted in 1993 legislation. The landowner and/or the government (provincial and municipal) would determine the desired end land use. In most cases, Class 2 agricultural land would still be Class 2 agricultural land, but other options could be considered. Vegetation would be one indicator of success, but it would not be the sole determining factor.

Evolution

Reclamation professionals often quote Mark Twain's comment about land: "They're not making any more of it."

As much as land conservation and reclamation have evolved in the past half century, it seems certain that the evolution will continue far into the future. Meeting the expectations of landowners and the public will require much work on the ground as well as planning, oversight, time, and substantial investments in science and technology. It always comes down to people, their values, knowledge, skills, and commitment—politicians, regulators, corporate executives, scientists, managers, consultants, planners, equipment operators, and ultimately someone seeding crops or grasses or planting trees.

According to retired research scientist Terry Macyk, time is the most critical factor in evaluating reclamation success. "You have to do a lot of long-term follow-up on many of the things that we did, just to make sure that everything is on the right path and to confirm that, indeed, the reclamation that was done in the past is going to stand that longer test of time."[21]

The Landscape

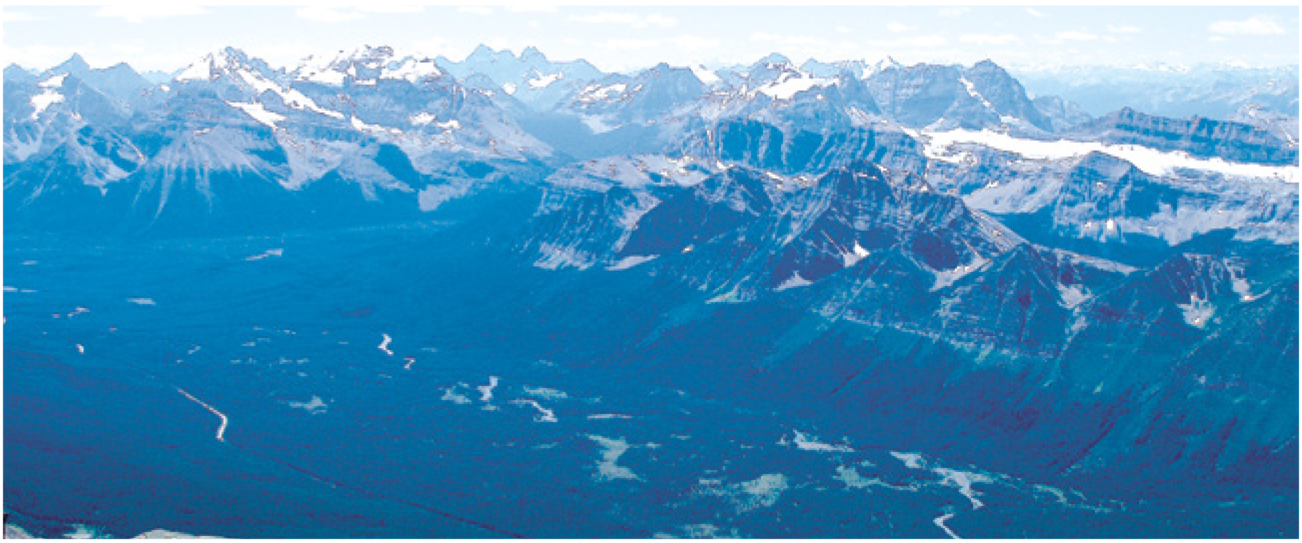
This is the native land of hope.

Wallace Stegner

Geology

Millions of years ago, the part of the Earth that would become Alberta lay beneath a warm inland sea. Marine life thrived, coral reefs abounded, and layer upon layer of sediments accumulated on the sea floor. The growing weight of sediments compressed these materials, gradually forming limestone and sandstone. Trapped in the sediments under heat and pressure, some of the organic matter was converted into crude oil and natural gas and trapped in the rocks. A huge amount of the oil migrated to areas near the surface where micro-organisms converted the hydrocarbons into deposits of heavy, viscous bitumen. The land later hosted forests and swamps that also were buried and became rich seams of coal interspersed with shale and sandstone. The slow but inexorable movement of tectonic plates eventually thrust this multi-layered club sandwich of rock and hydrocarbons sideways and upward. Strata slid, tilted, and folded as they pushed against each other, eventually forming the peaks and ridges of the Rockies and foothills. Wind, rain, snow, and ice then ground down the jagged edges of the rocks, and the resulting sand, silt, and gravel filled the valley bottoms and adjacent plains.[1]

The landscape was carved by grinding glaciers during the long, cold Pleistocene epoch that lasted for more than a million years, and then by rushing meltwater when a warm climate returned. During the Pleistocene, the mountains, foothills, and plains were buried under ice sheets several kilometres thick, most recently during the period known as the Wisconsin maximum that peaked about 18,000 years ago. Just six millennia after that maximum, a sharp increase in the sun's radiation triggered a dramatic warming period, beginning about 12,000 years ago. As this warming melted



Tectonic forces, acting over geologic time spans, pushed up ancient sea beds to form the Rocky Mountains, viewed here from the summit of Mount Hector in Banff National Park. Erosion then shaped the peaks into their present form. *Robert Bott*

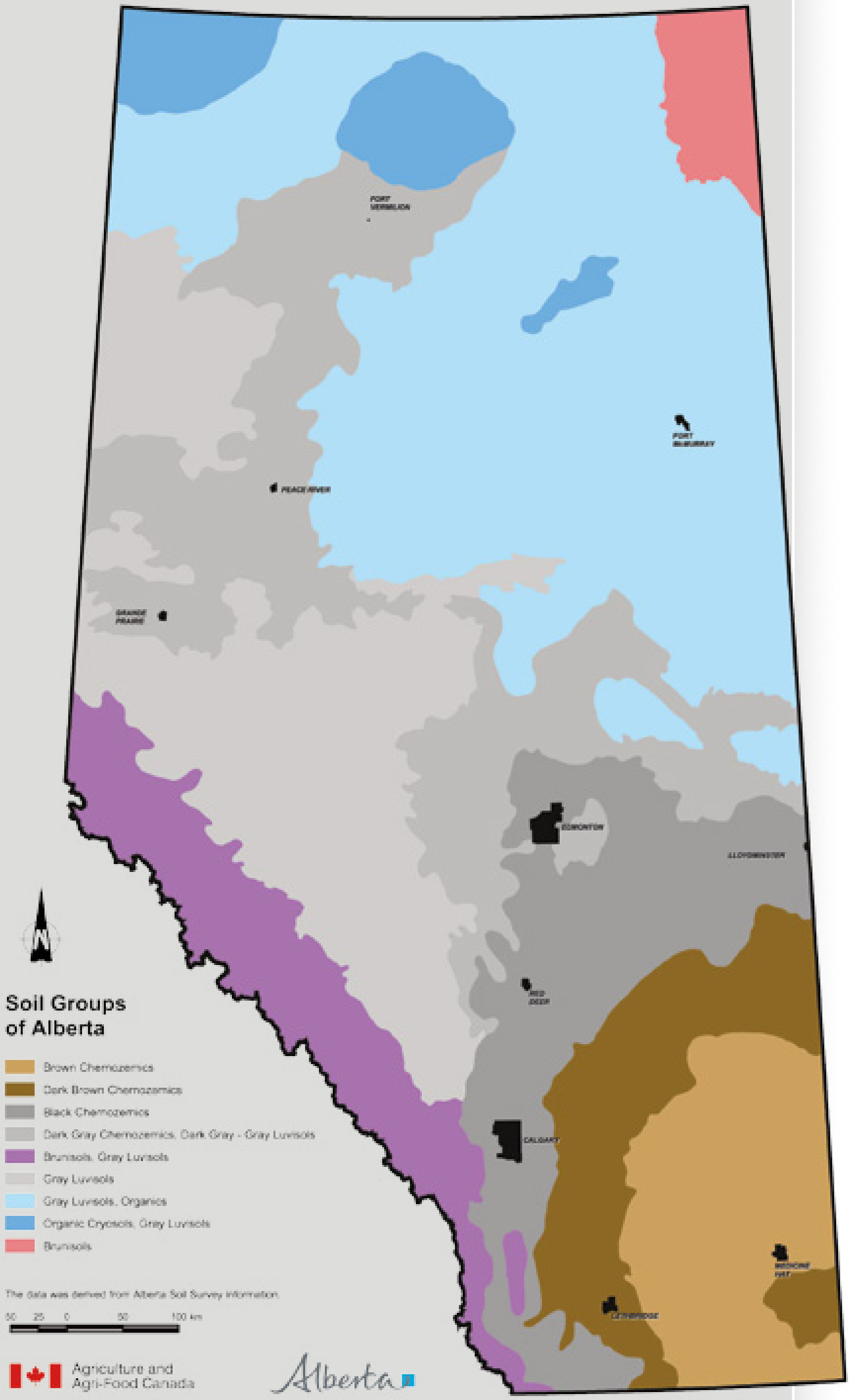
Soils of Alberta

By Terry Macyk, P. Ag.*

Soil is the product of climate, vegetation, and topography acting on the parent material over a period of time. The Soil Groups of Alberta map provides a distribution pattern of soils in the province. However, the soil groups are not as distinctly different or as sharply separated as the map shows.[4] Since the climate and vegetation gradually change from one area to another, the soils themselves show this gradual transition. The characteristics of the soil, in particular texture and organic matter, provide the basic building blocks for successful reclamation of a site; in some places they also create significant limitations to success (e.g., salinity and sodicity).

In general, in Alberta there is an increase in effective rainfall from south and east to the north and west. As a result of this there is a corresponding change from short grass prairie to parkland vegetation to wooded areas.[5]

Soils characterized by the long-term effects of grassland vegetation are called Chernozemic soils. The Brown Chernozemics in southeastern Alberta have a thin layer of brown humus-rich topsoil. To the west and north the topsoil layer becomes thicker, higher in humus (organic matter) content, and



* Terry Macyk retired in 2010 after 43 years as a soil scientist with the Alberta Research Council, now called Alberta Innovates – Technology Futures. Raised on a farm near Radway, 90 kilometres northeast of Edmonton, he began doing soil mapping for the council while an undergraduate at the University of Alberta and continued doing soil and reclamation related work through graduate school and for his entire career.

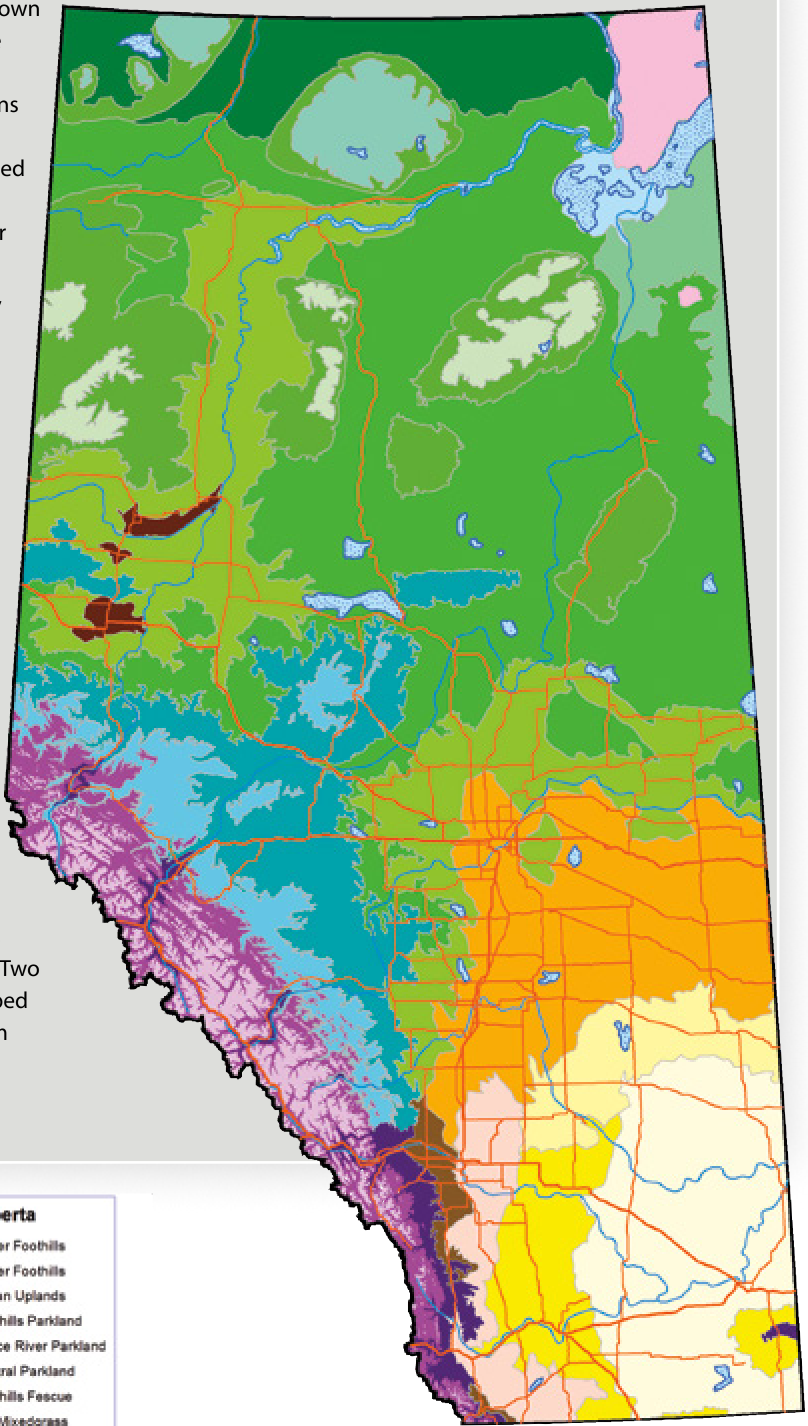
darker in colour. These soils comprise the Dark Brown and Black soil groups named for the colour of the surface soil.

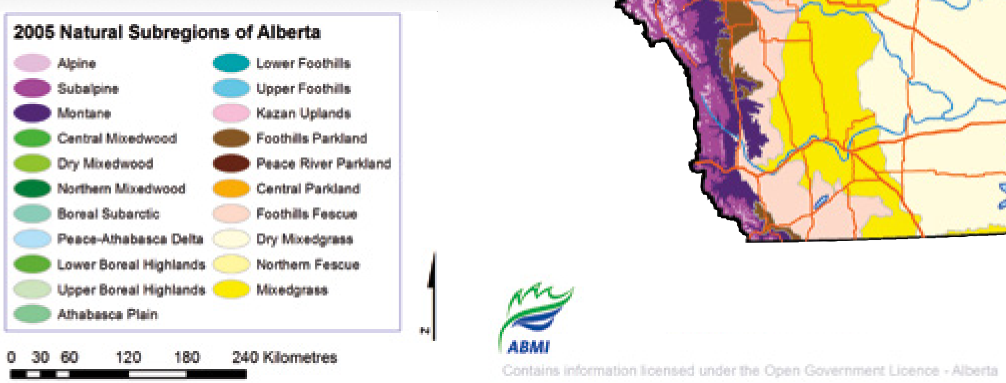
Several soil groups occur in the forested regions of the province, but the most common are a distinctive group, the Gray Luvisols or Gray Wooded soils. As a result of hundreds of years under tree vegetation, Gray Luvisols have a thin surface layer that is low in organic matter overlying a gray coloured layer of mineral material that is leached, low in humus content, and ash-like when dry.

The Black soils are often separated from the Gray Luvisols by two other soil groups, the Dark Gray Luvisols and Dark Gray Chernozems; these have appearance and characteristics intermediate between those of the Chernozemic Black and Gray Luvisols. The Dark Gray Chernozems are higher in humus content and are more like Black Chernozems than the Dark Gray Luvisols, which have only slightly more organic matter than Gray Luvisols.

Brunisolic soils have developed under forest, mixed forest, and grass, or heath and tundra vegetation associations. They have thin organic surface horizons and generally coarse textured brownish-coloured subsurface horizons.

Organic soils are very poorly drained and are characterized by a surface accumulation of peat 40 centimetres thick or greater. The peat has organic carbon content greater than 17 per cent. Two main types of organic soils include those developed from sedge vegetation and those developed from moss. Organic soils most commonly occur in the northern half of the province.





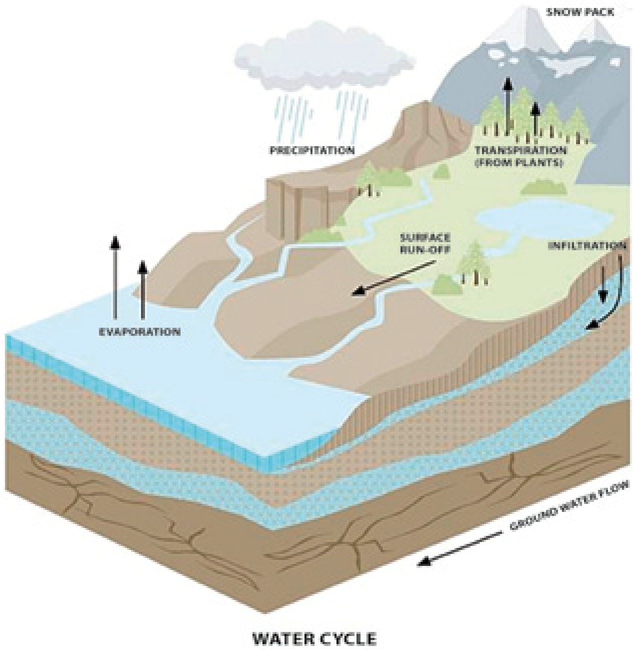
the two great North American ice sheets, plant and animal life flourished. Forests and grasslands became established in a relatively short time. Most of the major species in the region, including humans, appeared by about 10,000 years ago. The forests hosted moose, elk, and beaver, while bison roamed the grasslands.[2] During the ensuing millennia, decomposing plant and animal matter added organic material and nutrients to the soils. Farmers, ranchers, and foresters have harvested the bounty of this landscape since they began arriving in large numbers in the late 19th century.[3]

Climate and Hydrology

The main elements of Alberta's current climate and hydrology have been present for about 5,000 years.[6] Prevailing westerly winds from the Pacific Ocean lose much of their moisture as they rise over British Columbia's mountain ranges, and dry winds often cascade down the eastern slopes of the Rockies. These same slopes also shepherd winds into the province from the Arctic. Aside from the distant alpine glaciers and snowfields feeding rivers such as the Bow, North Saskatchewan, and Athabasca, much of the crucial water supply comes from summer rains and the slow melting of snow from shaded and sheltered forest areas. Where snow falls in open areas, it melts or evaporates quickly under the combined effects of sun and wind. Torrents from cloudbursts or rapid melting can cause erosion of land and siltation of rivers. Water from slow-melting snow or a gentle steady rain percolates through the soil, nourishes plants, feeds clear streams, and replenishes groundwater.[7] Towering cumulus clouds are common from spring to fall, but they may bring only lightning, without rain.[8]

Ecosystems and Biological Diversity

The combination of an often-dry climate, lightning strikes, and abundant fuel brought frequent fires throughout the past 100 centuries. Some sites would be affected more frequently, others less often. Depending on moisture, fuel, and wind conditions, a fire might consume a small patch or envelop millions of hectares. The 1880s, when smoke from widespread fires in western Canada darkened skies over London, England, typified the devastating fire cycles that probably occurred at least once a century during the preceding millennia. The first inventories of the foothills forests in the 1950s indicated about one-third of the timber dated from regeneration after the fires of the 1880s, one-third from regeneration after more recent fires, and only one-third originated before the 1880s. Such a mixture of



Hydrology varies widely across the province–from place to place and region to region—but the basic elements are combinations of precipitation, surface and groundwater flows, evaporation, and transpiration.[9] *Alberta Environment and Parks*

old, middle-aged, and young forest stands was probably common in the foothills for most of the post-glacial period. Fires may have been even more common in boreal Alberta and prairie grasslands. Plants and animals adapted to the frequent fire cycles.[10]

The Human Footprint

Fire, wind, and water not only shaped the landscape but also destroyed most signs of human use. Archaeological artifacts and their provenance tell us more about early peoples in Alberta. Evidence from campsite remains indicates the presence of Aboriginal people as early as 10,000 to 11,000 years ago, although there is little to suggest there were permanent settlements.[11] Travel was often leisurely, and a party might remain for weeks, months, or even years in one area if the hunting, trapping, fishing, and gathering were plentiful.

The frequent fire cycles must have played a major role in the lives of Aboriginal people. Although burned-over areas soon support a wealth of plants and animals, the immediate aftermath can be bleak and barren. This was another reason for people to keep moving, perhaps to return later when wildlife populations responded to the new growth. Judging by the later practices, the early peoples may have used this knowledge and deliberately set fires to create

Wildlife on reclaimed land. *Bob Logan*

habitat for favoured species such as bison and moose, to encourage growth of berries and other food plants, or to clear travel routes along streams and rivers. Fire was essential to these people for cooking and warmth, and their survival depended on the ability to light or carry fire. There were undoubtedly instances when they accidentally ignited wildfires, too. A number of large North American species—woolly mammoths, for example—may have become extinct partly as a result of Aboriginal hunting (climate change was another factor in many extinctions).[12]

In addition to fuel for campfires, the forests provided many vital resources—lodgepole pine for teepee and travois poles, saplings and bark to make canoes, conifer gum to seal seams, split spruce roots for sewing—and foods such as birch syrup, berries, and plants. Equally important, the forests offered habitat for animal species, from rabbit to moose, which were valued for skins as well as meat. Aboriginal life was radically altered in the 18th and 19th centuries by the introduction of the horse, the growth of the fur trade, and the arrival of European and Métis traders.

The scientific expedition led by Captain John Palliser between 1857 and 1860 warned that the arid conditions would pose challenges for settlement in areas that would comprise part of southern and eastern Alberta. The Dominion Land Survey had mapped central and southern Alberta by 1881, and the Canadian Pacific Railway (CPR) arrived in 1883, bringing the first wave of settlers. The foothills forest reserves were established between 1896 and 1910 (transferred to the province in 1930, continued and expanded under the Forest Reserves Act of 1964).

Land titles acquired before 1887 included mineral rights; the Crown retained mineral rights in the majority of land titles acquired later.[13] Canadian settlers who purchased homestead lands from the Dominion Government prior to 1887, from the Hudson's Bay Company prior to 1908, or from the CPR prior to 1902, acquired title to all mines and minerals within, upon, or under their lands. As a result, the petroleum and natural gas resource beneath approximately 81 per cent of the province's surface area is now owned by the "Crown in right of Alberta"; the resource beneath approximately 10 per cent is privately owned, and the remainder is under First Nations lands (federal) and National Parks.

The most extensive "land disturbance" in Alberta was the ploughing and seeding of prairie and parkland ecosystems to grow crops and feed livestock. Most of the conversion happened between the arrival of the railway and World War I, although some homesteading continued in northwestern Alberta after World War II and until the early 1980s. Oxen pulled ploughs in the early years, but horses soon dominated as the power source for farm machinery, local transportation, and tasks such as road building. A network of coal-fired, steam-engined railways moved passengers and freight over longer distances. A few steam-powered tractors and combines also appeared in the first decades of settlement. Gasoline tractors, trucks, cars, and construction machinery started to replace horses during and after World War I; wider use was delayed by drought and economic depression from the late 1920s until World War II.[14]

The vast forest lands of Alberta's foothills and boreal regions remained relatively untouched until the 1950s. Coal mines, transient logging operations, and hydroelectric development made inroads into the foothills, but the impacts were limited by what could be accomplished with horses and hand saws, depending on rivers and a few railways for transportation. The diesel-powered crawler tractor, epitomized by the Caterpillar D-8 introduced in 1935,[15] enabled a penetration of wilderness areas that began after World War II and continues today. Forestry was transformed by the arrival of chainsaws in the 1950s, articulated skidders in the 1960s, and feller-bunchers in the 1970s. New technologies in the 1980s led to utilization of hardwoods such as aspen as well as the previously harvested softwood species.[16] By the early 1990s, almost all of the "allowable cut" on public lands was allocated to forest product companies on a "sustained yield" renewable basis; this concept was subsequently modified to "sustainable forest management" incorporating other values such as biodiversity, recreation, and traditional use.[17]

Mechanization also facilitated the search for energy that accelerated after the Leduc oil discovery in 1947 and continued through spurts and lulls ever since. Bulldozers cleared seismic cutlines, wellsites, roads, and rights-of-way

By the 1920s, more than 11 million hectares of Alberta were listed as "occupied farmland" after a massive conversion of prairie and parkland to farming and ranching uses over the previous decades; the total agricultural area would double again by the 1970s. The province's horse population peaked at about 800,000 in the 1920s; it dropped sharply in the 1940s and 1950s before stabilizing at about 140,000 animals today. *University of Saskatchewan Archives and Special Collections, R. Wall Fonds, MG284*

for pipelines and electric transmission. Increasingly powerful earthmoving machines enabled large-scale, open-pit mining of coal and oil sands. Giant scrapers and graders built roads connecting all these centres of activity and the communities housing them. Urbanization and urban sprawl often brought about a second transformation of former farm, ranch, and forestry lands surrounding the towns and cities. New technologies, such as hydraulic fracturing and in situ bitumen extraction, have continued to enlarge the human footprint on Alberta landscapes. For example, almost two-thirds of the pipelines underlying Alberta have been installed since 1990.[18]

Conservation and reclamation provide the means to counter negative effects and irredeemable losses from the transformation of land and its use. Awareness of the risks and measures to minimize them have arisen in parallel with the impacts. As Wallace Stegner wrote in a 1979 essay: "Angry as one may be at what careless people have done and still do to a noble habitat, it is hard to be pessimistic about the West. This is the native land of hope."[19]

This site was a well pad constructed on fen peatland with borrowed fill. The fill was removed almost completely. The 10-15 cm remaining on the surface was turned under with an excavator to produce a mounded surface with a heterogenous mix of organic and mineral soil. *Terry Osko*

People

Society, Laws, and Regulations

You can't just drill a well and then walk away. You have to reclaim.

Larry Brocke

This chapter is divided into three sections. The first section provides a general overview of eras and trends in the evolution of reclamation regulation in Alberta. The second section is a detailed account of events and developments up to 1983 by Henry W. Thiessen, who had first-hand experience as a senior official in the provincial government during that particularly formative period in conservation and reclamation policy. The third section describes the regulatory evolution from 1983 to the present.

Decades of Development

Land conservation and reclamation in Alberta evolved in parallel with transformations in the province's society, economy, and environment. In the five decades after the first legislation in 1963, the population tripled to 4.2 million and became more urban, educated, and informed. Adjusted for inflation, the province's 2014 gross domestic product of $365 billion was more than 13 times larger than in 1961.[1] Production and distribution of energy became a much larger part of the economy. Industrial activity spread to landscapes in almost every part of the province, including areas that once seemed remote and pristine as well as onto agricultural, residential, commercial, and recreational lands; this resulted in both land disturbance and land-use conflicts. What began as an effort to address localized concerns such as safety, erosion, and property rights broadened during the half century to embrace ecosystem health, watershed protection, recreational opportunities, and regional land use.[2]

Landmark events in Alberta land conservation and reclamation occurred at 10-year intervals. Major legislation was passed in 1963, 1973, and 1993. There were significant amendments to the legislation in 1983 and major changes in regulatory responsibilities in 2003 and 2013. As a result, there was a decade-by-decade progression of policy, regulation, and practice that reflected the rate at which experience and knowledge accumulated under one regime until the need for a new approach became evident. The brief summary below risks oversimplification; changes happened at different rates for different industries, activities, and areas. The specifics appear later in this chapter and in the sector chapters that follow.

Historical Eras of Alberta Land Conservation and Reclamation[3]

"You can't just drill a well and then walk away. You have to reclaim,"[4] said Larry Brocke, a soil scientist who observed the evolution of land conservation and reclamation from roles in both the private and public sectors. Around Alberta that position grew ever-deeper roots as the impacts of petroleum, coal, quarries, sand and gravel, and other industries spread across the landscape. After the Leduc discovery in 1947 ushered in the modern oil age in Alberta, Brocke said, "there was a lot of noise being made about the oil and gas industry. It was growing so fast, wellsites everywhere, interrupting the farming, just destroying the space.

Producers were not doing anything to fix it after they were done. Landowners would ask, 'How come all they have to do when they're done on a wellsite on my place is come in, take the wellhead out, take away the garbage, and they're done? I can't farm this!'"[5]

That, he said, was the initial trigger for industrial land reclamation legislation.[6]

Pre-1963: Mining and petroleum regulations of the federal and (after 1930) provincial governments focused mainly on safety of mines and wellsites. Provincial legislation in 1935 also addressed soil drifting. Government officials educated farmers about soil conservation and erosion. In 1951, private landowners gained rights to sand and gravel deposits on their property.

1963–72: The Surface Reclamation Act of 1963 initially applied only to surveyed lands (settled areas of the province). It established a council of provincial and local officials to inspect and certify sites. Certification ended the leaseholder's reclamation liability for the site. Standards were site-specific and largely cosmetic; there was no requirement for soil conservation. In 1969, legislation extended reclamation requirements to oil and gas wells, pipelines, batteries, mines, and quarries on public lands. Reclamation regulation and the administration of these activities transferred in 1972 from the Department of Mines and Minerals to the Department of Environment, established in 1971.

1973–82: The Land Surface Conservation and Reclamation Act in 1973 introduced a proactive approach, including pre-disturbance soil surveys and the submission of development and reclamation plans. Major projects required an environmental impact assessment. Specific policies and approval processes were subsequently developed for coal mines, oil sands mines, in situ oil sand schemes, oil and gas pipelines, and sand and gravel operations, including reclamation security requirements. In 1977, Alberta Environment published *Guidelines for the Reclamation of Land in Alberta*.[7] After 1978, the Alberta Heritage Savings Trust Fund financed a wide-ranging research program and rehabilitation of sites such as abandoned coal mines, industrial sites, and municipal developments including garbage dumps, sewage lagoons, and reservoirs. Policies and regulations emphasized protecting and returning the productivity of the land: this meant re-establishing the ability to grow crops or forage in agricultural areas; in other areas, it generally meant "green and stable" (erosion controlled and something growing, typically from an agronomic seed mix). In 1980, the Canadian Petroleum Association released Environmental Operating Guidelines for the Alberta Petroleum Industry, and in the same year Alberta Environment published *Minimum Reclamation Requirements for Patented Land*,[8] followed in 1982 by *Minimum Reclamation Requirements for Public and Private Lands in Alberta*.[9] After extensive hearings, the Legislative Assembly's Select Committee to Review Surface Rights released its report in November 1981.

The Special Committee on Surface Rights

For two years, 1980 to 1982, a nine-person special committee of the legislature conducted a "total review of surface rights" in Alberta. The committee chair, Ken Kowalski, reported its findings on April 26, 1982.[10] Among the 70 recommendations were 11 dealing with reclamation, restoration, and land conservation. A priority was restoring agricultural land, after energy development, "to as good or better use than originally." Kowalski noted that some might wonder how reclaimed land could be "better than" before, but "it's essentially the area of drainage that can be improved upon." He added:

> Mr. Speaker, in my view reclamation is simply the repaying of a debt to the land. We can repay that debt, because technology now exists that will allow us to heal surface scars. Reclamation has not been a dirty word in the province of Alberta for a large number of years. The first legislation in this area, essentially very good legislation, was introduced by the former government in 1963. It has been improved upon since then and can be further improved upon. We have to be cognizant of the very important role our prime agricultural land plays in the tradition, history, and future of this province. We should not avoid spending as much time and attention on that one matter as we possibly can.

1983–92: Scientific research and operating experience led to more sophisticated requirements for soil salvage and replacement in all disturbed areas. Depending on the kind of disturbance and soil types, two or three separate "lifts" might be required when removing and replacing layers of soil. Hydrology, native vegetation, and wildlife habitat began to be integrated into reclamation planning, operations, and regulation. Industry developed equipment and

Name Changes

The **Department of the Environment**, established in 1971, became the **Department of Environmental Protection** in 1993 and assumed many responsibilities from the Department of Forestry, Lands, and Wildlife as well as responsibility for the Parks Division from the Department of Tourism, Parks, and Recreation. The department name reverted to **Department of the Environment** in 1999.

In 2001, a **Department of Sustainable Resource Development** was established. It was created from the administration of Public Lands, the Surface Rights Board, and Land Compensation Board from the Department of Agriculture, Food, and Rural Development; Forest Industry from the Department of Resource Development (renamed Energy); and Land and Forest Service, and Fisheries and Wildlife Management from the Department of Environment. This new department and the Department of Environment then jointly administered the **Natural Resources Conservation Board**, previously reporting to only the minister of the Environment.[11]

In October 2011, the department was renamed **Alberta Environment and Water** and in May 2012 the department merged with Sustainable Resource Development to become **Environment and Sustainable Resource Development.** Monitoring and enforcement of energy-related development transferred in 2013 to the Alberta Energy Regulator. After election of a new government in 2015, the department was renamed **Environment and Parks**, and some of the forestry responsibilities moved to the Department of Agriculture and Forestry.

The **Alberta Energy Regulator** of 2013 is the latest incarnation of the provincial agency established in 1938 as the Petroleum and Natural Gas Conservation Board, which subsequently became the Oil and Gas Conservation Board (1957–71), Energy Resources Conservation Board (1971–95), Alberta Energy and Utilities Board (1995–2007), and once again Energy Resources Conservation Board (2008–13).

techniques such as those for winter soil salvage. More specialized consultants and contractors emerged. The government developed standards and guidelines for industries such as pipelining and sand and gravel. Reclamation requirements shifted from returning *land productivity and usefulness* to the broader and more adaptable concept of returning *equivalent land capability*.

1993–2002: Land conservation and reclamation came under the new Environmental Protection and Enhancement Act in 1993, which allowed for more flexible, science-based approaches to planning, operations, and regulation. The first criteria produced under the act dealt with wellsites (issued in 1993, then revised in 1994 and finalised in 1995); industry began using more sump tanks instead of pits to reduce land disturbance and risk of soil contamination. Soil criteria dealt with the total root zone, including subsoil. An industry fund was established for reclamation and remediation of "orphan" oil and gas sites. Geographic information systems (GIS) and geographic positioning systems (GPS) improved the effectiveness of planning, operations, and monitoring. In 1996, the government began a trial of audit-based reclamation for some situations—certifying wellsites without on-site inspection in forested Crown lands (Green Area), subject to audit. In 1999, responsibility for development and reclamation approvals shifted from Edmonton to regional offices.

2003–12: Legislative amendments in 2003 enabled the development of codes of practice to govern reclamation in industries such as sand and gravel. Audit-based certification of upstream oil and gas sites (wells, industrial pipelines, and batteries) was extended to the rest of the province in 2003. Remediation (removal of contamination) received increasing emphasis, with information required as part of the application for an upstream (exploration and production) oil and gas reclamation certificate. Rapid expansion of both mining and in situ oil sands projects, including related pipelines and facilities, along with other industrial, residential, and commercial infrastructure developments led to backlogs of sites awaiting remediation, reclamation, or certification. After 2007, reforestation became a requirement on formerly forested upstream oil and gas sites. After 2008, applications for oil and gas site certification required sign-offs by certified professionals such as agrologists, biologists, foresters, and engineers, subject to audit. Alberta Environment issued revised upstream oil and gas reclamation criteria in 2010.

2013–15: The Responsible Energy Development Act of 2013 transferred responsibility for energy-related conservation and reclamation to the newly established Alberta Energy Regulator; many of the head office and regional delivery staff also transferred to the energy regulator. Non-energy activities (e.g., sand and gravel, quarries) and the establishment of reclamation policies and criteria for all industrial activities remained under Alberta Environment and Sustainable Resource Development, now called Alberta Environment and Parks.

The Evolution to 1982

By Henry W. Thiessen

Before 1963: A Focus on Agriculture

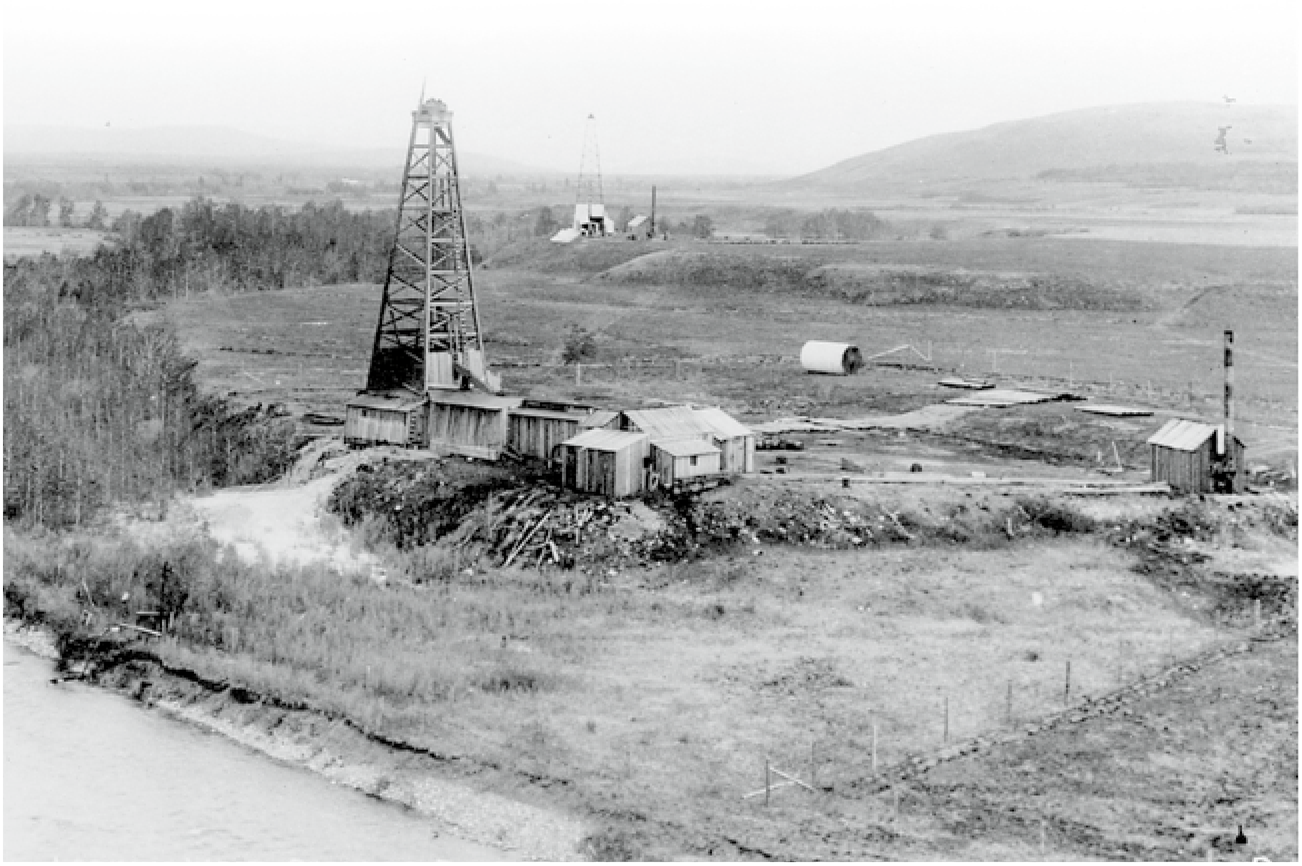
Until the transfer of resources to the province in 1930, the federal government regulated development of Crown resources in Alberta, including coal, oil, and natural gas, as well as grazing and timber lands. The federal government's main priorities were settlement and agriculture. Ottawa's biggest contribution to land conservation was the establishment of national parks and large forest reserves on the Eastern Slopes of the Rockies, in part to protect the water supplies that were so vital to agriculture on the arid prairies. After gaining control of resources, the province retained the forest reserves and extended similar management to northern forest areas as well.* In the post-war years, the provincial government focused on soil conservation in agricultural areas, emphasizing education rather than regulation and enforcement. Rapid expansion of the oil and gas industry after the Leduc oil discovery in 1947 created challenges for a voluntary approach to conservation and reclamation.

Alberta's first legislative efforts to conserve the productivity of its soil base date back to 1929, when it enacted the Noxious Weeds Act.[12] The Control of Soil Drifting Act[13] followed in 1935 during the dire drought and depression years. This act encouraged farmers to use tillage equipment properly to combat wind and water erosion while also conserving soil moisture. Both statutes were reactions to natural weather conditions then occurring, not to any form of industrial development.

On March 28, 1945, more than 31 years after Dingman No. 1 began production at Turner Valley, the Lieutenant Governor in Council (LG/C) assented to An Act to Provide for the Extension of Agricultural Services in Association with Municipal Authorities.[14] The act established Agricultural Service Boards within each municipality, jointly in cooperation with the local government and the Alberta Department of Agriculture. These boards, among other responsibilities, could investigate land conditions and, upon evidence of practices inconsistent with community standards of good husbandry, designate it becoming debilitated by wind or water erosion, infested by noxious weeds, or for other causes seriously affecting the land's productivity and becoming a menace to the community.

Upon the Agriculture Service Board's investigation the subject land could be designated under its supervision, subject to rehabilitation and reclamation at the landowner's cost and expense. Depending on the situation, circumstances, and severity the landowner had the option, subject to the board's decision, of conducting the remedial work at his own cost. The board could arrange for the work and invoice the landowner for payment or add it to the annual taxes, or the municipality could temporarily confiscate the land, conduct the work, and return it to the landowner only after all expenses were paid.

* After 1948, these Crown-managed lands, withdrawn from agricultural settlement, were designated as the Green Area. The Yellow Area included lands available for all sorts of agricultural settlement including homesteading; the White Area included all agricultural uses except homesteading. The term "surveyed lands" also appears in reclamation legislation and regulation. Surveyed lands are generally already legally surveyed and available for disposition in the settled areas, but they are not exactly contiguous with the White Area as the legal surveys may not yet have been completed to include the entire White Area. The Yellow Area designation was later dropped when homesteading ceased in the early 1980s—lands were designated as White Area.



Dingman No. 1 and 2 oil wells, Turner Valley. Cuttings and mud from the lease were dumped into the river in 1913 and 1914. *Glenbow Archives NA-246-1*

From 1926, when Alberta enacted its first comprehensive legislation to regulate oil and gas wells,[15] to 1969 when it enacted its sixth comprehensive statute,[16] plus four other comprehensive acts, in 1931, 1938, 1942, and 1950, and the numerous problem-specific enactments during those 43 years, there was no mention of the word "reclamation" in the legislative mandate of the Petroleum and Natural Gas Conservation Board (PNGCB) or its successor, the Oil and Gas Conservation Board (OGCB). The 1931 legislative version[17] did introduce a provision that the board could, upon taking over a well, conduct remedial measures at the well owner's expense, which Stan Tracy, former Surface Reclamation Council (SRC) secretary, described more as "downhole" measures, not reclamation of the wellsite per se.[18]

In 1947, the Right of Entry Arbitration Act[19] was intended to address the conflicts arising between mineral rights holders and surface rights owners during the post-Leduc oil boom. Its stated purpose was to enable the mineral owner's entry upon the land and the appropriate compensation to the landowner as determined by the statute's Board of Arbitration (a.k.a. the Right of Entry Board). This quasi-judicial agency to resolve access disputes had, according to policy analyst Eric Lizée,[20] serious flaws:

> For farmers to have been "protected" by the Board, they would have had to refuse any interaction with an oil company representative that could be construed as a contract, and then wait for the oil company to apply to the Right of Entry Board. If … a farmer had reached any kind of "understanding" with an oil operator, the act would not apply and the only recourse for an individual farmer would be to turn to the courts.

The petroleum industry's large financial reserves and legal expertise made recourse a waste of resources for farmers, enabling oil and gas companies to "circumvent the minimal protection afforded farmers by the act."

The strained and unsatisfactory situation outlined by Lizée describes the climate between the landowners and oil companies between 1947 and 1963 when site reclamation was first legislated. During this 15-year hiatus, the concept of a forced right of entry favouring the mineral owner over the surface owner's traditional property rights took root. Its implementation brought forth disputed compensation issues, vague reference to land reclamation, contested post-site use agreement, and minimal cleanup. Both the 1947 legislation and its 1952 successor legislation[21] had a similar provision that the vacated wellsite was to be restored, as near as possible, to the pre-wellsite use of the land, and that structures were to be removed and excavations filled. The state of administrative fragmentation complicated issues even further: geophysical investigators operating in the Department of Lands and Mines dealt with geophysical issues; a landowner's complaint about a well could be made to the PNGCB, independent and semi-controlled by the oil and gas industry; road placement and yearly rentals were adjudicated by the Board of Arbitration first reporting to the attorney general and later to the minister of the newly created Department of Mines and Minerals; and pipeline routing issues were resolved by the Board of Public Utility Commissioners.[22] As already discussed, the PNGCB, later known as the OGCB (1957–71), had virtually no legislative mandate to undertake wellsite reclamation. The Board of Arbitration had limited jurisdiction applicable only to those wellsites where the prospective well owner or his agents had not contacted the landowner and the board had issued a forced entry order. Only under those circumstances could the reclamation be ordered at the well owner's expense.

In a 1949–51 provincial court action and decision the trial judge established that mineral rights owners Western Minerals Ltd. and Western Leaseholds Ltd., the plaintiffs, also held the rights to sand and gravel on the property held by J. A. Gaumont and J. W. Brown, the defendants, who owned the land in fee simple and mined the gravel since the early 1940s.[23] The trial judgment came down in February 1951 favouring the plaintiffs. In March, the defendants filed an appeal and on April 7, 1951, the provincial government assented to the enactment of the Sand and Gravel Act, Ch. 77. This legislation declared that sand and gravel belonged to the surface rights owner, not the mineral owner, and applied retroactively. The provincial appellate court heard the amended appeal in September and rendered a decision in favour of the defendants (the surface rights owners) in October. The province had acted within its constitutional jurisdiction. The plaintiffs appealed this decision to the Supreme Court of Canada where it was dismissed in March 1953. In 1961, this designation was extended to clay and marl and later to peat. The designation (separating these resources from minerals) allowed landowners to decide when and how these resources would be developed (as well as removing royalty payments to the government). This decision could complicate the reclamation process, as it did at Wabamun Lake where the surface coal-mined lands were left unreclaimed until the surface landowner had disposed of the heaps of exposed gravel deposits: only then, several decades or so later, did reclamation take place.

The Utilization of Lands and Forests Act[24] was decreed in 1955 for the conservation and efficient use of Alberta's land, forest, and water resources following a large-scale land clearing program in the Peace River Block preparing half-section agricultural farming units for returning war veterans.[25] About 36 per cent (207 units) of an eight-township block selected for clearing had already been cleared of trees and brush, piled and burned, and deep disc-tilled to a depth of 46 centimetres; and another 7 per cent (43 units) were being piled and burned before it became evident that the deep tillage was burying the topsoil and replacing it with the subsoil on the surface. It should only have been tilled 20 centimetres deep. The government established an interdepartmental committee, the Conservation and Utilization Committee (CUC, a.k.a. the Land Utilization Committee), with membership appointed from the Departments of Agriculture, Lands and Forests, Municipal Affairs, the Power Commission, and the University of Alberta Soil Science Faculty. Its mandate was to review and study renewable resource issues for recommendation to the LG/C, specifically (1) irrigable lands, (2) marginal and sub-marginal lands, (3) lands abutting rivers and streams, and (4) forested lands and game habitat areas. This land in question was unsuitable for cropping but could produce forage; it yielded Alberta's first provincial grazing reserve, Wanham, about 40 kilometres east of Rycroft. Much of the CUC's first decade became taken up in buying or otherwise acquiring marginal or abandoned croplands and developing these marginal lands into productive native range lands throughout the province, and irrigated grazing reserves in the south.

On April 5, 1962, the LG/C assented to the Soil Conservation Act.[26] This legislation applied predominately to agricultural operations but could include other factors causing or likely to cause erosion or soil deterioration. The operative sections applicable to land reclamation are virtually identical to similar sections in the 1970 Agriculture Service Board Act. Staff in the Plant Industry Division developed program activities that were delivered at winter short courses and demonstrated at summer field days showing farmers how to till and seed wind- and water-eroded farmland. Little effort was directed at the agricultural clearing of native vegetation on intermittent stream courses, steep or rocky slopes, or otherwise marginal lands. Those decisions were left to the individual farmer. The department's thrust was education.

This basic concept, of having provincial and municipal officers make joint on-site inspections, was still in effect in the Agriculture Service Board Act,[27] after the 1963 Surface Reclamation Act came into force, and remained in effect after the Land Surface Conservation and Reclamation Act in 1973. Other changes were sec. 15 that designated a soil conservation officer; sec. 16 that defined the land as “impoverished farmland” that had its productivity seriously affected and whose owner’s or tenant’s welfare was thereby impacted; sec. 17 called for a public board hearing on site; sec. 18 called for a plan to determine the means and cost of the land restoration; and sec. 19 set out the content of a reclamation order including interim control of the land during reclamation and the landowner’s ultimate costs and expenses. These statutory requirements, with minor changes, were still in effect when the act was revised to become Ch. A-11 of the Revised Statute of Alberta (RSA) 1980.

Based upon Powter et al.[28] research, the duty to reclaim land existed in common law and was provided for in various lease agreements between the landowner and the oil company. Breen[29] has inferred that the PNGCB inspectors tried to manage lease cleanup as part of their regulatory function. Both Stan Tracy[30] and Ross Pituka have commented that there was seldom sufficient funding for wellsite cleanup from the PNGCB/OGCB. Obviously, as Larry Brocke’s quotes above demonstrate, common law and the efforts of the PNGCB did not satisfy affected landowners or Alberta’s public interest.

1963–68

A year after the introduction of the Soil Conservation Act, the legislature enacted the Surface Reclamation Act,[31] assented to on June 1, 1963, handing responsibility to the Department of Mines and Minerals.* The act bore a decided resemblance to the administrative framework first introduced in the 1945 Agricultural Service Board[32] legislation but was more inclusive and descriptive. It had the same basic elements: an investigative/hearing panel representing the municipal and provincial governments; the authority to issue reclamation orders specifying the corrective actions to be performed on any lands except in the forest reserves; applicable to all activities and lands used in connection with mines, quarries, oil and gas operations, pipelines, or batteries, and their opening up, drilling, construction, operation, and abandonment. The reclamation orders could include the land conditioning, maintenance, and reclamation; the prevention and destruction of noxious weed growth; the removal or remedy of any hazards to livestock or conduct of farming operations; and the installation and repair to fences, gates, cattle guards, culverts, or other installations. A most glaring difference was that the mineral regulator (Mines and Minerals) and not the soils guardian (Agriculture) would administer reclamation, now recognized as a required duty. Only two regulations were enacted: the first[33] establishing the Surface Reclamation Council (SRC)’s administrative procedures and another[34] confirming its office relocation. No written guidance for the inspectors was ever filed. The application of the act seems to have been left to the chairman’s discretion.

Hubert H. Somerville,[35] the deputy minister of Mines and Minerals, was appointed the first chairman of the SRC and Stan Tracy the first secretary; several departmental members were appointed and complemented the municipal inspectors.[36] On each site, two inspectors—one provincial and one municipal—issued written reclamation orders where warranted or reclamation certificates where the cleanup met the expectations. In the first few years most of their efforts were directed toward wellsites: in the first full year the council issued nearly 300 reclamation orders[37] before trending down to half that number. The number of certificates and orders issued annually averaged about 1,750 during the first six years. The higher numbers at the outset confirm the interview evidence from Tracy, that there was a backlog of wellsites needing reclamation even before the new act took effect.

Both Tracy and Pituka,[38] possibly the last original surviving SRC inspector, remember the large number of unreclaimed wellsites (hundreds of abandoned wells), coal mines, and gravel pits that the SRC became responsible to reclaim.[39] The SRC had the authority but seldom the funding, expertise, or other resources to conduct reclamation. The Board of Arbitration was responsible for downhole abandonment: site safety, spills, and other problem areas, and the SRC for the wellsite cleanup upon abandonment. Both Tracy and Pituka, in their reclamation efforts, characterized the Board of Arbitration as having a neutral effect, seldom infringing upon their reclamation endeavours.

The difference between the Surface Reclamation Act and the Soil Conservation Act was regulation vs. education. Mines and Minerals’s clientele was industry; its language was regulations and orders; its venue the office or boardroom. Their vision sought immediate returns. Agriculture’s predominant clientele were farmers and agri-business types; it had a proven record of working collaboratively with rural communities. Its language was education in the field, short courses in the winter, field days in the summer, demonstrations during the day, seminars in the evening; and in agricultural vocational colleges and university classrooms agrologists were teaching and demonstrating.

* The full title was An Act respecting the Maintenance and Reclamation of, and the Recovery of Rental for, the Surface of Land Used in Connection with Mines, Quarries, Oil and Gas Operations and Pipe Lines.

Whereas the non-renewable resource sector was quick to recover the seam, deposit, or pool and move on to the next, the renewable resource sector knew that with proper management and care the soil would continue to yield continually over the generations, giving to their grandchildren and far beyond.

In 1966, as several older members retired, the government revitalized the Conservation and Utilization Committee (CUC) and appointed Henry W. Thiessen as chairman, a position he held until the early 1980s. As before, other members were appointed from the Departments of Agriculture, Lands and Forests, Municipal Affairs, the Power Commission, and the University of Alberta Soil Science Faculty. The mandate was to review and study issues for recommendation to the premier.

The CUC began to develop administrative mechanisms to bring about and practise the coordination of natural resources conservation policy, both renewable and non-renewable. Part of the inspiration for this approach was from the writing of Dr. S. V. Ciriacy-Wantrup, a University of California professor of economics whose textbook, *Resource Conservation: Economics and Policies,* served as a valuable reference[40] for Thiessen. Wantrup's key theme was that "duplications, inconsistencies, conflicts, and administrative inefficiencies" could only be eradicated by coordination. This approach was ripe for application in Alberta. It applied equally as well in Alberta as in California. Agriculture Minister Harry Strom hosted a full-day seminar featuring Dr. Ciriacy-Wantrup's message of coordination and efficiencies.

The CUC was able to draw more upon the renewable resource expertise within government departments, partly because of several federal-provincial cost-sharing agreements of the time. The Agricultural Rehabilitation and Development Act (ARDA, 1961) provided federal money to initiate and expand provincial programs to rationalize marginal farm holdings, clear higher-class agricultural lands for production, and conserve lower-class agricultural lands for recreational and wildlife habitat or other compatible uses, or purchase it for alternative uses. The Canada Land Inventory (CLI) Program[41] generated the information needed to categorize land capabilities that were used first in the ARDA land clearing program. The CUC developed them into land clearing guidelines that northern Alberta homesteaders were encouraged to use when applying for permission and funding from the Department of Lands and Forests to clear public lands. These guidelines were designed to avoid having steep slopes, treed waterways, marginal soils, and other limiting factors cleared only to become a candidate for wind and water erosion reclamation. The benefits of selective land clearing on steep gradients as opposed to fence-line to fence-line clearing were presented to local farmers in the Rimbey/Rocky Mountain House region but were rejected at that time as outlandish views from the government in Edmonton.

The CUC sought opportunities and interacted with renewable/natural resource managers, and used short-term, problem-solving task forces to mitigate interdepartmental issues. The task forces were charged with a defined task and designed to disband upon completion. From 1967 to 1968 the committee frequently dealt with the topic of land reclamation, partly because of the discussions on the ARDA land clearing program and the development of the guidelines.

The CLI aerial photography revealed to Forestry the vast lineage of seismic cutlines criss-crossing what had previously been seen as a pristine boreal forest. Emissions from wellheads and battery sites obscured the otherwise clear atmosphere. Frequent complaints about wellsites littered with cables, sumps, and weeds were brought to the attention of Agriculture's Plant Industry Division, as well as the unreclaimed coal mining operations and gravel heaps along the Yellowhead Highway adjacent to Lake Wabamun. By 1968, the CUC soon agreed that a task force on surface reclamation should be formed.

1969–71

The CUC continued working on draft legislation in 1969–70: its ultimate objective was the establishment of a Natural Resources Development Authority (NRDA) to serve as the CUC secretariat. The newly chosen Premier Harry Strom appeared to support this when Thiessen briefed him; Agriculture Deputy Minister Edwin Ballantyne was also encouraging. The soon-to-be released CUC task force report on surface reclamation caught Mines and Minerals Deputy Minister Somerville unprepared; the upshot was that written reclamation standards were accepted at the ministerial level only. A senior member of the Mines and Minerals Department was appointed to the CUC, beginning the building of a much-needed bridge between the renewable and the non-renewable resource managers.

The movement to create an Environment Department in Alberta had its roots in the work of Rachel Carson's 1962 book,[42] *Silent Spring,* which drew attention to the dire environmental consequences of the indiscriminate use of chemicals. The CUC also kept a watchful eye on legislative developments in the United States where Carson's book was being hotly debated and cited as the fulcrum to create an enforcement agency. In the spring of 1970, US Senator Gaylord Nelson had created Earth Day to force environmental pollution issues onto the national agenda.[43] On

December 2, 1970, the US Congress authorized the creation of a new federal agency to tackle environmental issues, the US Environmental Protection Agency.

Rather than forming an environment department, the Strom government concluded that what was first needed was a public body with the power to hold hearings, interact with environmental interest groups, and draft decision reports for public release. The chairman should be a well-spoken communicator. The draft legislation to create the NRDA was hurriedly altered in late 1969 to early 1970 to establish the Environment Conservation Authority Act (ECA).[44] The act was given assent on April 15, 1970. In addition to its mandate to hold public hearings and create public advisory committees, it also held residual powers more appropriate to the now defunct NRDA concept or to a line department. The CUC reported to the ECA, and membership was expanded to include Health, Highways and Transportation, Industry and Tourism, Mines and Minerals, and the Oil and Gas Conservation Board, which soon became the Energy Resources Conservation Board (ERCB).

However, by late 1970 the Social Credit government, in light of continuing public concern and interest partly driven by the Man and Resources program of the Canadian Council of Resource and Environment Ministers (discussed below), decided to amalgamate Agriculture's Water Resources Division, the Conservation and Utilization Branch, the Agricultural Chemicals Branch, and the Department of Health's Environmental Health Division into a Department of the Environment. The Alberta Department of the Environment Act,[45] drafted in considerable confidentiality, was enacted as Bill 32 on March 30 and came into force on April 1, 1971.

The act re-established the CUC linkage to the deputy ministers and constituted the Natural Resources Coordinating Council (NRCC) comprising the deputy ministers of Agriculture, Environment, ERCB, Health and Social Development, Highways and Transport, Industry and Tourism, Lands and Forests, Mines and Minerals, and Municipal Affairs. The NRCC chair was the deputy minister of Environment. Notwithstanding some of the legislative duplication with the ECA, the government did specify that the coordination of environmental issues was the prerogative of the Department of the Environment.

In May 1971, the ministers of Environment (James Henderson) and Lands and Forests (J. Donovan Ross), were considering the McIntyre-Porcupine coal mine application at Grande Cache. They concluded that in light of the increased foreign and domestic demand for coal, which would be mined predominantly from surface deposits, and the public's concern with environmental degradation, the CUC should structure a Surface Reclamation Task Force. Its purpose was to identify the various agencies involved to design a functional activity network, emphasizing its administrative efficiency, rather than focusing on the existing institutional arrangements. The more specific criteria should be identified for inclusion in regulations and the less specific criteria identified as guidelines. One can imagine the ministers were already contemplating what later would become a coal development policy. The task force released its report, *Surface Reclamation and Its Application to Coal Mining*, in 1971.[46]

The task force noted that the Surface Reclamation Act of 1963 and the Public Lands Act of 1966[47] duly amended in 1969[48] afforded similar basic protection, but the latter, because of inherent Crown ownership and enhanced land management supervision, especially in negotiating the right of entry access, provided a higher standard of environmental protection. The amendment brought public lands, not then subject to the Surface Reclamation Act, under its purview for wells, pipelines, batteries, mines, and quarries. It was an early example of two departments, formerly jealously guarding their jurisdiction, now cooperating for the common good. It also concluded that only comprehensive environmental planning, being multidisciplinary and interdepartmental, could accommodate the activities associated with surface mining. In addition to the statutes already mentioned, there were another 10 that could be impinged upon by a surface mining application. To achieve the combined legislative benefit of this array of legislation a three-pronged coordination system of interdepartmental committees was recommended: the first at the mineral disposition stage, the second at the mineral exploration stage, and the third at the mining and development stage. To most advantageously administer these regulations and guidelines the task force recommended they be enacted under the recent Department of the Environment Act.

Several Wilderness Act hearings, to receive the public's views on the candidate sites, were held in mid-1971 and a large crowd of 300-plus gathered at the hearing in Calgary to voice their concerns. One very contentious issue was the proposed disposition of a petroleum lease for development in the Spring Creek area west of Calgary, which had been the subject of a multi-year scientific study. Notwithstanding the efforts to coordinate interests in the government, this lease was issued before the hearings concluded. As a result, the Crown Mineral Disposition Review Committee (CMDRC) was established in 1971. Its purpose was to provide an interdepartmental review of all proposed mineral dispositions to identify their impacts or possible impacts on the environment. This was the second example of using an interdepartmental mechanism that worked well: the first was the Land Use Assignment Committee.

The Land Use Assignment Committee had been established by the Department of Lands and Forests to pre-plan the disposition of public lands for timber management and homesteading. Committee members physically studied or inspected the land to determine where the boundary between the Green Area and White Area should be drawn. It was also partly in response to the Department of Agriculture's contention that the disposal of marginally rated agricultural soils was fostering the extension of sub-marginal farming tracts in the Peace River Bloc. Public lands available for agricultural use, excluding homesteading, were coloured white on its Lands and Forests map; lands available for homesteading were coloured yellow; and lands unavailable for settlement but retained for timber production and wildlife habitat were coloured green.[49]

1971–73

After the August 30, 1971, election that brought about the defeat of Strom's Social Credit government and the election of the Progressive Conservatives under Peter Lougheed, who took office September 10, 1971, the CUC continued its regular monthly meeting schedule. The NRCC began to take on a more active role in September. Some good teamwork and positive relations developed between various deputy ministers while others remained indifferent or had strained relations because of competing mandates. In October 1971, after eight task force meetings, the CUC submitted the surface reclamation report to the incoming government ministers: William Yurko of Environment and Allan Warrack of Lands and Forests.

On October 29, 1971, Minister Yurko met with the NRCC to confirm the department's mandate. At about the same time the ECA learned it would hold public hearings on the environmental impacts of surface mining. The task force report would become background material to the ECA hearings, and the minister ultimately decided that the ECA would also receive public input on proposed coal mining regulations. A consultant's report[50] also provided background for the hearings, and the ECA issued its report and recommendations[51] in 1972.

Another technical report presented to the ECA hearings in late 1971 was Forestry's *The Present Situation and Reclamation Possibilities of Coal Strip Mines in the Province of Alberta*,[52] written by Jerry Selner. Even though the ECA hearings were well organized, extremely well attended, and generally well received by the public, some members of the coal industry continued to hold the view that land reclamation was a waste of money or that coal deposits could be mined and reclaimed without causing irreversible environmental damage.

The ECA began its public hearings on surface reclamation mining in Grande Prairie in December 1971, carrying on to Lethbridge, Edmonton, Calgary, and concluding at Red Deer in January 1972. Senior Environment Department staff attended the ECA hearings and began drafting coal regulations that were then circulated to the CUC for further input and then transmitted to the NRCC in early 1972.

During 1971, the CUC engaged in an interesting but extremely mind-bending exercise trying to conceptualize the impact of mining the Athabasca tar sands (over time tar sands became known as oil sands). Premier Manning had approved the Great Canadian Oil Sands Project, which was completed in 1967 with little or no information on environmental impact, reclamation, or post-mining land use. Most of the research that had been done focused on separating the bitumen from the sand. The CUC asked Esso Resources Canada, a division of Imperial Oil, to present the details of the proposed Cold Lake heavy oil drilling program before filing an application. This was done. Alberta's environmental impact assessment (EIA) process requirements were not in place at this time.

The CUC decided to conduct a virtual EIA on the mining of oil sands. The model adopted was the one promoted by the United States Geological Service (USGS): a large matrix listing in detail all the natural features, flora, and fauna occupying the subject lands on the horizontal axis, and all the man-made disturbances on the vertical axis. Each cell received a rating—1 meaning insignificant and 5 being total destruction. The committee laboured over this, with the assistance of specialists, for several days before completion. It was an exercise in mass education that helped every person present.[53] The CUC membership now had a much better knowledge base of mining the oil sands. However, this knowledge was not yet known or available to Members of the Legislative Assembly.

The year 1971 had been full but varied; its highlight was the establishment of the Alberta Department of Environment, closely followed by a change in political leadership. The department's basic objective was long-range comprehensive planning and orderly development: preventing pollution or environmental degradation, managing Alberta's water resources, regulating water and air pollution as well as municipal and industrial wastes and the expanding use of agricultural chemicals.

Remedial actions to reclaim past degradation, as well as minimizing future industrial degradation, were to form an integrated land conservation policy. The department was responsible for coordinating such policies, programs, services, and administrative procedures in matters pertaining to the environment. Many of these initiatives were to be devised and evolved through the deliberations of the time-proven CUC and its judicious use of interdepartmental and interdisciplinary task forces, which brought out the technical best in the civil service.

Several key task forces, as described in unpublished documents,[54] were established in 1971 and contributed to the CUC role of examining, analyzing, and recommending solutions to environmental issues, especially those related to conservation and reclamation.

The Tree Removal and Stream Bank Protection Task Force terms of reference were to be examined to render a broader interpretation and application of the Land Conservation Rules (a.k.a. regulations or guidelines until 1974 when they were appended to AR 125/74 as the Land Conservation Guidelines). The task force would review the existing regulations to determine their applicability and effectiveness and identify any need for change or updating. The task force would also investigate the need for enforcement programs, zone adjustments, as well as coordination and service to the public that would encourage positive attitudes and actions in conserving the riparian features. It recognized at the outset that the problem of tree removal and stream bank protection had to be considered from the point of view of land ownership—that is, Crown lands versus patented (meaning alienated from the Crown, titled, deeded) lands. The task force submitted its report and recommendations in September 1971. The issues first focussed on Stauffer Creek (a.k.a. North Raven River), a small but popular fishing stream and tributary of the Red Deer River west of Innisfail, which was having its unprotected stream banks overgrazed by domestic livestock. This was an example where conservation needed to be emphasized and practised, not reclamation.

The Rights of Way and Pipeline Corridor Task Force was formed when the Provincial Planning Board joined with the CUC to investigate all aspects and problems of rights-of-way, both above, on, and under the ground, including electric power transmissions, oil and gas pipelines, private roadways, irrigation ditches, canals, and utility corridors.[55]

In 1972, task forces were struck for Oil and Gas, Sand and Gravel, Lake Wabamun, Subdivisions of Land and Planning, and the Fort McMurray Athabasca Tar Sands Development Strategy, discussed in greater detail later in this chapter.

Reclamation criteria, both for the Athabasca tar sands mining and quarry excavations, were developed in tandem; subsequently, detailed land surface conservation and reclamation criteria were developed in connection with the extraction of crude bitumen from tar sands as well as for quarries. The primary objective was to ensure that the land surface would not limit future land development and use, then undetermined, following the completion of mining/excavation operations.

In March 1972, the administration of the Surface Reclamation Act and the Surface Reclamation Council were transferred by Order-in-Council[56] from Mines and Minerals to the Environment Department. Behind the scenes the ERCB had been lobbying to have the legislation transferred to its jurisdiction, but Cabinet decided otherwise: it accepted Environment's proposition that reclamation should remain separate from the ERCB to maintain the checks and balance system of administration. Later that summer Cabinet confirmed the department's role in promoting a balance in resource management, environmental protection, and quality of life.

During the next several months, with the assistance of Justice and Environment lawyers, five meetings were needed to resolve differences in practice and objective between the 1963 Surface Reclamation Council while in the Mines and Minerals Department and then after its transfer to Environment. This revised administrative procedure remained in effect until Part 3 of the Land Surface Conservation and Reclamation Act was proclaimed. Since its inception in 1963 the SRC had grown to 14 government members plus 57 local municipal members.

During 1972, following the experience with the McIntyre-Porcupine Mine coal mine application, another intergovernmental committee, the Development and Reclamation Review Committee (DRRC) was established to review major coal developments proposed for Crown land. In its first year the DRRC reviewed seven surface mining operations to which the Interdepartmental Relations and Land Conservation Division provided much-needed expertise on land conservation and reclamation issues.

On August 22, 1972, the Executive Council approved the role of Alberta's Department of the Environment:

> The role of the Alberta Department of the Environment, within the context of total function of Government, is to promote a balance between resource management, environmental protection and the quality of life.[57] This role will be achieved through interdepartmental government planning of policies, programs and services. These will generally be initiated and co-ordinated by the Department of the Environment in cooperation with other departments and agencies of the Alberta government, other governments, and non-governmental organizations including industry and the private sector.

Members of the Surface Reclamation Council, July 1963. *Stan Tracy*

Back row (L to R): unknown, Roger Baert, Don Knopp, Ken Ovelson, Noyce Boddy, Trevor Graham, Glen Acorn – department solicitor, Mel Pittman, Stan Tracy, Ross Pituka. Third from right: Ron Buckley. First on right: Don Rees

Seated fifth from right: Hubert Somerville, deputy minister, Mines and Minerals and chairman of the council

Many of the goals and objectives, originally included in the proposed Natural Resources Development Authority, were now imbedded in the department's legislation and mission statement.

In 1972, the CUC submitted the *Fort McMurray Athabasca Tar Sands Development Strategy* to Executive Council via an oral presentation. The study had been assigned to the CUC by the ministers of Municipal Affairs (David Russell), Industry and Commerce (Fred Peacock), and Environment (William Yurko). The full CUC had authored the report, supported by five task forces examining specific secondary objectives: social, economic, environmental, technical, and administrative. The report[60] took five months and was presented to the Cabinet in August. The CUC chairman remarked that the reclamation legislation, then being drafted, could be instrumental in garnering public support for the development of the oil sands. In response to the premier's query it was clarified that two processing plants could be under construction simultaneously provided there was a sufficiently large Canadian work force and the increased development would benefit Canadians.

Intercontinental Engineering consultants presented Cabinet with a second report,[61] commissioned by Alberta Environment, where they described the "environmental constraints and research priorities for mining/hot water extraction technology." The two reports, presented and discussed in tandem, gave the Cabinet a state-of-the-art presentation of the process and consequences of oil sands development—obviously a far better understanding than when the GCOS development was approved.

The CUC study concluded:

1. Alberta should regulate and control the Athabasca tar sands development for the socio-economic benefit of Albertans.
2. The social benefits accruing to Albertans should be inherent in the development of the resource and the associated urban development.
3. The rate and direction of the development should be dependent on Canada's ability to participate economically and on Alberta's requirements for economic development.

The Development and Reclamation Review Committee[58]

The Development and Reclamation Review Committee (DRRC, D&R Committee) was established in 1972 as an interdepartmental mechanism to review major coal development proposals on Crown land. Staff of the Interdepartmental Relations and Land Conservation Division of Alberta Environment provided support. The proclamation of the Land Surface Conservation and Reclamation Act in 1973 formalized the committee's mandate to require a development and reclamation plan for any regulated surface disturbing activity such as a coal mine. By 1975, the committee was reviewing numerous coal and oil sands development applications.

The benefits of coordination and collaboration in the interdepartmental review of resource development applications were recognized in 1975 with the creation of full-time chairman and secretary positions for the DRRC within the Land Conservation and Reclamation Division. Dennis Lang was appointed chairman. During 1976 to 1977, division staff worked to establish broad reclamation standards that would apply to the entire province. It was hoped that some basic uniformity of reclamation could be established for industry, local government, and government departments.

The committee provided a coordinated cross-ministry approach to reviewing applications, identifying the need for additional information from the applicant, and making a recommendation to the chair of the Land Conservation and Reclamation Council on whether to issue an approval. When the recommendation was to issue an approval, the committee provided the conditions to be included in the approval.

In the 1980s, the committee worked hard to provide a thorough, effective, and efficient process within the government and with the operators. A key government challenge was to deal with "conflicting mandates" among government ministries and agencies. A simple example was the mandate of the ERCB to maximize the recovery of a resource such as coal and the mandate of Alberta Environment to provide adequate setbacks from valley breaks to avoid problems with slope stability, erosion, and revegetation success.

To be successful the committee had to provide a forum that encouraged open and honest debate on issues and the development of positive relationships among committee members, even when there were strong differences of opinions. The committee also had to ensure that its members had a solid "on the ground" understanding of the operations it was regulating. In this regard, the practice of the committee was to visit the sites where an applicant was seeking an approval or an amendment to an approval. Regional staff from the member ministries and agencies would be brought into these visits to add their experience and perspectives. From an industry perspective, working with this committee had three particular benefits: (1) government representatives developed a high level of understanding of reclamation issues, (2) they were also very familiar with field conditions and operational realities, and (3) the committee would discuss and vet many issues internally, rather than simply adding them as conditions or information requirements in operating approvals. This latter point emphasizes the value of a strong chairman—that regardless of the collaborative approach taken by the committee, a firm and final decision was reached and conveyed to industry.

The DRRC recognized the critical value of reclamation research and worked closely with the Reclamation Research Technical Advisory Committee (RRTAC). The RRTAC chair was also the vice-chair of the DRRC (and vice-versa), providing a vital link between research and regulatory authorizations (see Chapter 4).

At times the committee worked with industry to encourage collaboration among operators. In the late 1980s, the committee was instrumental in arranging the first forum for Syncrude and Suncor—along with other research agencies—to exchange information on the reclamation of tailings, a critical issue in oil sands mining. Up to that point industry research was not openly shared. This forum set the stage for further collaboration. One of the key principles for the success of the committee was a strong focus on positive relationships among the ministries and agencies on the committee and with sectors and individual companies. Larry Brocke, chair of the committee from 1981 to the late 1990s, understood that these relationships operated at the "people level." Both the government and companies could aspire to positive relationships, but it was the people involved that made it happen (or not happen).

In 1993, the Environmental Protection and Enhancement Act (EPEA) came into effect and the DRRC continued under

EPEA. Under EPEA, operators received a highly integrated approval, one part dealing with "conservation and reclamation," which was under the purview of DRRC.

In 1998, government shifted to "regional-based delivery" and "place-based approaches." As a result, the Development and Reclamation Review Committee was discontinued. This committee, with its counterparts: the Crown Mineral Disposition Review Committee, the Exploration Review Committee, the Environmental Impact Assessment Process, the Land Conservation and Reclamation Council, and the Public Participation mechanism, all engaged in a unique planning process.

A testament to the effectiveness of the committee was a recommendation of an expert conference on land capability in 2011 to: "Re-institute the Development and Reclamation Review Committee as a tool to get better integration of government agency approaches and issues."[59]

4. The development should result in a net long-term benefit and improvement to Alberta's physical and ecological environment.
5. The evolvement of tar sand technology should be led by Canadian technologists for the benefit of Canadians.
6. The development should be an integration of community, industry, and government.

Thiessen recalls that during the lively question-and-answer session the premier posed questions clarifying the rate of development and the beneficiaries of the developments. Some ministers queried whether there would be sufficient Canadian investment capital to undertake such expensive developments.

Soon after a group of four or five ministers, including the ministers of Industry and Commerce, Intergovernmental Affairs (Donald Getty), and Municipal Affairs,

Construction at Great Canadian Oil Sands plant near Fort McMurray, circa 1967. *Glenbow Archives PA-3672-5*

attended a CUC meeting where a great deal of time was devoted to answering their questions on oil sands development. It was a broad-reaching question-and-answer session, over a couple of hours, where infrastructure, environmental impact, water diversion, reclamation, etc., were all mentioned. It was probably the first time that these senior civil servants had the opportunity to voice their views on oil sands development. When the ministers were leaving, the Intergovernmental Affairs minister said to the chairman that he never realized before how complicated the development of the oil sands would be.

Although the report had concluded that one plant every four years was consistent with the 1972 technology and construction capacity, subsequent discussions with Premier Lougheed (1971–85) confirmed that as Alberta's and Canada's technology and construction capacity increased it should be feasible to bring onstream one plant every two years, a view he continued to hold well into his retirement. As late as 2006, after flying over the oil sands, Lougheed remarked: "I was just up there on a trip, just helicoptering around, and it is just a moonscape. It is wrong in my judgment, a major wrong, and I keep trying to see who the beneficiaries are."[62]

Work continued on surface reclamation draft regulations; a reclamation bill was submitted to the NRCC in October 1972. The department maintained a close liaison with Lands and Forests on the McIntyre-Porcupine coal mine at Grande Cache. After 1971, soil salvage had been included as a requirement for coal mines at Grande Cache and Canmore.[63]

1973–75

The Land Surface Conservation and Reclamation Act[64] (LSCRA) received Royal Assent on May 10, 1973. Broadly speaking, the act achieved three purposes:

1. It added several key components to the department's legislative framework, the Department of the Environment Act, which had not been incorporated in 1971, e.g., environmental impact assessments, and formalized the interdepartmental review and coordination committees: the Crown Mineral Disposition Review Committee, the Exploration Review Committee, and the Development and Reclamation Review Committee that required a Development and Reclamation plan as part of the application to proceed with the project.
2. It fortified and expanded the original scope of the 1945 Agricultural Service Board's role in safeguarding Alberta's land base, and the 1963 Surface Reclamation Act decision to specifically include all forms of energy and aggregates development, keeping the joint provincial/municipal/public lands inspection format with unrestricted access.
3. It incorporated various resource conservation measures, i.e., coordination within government and public participation by affected landowners and communities, oversight, etc., prior to the final stages of reclamation. It merged the two factors of resource conservation and land reclamation to counter non-renewable resource development or exploitation.

Section 2 of the bill provided two very important exclusions:

- The act would not apply to subdivided residential land unless the landowner specifically requested otherwise in writing.
- Farming and agricultural operations could not be designated as a regulated surface disturbing operation.

The bill focused on joint resource development planning; it bound the Crown but didn't make it liable to prosecution, as non-governmental entities were.

The original draft bill, written by the CUC chairman, had been vetted by the CUC, the NRCC, and the minister before the Legislative counsel wrote the final draft. The appropriate committees of the Executive Council and the Cabinet reviewed it before it was tabled as Bill 47 in the Legislative Assembly. In his introductory remarks, recorded in Hansard, Minister Yurko spoke about the extensive public and governmental review during the 16 months the bill was being prepared, probably far more than any other in recent memory. The vetting Cabinet committee specified that the chairman, yet to be appointed, was to be one trained in agricultural soil science, not in engineering.

At all three stages the bill received positive support, both from Progressive Conservative government members as well as Social Credit Opposition members, especially from James Henderson, the former minister. The two exclusions mentioned above—subdivided residential land and agricultural operations—were frequently raised for clarification, but once understood always supported. Questions on administrative process, definitions such as surface disturbance or regulated surface operations, once clarified were accepted. One opposition MLA suggested that the chairman of the Land Conservation and Reclamation Council should have two deputy chairs: one from Lands

Henry W. Thiessen

Henry W. Thiessen was born midway through the Dirty Thirties and was raised on an irrigated farm east of Lethbridge, Alberta. After high school he farmed for several years before enrolling at the University of Saskatchewan where he graduated in 1959 with a B.Sc. in agriculture, specializing in soil science, with additional classes in irrigation engineering and plant ecology. During most of his summers he worked for Alberta Agriculture, engaged in irrigation-related soil and topographic surveys.

For nearly a decade, as a student and professional, Thiessen worked in southern Alberta on irrigation expansion and saline-wetland remediation, as well as assisting in the development of the first irrigated grazing reserves (community pastures) at Purple Springs, development of the Seven Persons and Bow Island irrigated reserves, and organizing the Pinhorn Grazing Reserve—the largest in Alberta. During that decade he also obtained an M.Sc. in Agriculture from Colorado State University, specializing in land use and economics. In addition to his practical experience and academic training, he acquired an invaluable ability to communicate effectively with landowners and tenants, farmers, and ranchers.

Henry Thiessen at ERCB public hearing, 1979. *Henry Thiessen*

In mid-1966, Thiessen was transferred to Edmonton and appointed Conservation and Utilization Committee (CUC) chairman, a position he held for nearly 17 years, until early 1983. A primary duty was the administration of the Land Assembly Program, purchasing land for various major government programs. Thiessen's administrative role expanded when the federal government's Agriculture Rehabilitation and Development Act (ARDA) funding became available, co-sponsoring several Alberta programs including Land Assembly, Farm Adjustment, Land Clearing, the Canada Land Inventory (CLI) Program, and assisting in the funding of Resource Allocation Planning Studies.

The CUC broadened its interdisciplinary knowledge base and membership in the early 1970s. Thiessen also became chairman of the 1963 Surface Reclamation Council, and later chairman of the 1973 Land Surface Conservation and Reclamation Council (LSCRC) from 1973 to 1981, an appointment predicated on being a graduate in agriculture majoring in soil science, specializing in soil physics, irrigation, and drainage. At the same time he was named an assistant deputy minister in Alberta Environment from 1973 to 1983.

The division of which he had been director—Interdepartmental Relations and Land Conservation—was now subsumed in the newly formed Environmental Coordination Service consisting of three separate divisions: the Land Conservation and Reclamation Division (LCRD), the Interdepartmental Relations Division (IRD), and the Land Assembly Division (LAD). The LCRD became responsible for administering much of the Land Surface Conservation and Reclamation Act (LSCRA), except for sections pertaining to environmental impact assessments, public participation, and role definitions, which were administered by the IRD. The LAD responsible for land acquisitions and Restricted Development Areas drew its operating authority from the Department of Environment Act. Thiessen continued as chairman of the CUC as well.

Following the establishment of the legislation and regulations under the LSCRA, and the noticeable slow-down in industrial activity and the severe time constraints demanded by the Fish Creek expropriation court action,[65] Thiessen phased out of his leadership position as chairman of the LCRC to devote more time to his land-buying responsibilities, especially in the Calgary and Edmonton areas, which had accelerated as prices began to plummet. Government land purchases for major projects, including the many grazing reserves, Dixon Dam and Paddle River Dam, Capital City Park in Edmonton, Fish Creek Park in Calgary, irrigation diversion works on the Peigan Indian Reserve and Blackfoot Indian Reserve, and especially for the Edmonton and Calgary Transportation and Utility Corridors

(TUC), and many dozens of other projects between 1966 to 1983 (17 years) were still active. Thiessen was the Crown's chief witness on several precedent-setting expropriations in Fish Creek Park and the Edmonton Transportation and Utility Corridor. The total land area purchased provincially during his tenure was equivalent to about one-third the area of Prince Edward Island.

In early 1983, the premier requested that Thiessen, given his settlement of the Peigan conflict, become deputy head of the Native Affairs Secretariat to negotiate Aboriginal rights issues and outstanding land claim entitlements during the First Ministers conferences on constitutional Aboriginal rights. The secretariat was able to implement an agreement, negotiated by Attorney General Neil Crawford, bringing to an end an extremely volatile road-block situation in the early oil sands mining days. More than a dozen meetings ensued involving Chief Dorothy McDonald and Thiessen trying to implement the numerous commitments. Generally, they were successful, except for their request for a baseline health study, which the ERCB turned down.

Thiessen and his staff negotiated the Lougheed administration's first treaty land entitlement with the Fort Chipewyan Cree Band. The band councillors signed the entitlement claim document on December 23, 1986.

Thiessen was also involved in motivating numerous Aboriginal and non-Aboriginal entities to adopt a Native child welfare policy, following a long and rancorous history (including the era of displacements known to Aboriginals as the "sixties scoop") that had a negative impact upon Aboriginal children.

After leaving Native Affairs, the Department of Public Works—now responsible for land buying formerly done by Environment—was directed by the courts to produce Thiessen as a witness to provide evidence in several Edmonton TUC/RDA expropriation examinations for discovery. This took him into retirement in 1991 from where he continued consulting on numerous expropriation cases and consulted with the Alberta government, industry, and First Nations on Aboriginal land issues until 2006.

and Forests and another from Mines and Minerals; but no amendments were made. Upon coming into force, the chairman of the newly created Land Conservation and Reclamation Council, named in the act, was Henry W. Thiessen. Thiessen continued as chairman of the CUC as well.

The act enabled the government to require development and reclamation plans for any designated activity; the long list of potentially designated activities included things such as railways and airstrips as well as oil and gas, minerals, and aggregate operations. It also provided for financial assistance in the form of grants or loans to restore derelict lands or to prevent lands from becoming derelict. "There are in Alberta many abandoned coal, quarry, and gravel pit operations where the government is responsible for reclamation," Doug Harrington told a workshop on reclamation organized by Alberta Environment and the Canadian Forestry Service. "Many of these areas can be landscaped and reclaimed for farming, grazing, land fill sites, parks, or other land uses."[66]

By mid-1973, the legislative framework supporting land conservation and reclamation was in place. Interdepartmental roles were being identified and defined to improve liaison and coordination with numerous departments. Executive Council* had given its approval to the Environment Department's course of action through policy statements. Organizational changes were implemented to execute a fresh course, especially relative to oil sands and coal mining. An early challenge was the operational definition of an EIA. The department commissioned two separate consulting firms for advice and also relied on the USGS model before choosing a comprehensive format to conduct an in-house, by government staff, EIA assessing the impact of the Kananaskis Highway. More sophisticated and comprehensive formats were soon developed and submitted by the private sector in support of their project applications over the years, e.g., Syncrude's Mildred Lake mine and plant (the province's first formal EIA in 1973[67]), Esso's Cold Lake in-situ bitumen extraction, or Shell's Alsands[68] oil sands surface mining operations.†

By 1974, 16 EIAs were requested for proposed developments.[69] In 1976, the CUC reviewed and approved Interim Guidelines for the Preparation of Environmental Impact Assessments that had been drafted by departmental staff and then released to the public.

Senior executives from Alberta Agriculture and from

* Formally, government ministers and the lieutenant-governor comprise the Executive Council that issues such decisions; for all intents and purposes, the Cabinet is the decision-making body.

† Cold Lake (operated by Imperial Oil subsidiary Esso Resources Canada) and Alsands were both proposed in the 1970s as megaprojects that included upgraders. Due to changing economics, Cold Lake was eventually developed in stages, without upgrading, while the Alsands proposal was dropped. In 1999, a Shell-led consortium began its Muskeg River mine development on the same leases. Better known as the Athabasca Oil Sands Project, the project went onstream in 2003.

Lands and Forests had actively participated in the Canadian Council of Resource Ministers (CCRM) national programs from about the mid-1960s, jointly improving and promoting their public service mandates. During this time the interprovincial organization was broadened to become the Canadian Council of Resource and Environment Ministers (CCREM). The "Man and Resources" national forum, a two-faceted public participation event started in about 1969, held a national workshop at Montebello, Quebec, in the late fall of 1972, and its first phase concluding conference in late 1973 at Toronto.

Alberta was well positioned to forge a major public participation component, based on its experienced team of public participation practitioners from Agriculture and their successes in the rural ARDA programs. The program's objective in this first phase was to organize a diverse group of Canadians to identify and prioritize national issues. This was overwhelmingly achieved; twelve issues were identified, including, in priority listing: (1) citizen participation, (6) long-term planning, (7) environmental protection, and (8) energy.[70] But the planned second phase to debate the issues and formulate guidelines to "achieve and sustain a balance of social and economic benefits derived from the resource base" never took place. For a variety of "political" reasons CCREM concluded that the second phase with its attendant public participation component was too controversial. The first phase had generated too much interest and too many expectations. CCREM opted to downplay its role and, as an alternative, began an in-house examination of land-use issues facing Canadians.[71] Discussions on "sustainable development" were deferred for more than a decade.

The Alberta government had, during the five years (1969–73) or so that the Man and Resources Program was operative, enacted at least six major statutes, followed up by numerous regulations and guidelines, complemented by interdepartmental/interdisciplinary task forces, coordinating review mechanisms, environmental impact assessments, development and reclamation plans, and an efficient monitoring program that effectively reorganized the administration of the resource base and protected the environment.

In early 1973, the government held discussions with industry regarding the feasibility of using existing railway rights-of-way for the expansion of electric transmission lines and oil sands pipelines. Industry angrily dismissed this suggestion.[72] These discussions, however, resulted in the commissioning of an independent but interdisciplinary engineering/survey group supplemented by other technicians and lawyers, fortified by Environment's public participation team, Transportation's engineers, and Lands and Forest's biologists to study the feasibility of a common right-of-way corridor between Edmonton and Skaro, a hamlet 80 kilometres northeast of Edmonton. They chose Skaro as the refinery hub (eventually centred in the Fort Saskatchewan area), Hardisty as the southern pipeline terminal, and Fort McMurray as the northern terminal.[73] The objective was to focus on the conservation of agricultural land, timber, habitat (environment), and construction and operational costs (economy).

A task force on oil sands reclamation research,[74] established in 1974, defined the need for applied/operational research to bring about the reclamation of mined lands and tailings (a.k.a. sludge) ponds.[75] The report was probably the most comprehensive study to date at that time, available to the government, of the tailings issue that was to challenge bitumen mining for decades to come—and may still be a problem. The 18-page document examined the numerous operational steps involved in mining and separating bitumen from sand and focused on the key reclamation impediment: the tailings pond dyke and its sludge content. The four problematic aspects were: (1) the landscape characteristics following mining had not been defined, (2) the "soils" available for reclamation were uncertain, (3) the plant and animal life that could survive such conditions were unknown, and (4) the timing and integration of reclamation was in a distant future. The report identified areas requiring further research including: "current research status, tailings, water management, materials management, soil reclamation and vegetation, and waterbodies and wildlife biology." The report and many similar oil sands related studies were tabled in the Legislature Assembly and the Legislative Library.

Two other task force reports were undertaken: one on the climatological conditions prevalent in the oil sands mining area,[76] and another describing the hydrological research needs necessary to plan reclamation.[77] These reports were again widely distributed.

The first regulation under the LSCRA, the Conservation and Reclamation Regulations,[78] was introduced by Minister Yurko and published in the *Alberta Gazette* on May 15, 1974, available for all to read. Its content described much of the administrative procedures adopted by the newly formed council, and included a schedule of the three-and-a-half page Land Conservation Guidelines now in their third stage of Alberta's early prescriptive efforts at practising land conservation; the first stage having been the ARDA-funded land clearing program and the second the homestead land clearing loans program administered by the Lands Division's Homestead Lease Loan Advisory Board.[79]

The Land Conservation Guidelines, as first envisaged by former ministers Henderson and Ross, were to be applied judiciously to complex natural situations by common-sense staff in the administration of the LSCRA: they were guidelines, not regulations. The prescriptive criteria were based on the ARDA-inspired CLI classification system applicable to land, waterbodies, or watercourses and included the various capabilities inherent therein. Review committees and approving authorities were duty bound to have regard for the guidelines when considering regulated surface disturbing applications. The guidelines provided direction on retention of natural shelterbelts on sloping lands; leaving uncleared setbacks from steep or deep coulees, ravines, or valleys or bordering on watercourses or shore lands depending on their depth and severity; and protection of higher capability natural cover for waterfowl or recreational use depending on the size of the watercourse or waterbody. Road crossings, bridges, pipelines, and tree felling were also dealt with in the guidelines. Information required for water crossings included water flows and levels, below water topography, and design features of the proposed installations. The guidelines were assembled to protect watersheds from erosion, protect the natural habitat for waterfowl and wildlife, and preserve the higher capability recreational lands.[80]

In mid-July 1974, the corridor consultant team presented its conclusions in a Corridor Development Plan to the Cabinet.[81] It concluded that:

- Legislation should be enacted to designate and zone corridor lands, create and staff a managing authority having the power to buy and expropriate land, and manage all aspects of the corridor for its intended uses including highways, pipelines, transmission lines, and railroads.
- The Athabasca Oil Sands corridor, paralleling the existing GCOS right-of-way, should be designated and the authority be created immediately.
- The corridor concept should be considered applicable in other parts of the province.

Simultaneously, Environment proposed designating the corridor a Restricted Development Area (RDA), similar to the first designation of the east leg of the Edmonton Transportation and Utility Corridor (TUC). Cabinet refused designating it an RDA but asked for a public communications strategy. On July 23, 1974, Cabinet conditionally accepted Environment's Request for Decision (RFD) detailing the implementation of the Corridor Development Plan, incorporating a communications and land purchasing strategy, but without an RDA designation. The department negotiated about 40 options or purchase agreements in fee simple during August and September, prior to the October public release period.

In October, Premier Lougheed announced the oil sands corridor, its purchase of land for the corridor, the planned approach in the government's expansion and diversification of the petro-chemical industry, and the distribution of industrial tax revenues to balance rural growth. Market forces would be sufficiently influenced by government policy to reflect the public interest, the premier said. It was a bold move reflecting the conservation of resources.

In the late summer to early fall of 1974, after successfully siting NOVA's petrochemical complex* east of Red Deer near Joffre with the aid of aerial reconnaissance and the participation of Deputy Minister Ballantyne, Assistant Deputy Minister Thiessen, and several technical staff, Minister Yurko requested draft regulations designating the larger scale industrial complexes as surface disturbing operations. Establishment of the complex was the beginning of the government's policy objective announced by the premier, stripping the relevant hydrocarbon fractions off for the petro-chemical industry and processing them, thereby adding value for the province, prior to exporting the natural gas. Appropriate regulations for the disturbance designation were prepared, vetted through the Business Development and Tourism Department, before submission to Cabinet, where they were refused without explanation. Notwithstanding, staff continued to render informative advisory assistance based on aerial reconnaissance, without relying on regulations, often through the EIA process.

1975–79

The Environmental Coordination Service staff, both at the headquarters and field level, had been actively developing a positive working relationship with the Coal Association of Canada (a.k.a. Alberta Coal Association) executive in Calgary, as well as with many of its corporate membership proposing, developing, or operating coal properties. Minister Yurko introduced the first regulation designating a surface disturbing operation, the Regulated Coal Surface Operations Regulations,[82] providing for:

- the filing of a proposed development and reclamation plan and environmental impact assessment
- a process of interdisciplinary and interdepartmental technical reviews

* The petrochemical complex was a key element in Premier Lougheed's industrial strategy to obtain more value from Alberta's oil and gas resources prior to export. NOVA Chemicals began producing ethylene at Joffre in 1979 and later added polyethylene production. The feedstock is ethane stripped from natural gas streams.

- public consultation and participation in the project planning and public hearing process involving affected landowners
- on-site ground inspections, often assisted by helicopter surveillance
- selected departmental reclamation of former mined lands as demonstration sites

Alberta Environment applied these administrative concepts and practical procedures toward the drafting of the government's Coal Development Policy.* Among other features the coal policy added the requirement for a full public disclosure by the applicant at the outset, and it supported Environment's participation on the ERCB public hearing panels. The government agreed to pay the legal fees of lawyers assigned to assist affected landowners, enabling them to present their views and grievances before the board. As a result of this regulation, the conservation of topsoil materials began at plains coal mines in 1975.

Soon after the presentation of the Regulated Coal Surface Operations Regulations, the Alberta government introduced the Security Deposit Regulation.[83] The purpose of reclamation security was to provide a source of funds for government to use should the operator be unable, or unwilling, to perform reclamation. This regulation was amended in mid-1977 when specified amounts for coal, oil sands, and oil and gas pipelines operations were establised.

In early 1975, the governments of Alberta and Canada entered into a joint Alberta Oil Sands Environmental Research Program (AOSERP) to conduct environmental research on the oil sands regions for the purpose of maintaining an acceptable environmental quality in recovery, transporting, and processing oil sands products.[84] Its objective was to direct practical solutions against social and technical environmental problems stemming from oil sands developments. Deputy Minister Ballantyne became its CEO; former assistant deputy minister Walter Solodzuk replaced him as deputy minister.† Ballantyne promoted a similar research thrust for coal mining, introducing operational research and science, replacing the surficial/cosmetic approach first introduced in the 1963 legislation to coal mining and other reclamation activities.

The April 1975 election resulted in David Russell replacing Minister Yurko. That fall Thiessen accompanied Premier Lougheed and about 50 others from the government and private sector in a trade and technology exchange mission to Europe including England, Scotland, Belgium, France, and Germany. A highlight was the visit to the National Coal Board's deep surface coal-mining activities in Scotland and especially the Rheinische Braunkohlenwerke (RBW) surface lignite coal mining and reclamation of farms, parklands, and villages in west-central Germany. The application of the RBW technology and operating attitude would undoubtedly enhance the mining and reclamation required in Alberta's oil sands development.

The premier must have been similarly impressed because he invited the RBW team, led by their board chairman/CEO Dr. Erwin Gärtner,‡ to visit Alberta the next year and inspect surface reclamation operations: the oil sands and coal mines. Their contingent of about a dozen executives, technicians, and politicians met with the premier and numerous ministers and senior officials, including the CUC and the NRCC, as well as with many of Alberta's corporate leaders from the energy sector and affected landowners. The premier attended many of the events, notwithstanding that the Legislative Assembly was in session, and participated in the aerial reconnaissance flights and other functions where the public was present. The week-long visit provided ample opportunities for the exchange of technical information to both groups.

In 1976, a major materials-handling study was commissioned to Techman Ltd.,[85] a consulting arm of the Mannix-Manalta mining conglomerate, exploring the techniques used in prairie surface-mining operations. Another commissioned study, with G. R. Shelly and Associates,[86] assisted in the resolution of conflicts in the north Edmonton Villeneuve gravel developments by prescribing reclamation activities and alternative land uses.

In 1977, the government also arranged for Techman Ltd. and Rheinbraun-Consulting GmbH, the RBW consultants,[87] to conduct a joint study, *Oil Sand Reclamation: A Study Integrating Mining, Tailings Disposal and Reclamation,*[88]presented to the mining community in September 1979 and discussed below.

Other regulations followed: Minister Russell introduced the Regulated Oil Sands Surface Operation Regulations[89] in mid-1976. The Oil and Gas Pipeline Surface Operation Regulations were also proclaimed.[90] This was done after

* The coal policy was produced by the newly amalgamated Department of Energy and Natural Resources (ENR) under its minister, Don Getty, and chief deputy minister, Dr. George Govier, the former ERCB chair.

† Solodzuk also chaired the Natural Resources Coordinating Council from 1976 to 1987.

‡ Germany, with coal mines in close proximity to denser populations and more intensive agriculture, was far ahead of the United States in coal mine reclamation, according to a 1972 U.S. report (http://web.ornl.gov/info/reports/1972/3445605662636.pdf). The paper quoted Gärtner: "Man urgently needs raw materials. The achievements of technology have provided him with a means of restoring the land to useful agricultural purposes after mining operations are completed. Furthermore, this can be done economically."

their vetting by the Canadian Petroleum Association in conjunction with ENR was completed.

In 1976, the premier's office requested suitable candidate programs that might qualify for Alberta Heritage Savings Trust Fund financing. Apparently the word "trust" had been deliberately selected by the premier to reflect the inclusion of protecting or saving for the benefit of future generations. The Reclamation of Derelict Lands Program was submitted as a potential candidate, building on a 1974 program requested by the Department of Advanced Education to train heavy equipment operators.[91] The sites included abandoned gravel pits and borrow pits, small mined-out surface coal mines, garbage dumps, abandoned sewage lagoons, and other unsightly uses. The premier and minister received positive feedback and appreciative comments from MLAs, municipal councillors, and the general public, and when the heavy-equipment training component was factored in, this became a very popular and useful program demonstrating what reclamation could achieve. By 1981, six years after its beginning, nearly $11.5 million had been invested in the reclamation of derelict lands scattered about the province in 1,076 separate projects.

In July 1975, the CUC had established a Shorelands Task Force to identify which of the 630 Alberta lakes were experiencing intense subdivision and development pressures. The task force identified 45 lakes; 15 were of major concern due to restricted public access and overcrowding.[92] These lakes included Baptiste, Gull, Garner, Island, Isle, Lac La Biche, Lac La Nonne, Lac Ste. Anne, Moose, Muriel, Nakumun, Sandy, Skeleton, Sturgeon, and Wizard. The Regulated Lake Shoreland Development Operation Regulations[93] took effect on August 24, 1977. Detailed soil surveys were conducted surrounding about one-third of the lakes for baseline information purposes before the preparation of a Lake Management Plan and the writing and adoption of lake management land-use zoning. Plans for any industrial, recreational, or residential developments on un-subdivided lands were held in abeyance until the bylaw was properly in place. Once the bylaw for a lake was adopted the regulation was repealed. The last of the Lake Management Plans was adopted in December 1986. This was an example of resource conservation, not of reclamation.

During 1976, the Land Conservation and Reclamation Division intensified efforts to work with the Coal Association of Canada, the Independent Petroleum Association of Canada, several wellsite and pipeline associations, the Alberta Roadbuilders Association, the Association of Counties and Municipal Districts, the Alberta Sand and Gravel Association, and government departments to establish broad uniform reclamation standards applicable to the entire province. In 1977, guidelines for the reclamation of land affected by a surface disturbance[94] were established and circulated widely to appropriate Alberta industries. Similar guidelines were circulated to 1,800 Alberta industries, one describing and explaining the EIA requirements and a second offering comparable guidance regarding the public participation process.

In early 1976, CanPac Minerals and Calgary Power submitted a joint surface coal-mining application to the government for the Camrose-Ryley region, pursuant to the newly adopted Coal Development Policy.[95] Locally it became known as the Dodds-Roundhill project, after two of the small farming hamlets lying in the path of development opposed the proposal. Departmental staff were in frequent contact with the joint applicants as well as the community association and the local farming community. The premier was kept apprised and had arranged one of the meetings with the visiting German RBW contingent to be held in Camrose in early May 1976. The applicants and representatives of the community association were also invited. Since the minerals had already been tendered and the exploration completed, the environmental referral process was focussed on reviewing the EIA and refining the proposed Development and Reclamation Plan in preparation for a joint ERCB/Environment public hearing.

These reviews revealed that the applicants had submitted little surface soils information, and in discussion with the minister, the department decided to undertake surface drilling using the Sterling drill* and sampling to test the physical and chemical feasibility of reclaiming the surface overburden. The investigation revealed that much of the "B" horizon was an impervious solonchak-solonetz-solod clay hardpan, columnar prisms with rounded tops, high in sodium (Na) content, typical of a classic solonetzic continuum. It was an amorphous, non-friable clump of clay when dry and slick and impervious to water and air when wet on the surface. The parent material "C" horizon was a typical glacial till somewhat weathered in the upper reaches.

On July 2, 1976, Thiessen accompanied the premier and Dr. Allan Warrack (minister responsible for utilities) on a helicopter tour of the Dodds-Roundhill community. The tour overflew much of the area destined to be mined, showing the gently rolling verdant landscape in its full summer bloom, before the party landed near the Sterling drill punching 4.5-metre holes and taking soil samples from the upper horizons. Thiessen found some classic representative sites from which he could visually explain the challenges of

* The Sterling drill was a sampler designed to take a core 15 centimetres in diameter. The department's drill was fitted with a 30-centimetre rotary bit to take large soil samples every foot. The self-powered boring machine was typically mounted on a 3-ton truck.

reclaiming the solonetzic soils; the premier ran his fingers over the problematic round-topped columns. The "A" horizon would have to be excavated and stored in a stockpile for several years while keeping the micro-organism biota viable. The "B" horizon would be over-excavated and stored until space was found to bury it at the bottom of the mined-out pit. Thirty to 60 centimetres of the slightly weathered "C" horizon would be excavated and saved until needed in the pit. The remaining parent material above the coal seam would be excavated to the top of the coal seam. Once the coal mining was finished in a cell the toxic and unproductive "B" horizon would be spread on the pit floor, followed by the un-weathered parent material and capped by the previous weathered "C" horizon; now substituting for the "B" horizon. The last layer returned would be the "A" horizon, the topsoil.

Several weeks later, after all the soil analysis data had been considered, Minister Russell received a report[96] concluding that the soil could possibly be reclaimed at great cost under strictly prescribed conditions, but that it might be more advantageous to delay such a project until more research and operational experience had been gained. Some days later the premier announced that the Dodds-Roundhill coal development would not proceed; this occurred even before the ERCB/Environment hearing was held. It was one of the first applications under the Coal Development Policy, estimated to be valued at $260 million (equivalent to $1.1 billion in 2014 dollars[97]) but rejected because of doubts that the mined farmlands could be adequately reclaimed.

The Dodds-Roundhill decision reflected a growing awareness during the 1970s of the need for soil conservation. It became a priority within government, industries, and the academic and agricultural communities. Soil information gathered by the Canada Land Inventory in the 1960s was soon bolstered by the need for sampling and research to support development and reclamation plans, environmental impact assessments, company operations, and regulatory decisions. The results from the initial research studies assisted with the eventual development of a science-based technical manual for use by individuals involved in reclamation of all types of land disturbances. The process was initiated in 1977 by a subcommittee of the Alberta Soils Committee and led to publication of proposed criteria in 1981. The acceptance and adoption of the *Soil Quality Criteria Relative to Disturbance and Reclamation* in 1986 provided a universal approach to measuring the suitability of undisturbed and reconstructed soils.[98]

The Environmental Conservation Authority was renamed the Environment Council of Alberta in 1977 and took on a more advisory role; the ECA continued to exist until its act was repealed in 1995. A major achievement of the ECA was its 1975 recommendation of integrated resource management in the Eastern Slopes Forest Reserves, which led to the government's Policy for Resource Management of the Eastern Slopes in 1977. The policy began a round of sub-regional planning.

The administration of the 1973 Land Surface Conservation and Reclamation Act was phased in over several years. On August 8, 1978, OC 871/78[99] proclaimed Part 3 and also repealed the 1963 Surface Reclamation Act. The Part 3 Administrative Regulations, AR 321/78,[100] with an attached map, now completed the transfer of jurisdiction to the Department of Natural Resources with the necessary authority confirmed[101] enabling designated staff in the Public Lands Division and the Forestry Service to exercise this delegated authority as reclamation inspectors on behalf of the Land Conservation and Reclamation Council.[102]

Techman Ltd. and Rheinbraun-Consulting GmbH completed their consulting report in September 1979. Several of the contentious environmental issues are still relevant today, 35 years later: the GCOS tailings disposal impoundment structure is still at risk within the Athabasca River floodplain and the entire Peace-Athabasca Delta; tailings deposits are finally being reduced to a dry state in preparation for reclamation; and the consultants' recommended one-metre deep forest litter and soil overburden is still being debated now as it was then when industry countered with a one-third metre "topsoil" depth. The marked improvement is the reduction of "make-up" water required.

A well-attended government-industry symposium followed to complete the proposed technology transfer from research to practice, which for several reasons never fully took place: the long, cold, and snow-covered winter climate conditions made drag-lines and huge trucks the equipment of choice over bucket-wheel and conveyor belts to excavate and convey the bitumen sand; the Clark Hot Water Process tailings problem is now purported to be resolved; and the state of joint planning, in the "public interest," between the public and private sector has not advanced in Alberta to the extent anticipated.

1979-82

Minister Jack Cookson introduced the Regulated Sand, Gravel, Clay & Marl Surface Operation Regulations[103] on December 6, 1979. Even though this was the last of the regulations designating surface disturbing activities, ministers continued to seek out the CUC for comment or analysis on various natural resource administration issues. A handful of other tasks reaching back into the early 1970s, reflecting its diversity, are listed below:

- Brazeau River Dam and lakebed timber removal and partial funding
- Foothills Resource Allocation Study guidance and partial funding of 23 drainage basin studies
- Grande Cache Crump Commission assessment and railroad rehabilitation
- guidelines for the orderly development of Alberta's peat industry[104]
- submission prepared for the National Parks public hearing
- Foothills Resources: a choice of land use alternatives prepared for the ECA
- environmental land use controls in Alberta's energy corridor
- erosion control in northwest Alberta: the oil and gas industry
- development of the Cooking Lake moraine
- remote sensing technology and capability in Alberta

By 1980, most of the regulatory features of the LSCRA had been implemented and used on a regular basis. The last vestiges of the Surface Reclamation Act had been repealed. The three-tiered referral system (mineral sales, exploration, and development) was working well for the representative departments as designed. The development and reclamation approvals included reference to the preservation of topsoil for reclamation and probably the use of native grass species in the foothills and mountain regions. The EIA mechanism was drawing government departments together, eliciting a government response from departments, as opposed to a dozen individual opinions. Their comments were well received and useful as evidenced by the ERCB/Environment hearing on the Esso Cold Lake proposal and the Shell Alsands Fort McMurray hearing. Affected landowners or residents were being heard and the government was responding. The EIA process was identifying the environmental consequences of many projects, especially in the oil sands where more and more the government was contemplating the cumulative effects of numerous and larger projects; it was functioning as it should, as a long-range planning instrument.

Many of the developments then being applied for stemmed from the energy sector; heavily influenced by the escalating price of crude oil or by energy sector profits looking for lucrative investment opportunities. In mid-1973, when the West Texas Intermediate (WTI) price of crude oil was a little less than US$20/bbl, it suddenly more than doubled because of the Arab embargo to US$46/bbl.[105] Between 1973, following the Yom Kippur War and the Arab Oil Embargo, and 1978 oil prices inched upward nearly to US$50; development applications sprouted throughout the oil sands industry. The Iranian Islamic Revolution (1978–79), and the Iran/Iraq War (1980–88) drove the price ever higher so that by mid-1980 it had peaked at nearly US$100/bbl. From that peak it plunged down for nearly seven years to flatten out at about US$35/bbl in the early 1990s.

There were numerous large oil sands projects (mining, upgrading, refining, pipelines, heavy oil pumping, etc.) under consideration at the end of the 1970s into the early 1980s. Some disappeared as the oil price peaked and as interest rates lurched ever higher into the 20 per cent range; but more fell off when the price tumbled. Thiessen vividly remembers bumping into Energy and Natural Resources Minister Mervin Leitch in the Calgary airport one evening. The Shell Alsands project hearings had been completed in 1981 and the ERCB Decision Report was either completed or being finalized before the government was about to grant conditional approval, when Shell called for an extra-ordinary meeting to inform the government it was withdrawing its application. Government ministers were badly shaken by this decision. It had nothing to do with environmental conditions imposed by the government but was a function of falling international oil prices.

Before this unprecedented event occurred, Environment, through its regulatory process, was instrumental in influencing a de facto regional development strategy in the oil sands, but the pre-1980s meteoric oil prices and the post-1980s recession and plummeting oil prices reduced many opportunities and options. Although nominally regional municipal planning was the purview of Municipal Affairs, their in-house typical model was not meeting the expectations and needs of the energy sector in that region. As a result, the government created a special legislative base. It appointed Manpower to set up a separate planning function headed by a retired naval commander. As the appointed Northeast Alberta regional commissioner[106] he published a preliminary plan. This model did not work noticeably better than the first. Finally the government hired a former land developer and an ex-government management consultant, but their success appeared little better, especially as oil prices continued plummeting. No one was interested in contemplating long-range planning in an industry and region where falling prices and non-existent profits were the talk of the town.

The Evolution after 1982*

The first two decades of legislated land reclamation in Alberta put in place a framework to address the major land reclamation issues facing a province with high levels of non-renewable resource development and resulting land disturbance. Development slowed considerably in the following decade. This hiatus allowed time for more operational experience and the development of science-based approaches that improved the effectiveness of conservation and reclamation at both the planning and implementation stages. New legislation followed in 1993, intended to improve the efficiency of regulation. The acceleration of energy development, beginning in the late 1990s, led to challenges as government attempted to deal with the growing volume of sites, increased public scrutiny, and the widening scope of reclamation issues.

1983–92: Soil and Land Capability

In 1983, the Land Surface Conservation and Reclamation Amendment Act added "contamination" to the definition of "surface disturbance" in the legislation. It also included "construction, operation, or abandonment of a plant" among the regulated surface operations, and it specified "removal and conservation of topsoil" as a reclamation requirement. Environment Minister Bradley said the legislation "provides for the prevention, containment, control, removal, or remedy of any contamination, degradation, or deterioration of the surface of land."[107]

Also, beginning in 1983, *equivalent land capability* started to be considered as a more appropriate objective for reclamation than *equal or better productivity*.[108] Productivity, based on vegetation, had seemed like a reasonable goal in early reclamation on agricultural land, but success turned out to be difficult to assess.[109] The difficulty was due to both natural factors (e.g., drought and precipitation) and human interventions (e.g., fertilizers, herbicides, and tillage). In forested areas, it could take many years to establish vegetation, and during that time trees and shrubs could be wiped out by fire, insects, disease, wind, or new development. Larry Brocke, who had joined Alberta Environment in 1982 as chair of the Development and Reclamation Review Committee, explained that it made more sense to consider factors such as soil quality and desired end uses.[110] Vegetation would continue to be evaluated, if present, but it would be used as a means of confirming expected performance and potentially identifying soil contamination.

The re-evaluation of the "productivity" standard arose initially from difficulties in assessing the reclamation of large disturbances such as coal mines. Experience with similar mines in the US Northern Great Plains region suggested "capability" as a viable alternative. Representatives from government, industry, and stakeholder groups discussed the capability concept at a workshop in 1984.[111] Land capability classification systems, based on the Canada Land Inventory, provided a scientific footing for the capability discussions. In Alberta, the concept was applied initially for plains coal mining where the primary end land use was agriculture. The approach was applied to more areas in the late 1980s and early 1990s, although it was not incorporated into legislation until 1993.

The Eastern Slopes Policy, adopted in 1977, was revised in 1984 "to reflect the realities of the economic situation in Alberta."[112] The policy had fostered a round of sub-regional planning that could have led to better determination of desired end uses. However, according to a 2002 analysis, these attempts at integrated resource management "failed to achieve integration in environmental and resource management" and were "clearly inadequate to address resource-use conflicts and cumulative environmental effects."[113] Efforts to integrate multiple values and uses resumed in the first decade of the 21st century and led to the Land Use Framework, the 2009 Alberta Land Stewardship Act, and the development of regional land-use plans.

For major projects, the environmental impact assessment process provided an important means to ensure that conservation and reclamation would be included right from the initial planning of developments. The 1985 Environmental Impact Assessment Guidelines provided guidance to proponents of major resource developments on the information that would be required for the early identification and resolution of significant adverse effects on the environment. A public participation program was an integral part of the EIA design, and so was a conceptual plan for eventual reclamation.

* By the authors (Robert Bott et al.)

EIAs were usually required for major new developments such as sour gas processing plants, underground or surface coal mining projects, hydro and thermal electric power plants, oil sands mining projects and associated processing facilities, large-scale industrial facilities requiring industrial development permits, pipelines, electric transmission lines, large recreational developments, and major water resources projects. Staff in the Environmental Assessment Division relied on project descriptions and site inspections to evaluate the need for an EIA on a specific proposal and make a recommendation to the deputy minister of Environment.

Once the EIA report was submitted and reviewed and deficiencies were addressed, the EIA would be deemed complete, and the ERCB would be notified that the EIA was suitable for public hearing purposes. Public involvement was limited in the review of the EIA. Some recourse was available in the hearing process for the public if they were granted intervener status.[114]

The interdepartmental DRRC continued to review large-scale industrial development applications and ensured that all relevant provincial government departments had input into recommendations on approvals for these activities. The committee could recommend approval, rejection, or approval with conditions. The conditions could cover such concerns as surface run-off control, erosion control, soil handling, soil salvage and replacement, groundwater monitoring, overall reclamation, and revegetation.[115]

The DRRC members "were charged with reviewing a company's development and reclamation application," Brocke said.

> Our chore was to review all the technical aspects. All the government departments with any interest at all were a part of it. We regularly reviewed all the technical parts of the application, questioned them, brought the company in, had them explain, went out to the site, looked, visited, trying to get an understanding of how the operation works and how this would fit in—make it so it would work. That's what we did. And we'd come out of it with an approval, with approval conditions that the company was to follow in their operation. That approval was then handed off to the director of the Land Reclamation Division for signature and issued to the company.

The 10-year approval renewal applications for major facilities such as coal and oil sands mines provided another opportunity to review reclamation planning and operations, Brocke noted.[116]

All through construction and operation, the activity would be monitored by inspectors from Alberta Environment and Alberta Energy and Natural Resources (ENR). If any of the conditions of the approval was not being met, the mine or facility could be shut down or forced to change its operations. This combination of detailed, iterative review of applications, coupled with frequent on-site inspections, allowed regulators to adopt an adaptive management approach to reclamation that had the effect of saying "we are in this together—you carry out the agreed upon plan and if it works great, if it doesn't we learn from that and change future plans."[117] This philosophy of shared accountability for results was later eroded by reductions of on-site inspections and the loss of the collaborative approach between government and industry.

In 1987, Alberta Agriculture published *Soil Quality Criteria Relative to Disturbance and Reclamation*, the culmination of work by the Alberta Soils Advisory Committee since 1978 (draft criteria had been circulated since 1981).[118] These criteria provided a universal approach to measuring the suitability of undisturbed and reconstructed soils.

On both large and small disturbances, inspectors worked with industry to incorporate soil salvage into planning, construction, and reclamation, as required by the 1983 legislation. "A lot of the adaptive information that had come out of the RRTAC program was being disseminated across industry as a whole," recalled former inspector Bruce Patterson. "Some companies would try it out—proven—away you go … Then some of the companies developed specialized equipment to deal with it. So, for that reason, I give industry credit."[119]

Ralph Klein served as Environment minister from his election to the legislature in March 1989 until he became premier in December 1992. Two forces shaped his tenure. On the one hand, public awareness of environmental issues reached high levels due to a series of factors—among them, the United Nations report on sustainable development (Brundtland Report, 1987), sour gas blowouts and other emissions from oil and gas fields, the "ozone hole" and climate change, controversy about hazardous wastes and landfill locations, and rapid expansion of the Alberta forest products industry. At the same time, the province faced growing deficits and weak economic growth following the National Energy Program of 1980, high interest rates, the recession of the early 1980s, and the collapse of oil prices in 1986. Slow economic growth would continue in Alberta through most of the 1990s and affect many government policies and programs, including those dealing with land conservation and reclamation.

One success during this era was the continued efforts of the Alberta Heritage Savings Trust Fund program (see page 59) to reclaim derelict and contaminated sites such as

Ralph Klein served as minister of Environment from 1989 to 1992 at a time when public awareness of environmental issues was growing and government revenues were sinking. *Glenbow Archives PA-1599-354c-81*

former coal mines, landfills, sewage lagoons, and gravel pits. The program also supported reclamation research through the Reclamation Research Technical Advisory Committee. On June 15, 1992, Klein told the legislature that the program "has been one of the most popular and successful programs with the municipalities." He continued:

> I'm letting you know at the outset that I intend to approach my colleagues in the near future for a renewed and expanded mandate to ensure that this province continues to reclaim the scars on Alberta's landscape and to continue with associated needed research. The essence of this program, which is so popular with the municipalities, is reclaiming derelict Crown and municipal lands in the province. This program provides employment to many local contractors and assists the municipalities in reclaiming abandoned landfill sites, sewage lagoons, gravel pits, industrial disturbances, water reservoirs, mine hazards, and so on.
>
> To date nearly 1,400 of these types of abandoned sites have been reclaimed to a variety of beneficial uses. Most land is reclaimed to agricultural capability. However, many sites are reclaimed to alternate land uses. Some past examples of these alternate land uses are, for instance, an abandoned coal mine which was reclaimed and then developed into a golf course and parkland at Cardiff by the municipal district of Sturgeon, an abandoned sewage lagoon to a walleye fish-rearing facility now operated by Fish and Wildlife in Lac La Biche, and one project nearing completion is an abandoned water reservoir in Legal which is being reclaimed to provide for development into an urban park and a trout pond. As well, a program to educate the public on caring for the land is being developed. To date separate components from kindergarten to Grade 9 are nearing completion, and a high school and adult program is presently under development.
>
> A second component of this program is to carry out research that will improve reclamation methods, determine methods that minimize land disturbances, and develop methods for ensuring prompt and accurate certification of reclaimed lands. This research has focused on four main areas: plains coal mining, mountain and foothills coal mining, tar sands mining, and conventional oil and gas. Research to date has provided information on a number of major problems and has produced some 73 technical reports, some of which are becoming classics within the reclamation field. [120]

The Heritage Fund reclamation program continued until 1994. It was one of many initiatives cut back or abandoned as the government attempted to reduce debts and deficits that had been mounting since the 1986 oil price crash.

As Environment minister, Klein also oversaw the preparations for a major overhaul of Alberta's environmental legislation, including the provisions for land conservation and reclamation. The legislation, Bill 62, was introduced and debated in 1992 and passed in 1993.

1993–2002: The Environmental Protection and Enhancement Act

The Environmental Protection and Enhancement Act[121] (EPEA) was proclaimed on September 1, 1993, and renamed the department Alberta Environmental Protection. The act consolidated and replaced nine previous acts, including the previous Land Surface Conservation and Reclamation Act. EPEA reclamation regulations continued to exclude agricultural, residential, commercial, and urban developments, forestry operations, and many types of industrial developments that were subject to other forms of municipal and provincial regulation.

For land disturbance on "specified land," the Conservation and Reclamation Regulation[122] under EPEA stated that "the objective of conservation and reclamation of specified land is to return the specified land to an equivalent land capability." The regulation defined equivalent land capability as "that the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical."[123]

The activities subject to conservation and reclamation requirements under the regulation always included lands used for oil and gas wells and for mines. However, the list of other types of activities was modified four times after 1993. The activities in the list are known collectively and individually as "specified land." (Prior to 1993, the equivalent list was known as "regulated surface operations.") The table below shows the five versions of specified land from 1993 to present.*

Two other key changes were embodied in the Conservation and Reclamation Regulation:

- It established specific time frames for operator liability following reclamation certification for things that were not foreseen at the time of certification: sites with approvals continued to have zero liability; most sites had five years, and plant sites had 25 years. Liability for upstream oil and gas sites was extended from 5 years to 25 years in

* Construction, operation, and reclamation phases of the majority of activities in the list are regulated. However, there are exceptions: railways (reclamation), public roadways (reclamation), roadways (construction and reclamation), and exploration operations (conduct or reclamation). A full understanding of the regulated activities, and the implications of the changes to the list over time, can only be achieved after reading the activity definitions contained either in EPEA or the regulation.

The Evolution of Specified Land Under EPEA Regulations

Year	**1993**	**1993**	**1996**	**1999**	**2003**
Regulation	**115/93**	**215/93**	**167/96**	**242/99**	**247/203**
Well	√	√	√	√	√
Oil Production Site			√	√	√
Battery			√	√	√
Pipeline	√	√	√	√	√
Industrial Pipeline					√
Municipal Pipeline					√
Telecommunication Line	√				
Telecommunication System			√	√	√
Transmission Line		√	√	√	√
Mine	√	√	√	√	√
Pit *sand, gravel, clay, or marl*	√	√	√	√	√
Borrow Excavation				√	√
Quarry	√	√	√	√	√
Peat Operation			√	√	√
Public Roadway	√	√			
Roadway			√	√	√
Railway			√	√	√
Exploration Operations	√	√		√	√
Exploration Operations for coal or oil sands			√		
Landfill	√	√			
Plant	√	√	√	√	√
Extra-territorial undertaking (federally regulated pipelines, international powerlines, railways, broadcasting undertakings, and any other interprovincial or international communications system)	√	√			

2003 when the certification process was changed to the audit system (described later in this chapter).

- In addition, the basis for reclamation security was changed from a specified amount for each type of activity to an estimate of the full cost of reclamation. This significantly increased the amount of security being held by the government. The changed amounts were not retroactive, however, so that lands disturbed prior to 1993 continued to be secured at the old (lower) rates. Implementation of the Mine Financial Security Program in 2010 changed the way that security was calculated for oil sands and coal mines and related plant sites to a risk-based system that required full cost security for pre-1993 lands as well as post-1993 lands. The program also added security coverage for oil sands processing plants that were previously exempt from security requirements.[124]

The new Environmental Assessment Regulation[125] also came into effect on September 1, 1993. For the first time, Alberta had a regulated environmental assessment process that allowed the public to obtain information on proposed new projects through a Register of Environmental Assessment Information. The regulation provided ongoing opportunities for the public to stay informed about the status of projects under review through the register. These opportunities included the Notice of Further Assessment, the Screening Report, the Notice of a Decision regarding the EIA Report, Notice of Proposed Terms of Reference, Notice of Final Terms of Reference, and the Notice of an EIA Report when it was completed and available for public review.

The Environmental Assessment (Mandatory and Exempt Activities) Regulation defined which activities were subject to assessment and which were exempt. The activities for which assessments were mandatory included: a quarry producing more than 45,000 tonnes per year; a surface coal mine producing more than 45,000 tonnes per year; a coal processing plant within the meaning of the Coal Conservation Act; an oil sands mine; a commercial oil sands or heavy oil extraction, upgrading, or processing plant producing more than 2,000 cubic metres of crude bitumen or its derivatives per day; a thermal electrical power generating plant that uses non-gaseous fuel and has a capacity of 100 megawatts or greater; and a sour gas plant that emits more than 2.8 tonnes of sulphur per day.[126]

Exempted activities, not requiring EIAs, included: a sweet gas processing plant that emits less than 384 kilograms of oxides of nitrogen per day; a pipeline with a length in kilometres times diameter in millimetres resulting in an index number of less than 2690*; a sand, gravel, clay, or marl pit that is less than 2 hectares in size; and, the drilling, construction, operation, and reclamation of an oil and gas well. The latter wellsite activities were regulated by the ERCB.

EPEA and the regulations gave inspectors clarity as they enforced conservation and reclamation in the field. “I think the biggest change would have been that there were regulations that went along with the act,” said former inspector Bob Onciul.

> If an operator was not doing the proper conservation and reclamation practice, we could issue a stop order. There was another emergency environmental protection order if something was going on that was definitely going to cause or could cause degradation of the land. You could actually get approval through the Crown to stop them from operating.

In most instances, the enforcement tools did not need to be used; their existence provided a lever to encourage the right behaviour.[127]

The Natural Resources Conservation Board Act also came into effect in 1993 in response to an unprecedented number of proposed recreational projects located in the Eastern Slopes areas of the Rockies. Many members of the public were very concerned about the scale and potential environmental impacts and the lack of a public hearing mechanism for proposed recreational projects such as golf courses. The government responded with the creation of the Natural Resources Conservation Board (NRCB), which had the authority to hold public hearings for “recreational or tourism projects” for which an environmental impact assessment report had been ordered. The act also provided the authority for the NRCB to review and hold public hearings for non-energy projects (outside the ERCB mandate); these included pulp and paper mills; lumber, veneer, panel board, or treated wood projects; metallic or industrial mineral mines or quarries; and water management projects.[128]

From 1993 to 1996, land management agencies for public land in the settled White Area in Alberta started to require native grasses for revegetation of prairie land. In

* The pipeline index thus excluded most small-diameter pipelines and a few relatively short large-diameter lines. For example, a two-inch (50 millimetre) pipeline could be up to 50 kilometres long and exempt, while a 40-inch (1,000 millimetre) would only be exempt if it were less than 2.5 kilometres long.

2001, the Native Plant Revegetation Guidelines for Alberta were released, and the use of native species for reclamation of native landscapes on public land became mandatory.[129] This coincided with a new emphasis on returning ecosystem functionality of disturbed lands (considering all components, including groundwater, surface water, soils, vegetation, landscapes). There was also more awareness of habitat fragmentation and cumulative impacts and the associated conservation planning needs.[130]

The Land Conservation and Reclamation Council ceased operation in 1994. Since 1963, the council and its predecessor, the Surface Reclamation Council, had been responsible for monitoring surface disturbances to ensure satisfactory reclamation. A feature of the councils was the inclusion of representatives from local authorities and regional planning commissions. Provincial inspectors continued to conduct inquiries for reclamation certification of oil and gas sites until the introduction of the audit-based system between 1996 and 2003, and on-site inquiries continued at other types of disturbance such as mines. The Reclamation Research Technical Advisory Committee, established in 1978 to assist the council, also ceased its work in 1994.[131]

In 1994, the government established the orphan well program to address abandonment of wellsites that lacked a legally responsible owner and financially viable owner. Opposition members argued during debate that the program should also address surface reclamation, but it was initially limited to contamination issues arising from improper abandonment. The program, financed by a levy on oil and gas companies, expanded in 2000 to include pipelines, upstream oil and gas facilities, and surface reclamation. An independent non-profit organization, the Orphan Well Association, with government and industry representation, took over management of the program in 2002.

Until the early 1990s, the standards for wellsite reclamation certification had been quite subjective, depending on the judgement of LCRC inspectors at the on-site inquiry. The Reclamation Criteria for Wellsites and Associated Facilities (first released in 1993, updated several times since then, most recently in 2014) provided more consistency and more certainty for applicants. The criteria addressed a common complaint from industry: “You can’t just go out there and say it’s not good enough without telling us why.”[132] Draft criteria for pipelines came out in 2001.[133] Objective standards set the stage for a transition away from on-site government inspection and certification over the following years.

Reclamation criteria were also issued for railways in 1996 and in draft form for sand and gravel pits in 1998.[134] The Land Capability Classification System for Forest Ecosystems was introduced in 1996 to support reclamation planning for oil sands mines and revised in 1998[135] and 2006.[136]

In 1996, the government began testing the concept of audit-based certification for reclamation of wellsites on Crown land in the forested Green Area, primarily in response to the difficulty in accessing remote sites in a timely manner to hold reclamation inquiries. Instead of on-site inspection by a government official, certification would be based on review of detailed technical information submitted by the operator. This change followed a 1996 amendment to EPEA allowing reclamation certificates to be issued without on-site inquiry; the amendment also allowed certificates to be revoked if deficiencies were found within five years. Occupants continued to have one year to appeal the award of a certificate.

“The new system that we’re looking at will in fact see a minimum of 20 per cent of the sites visited and audited,” Environment Minister Ty Lund told the legislature on February 23, 1998 (the number audited dropped to about 15 per cent after 2003 when “paper” certification was extended to wellsites on public and private land throughout the province[137]). Lund continued:

> More importantly, Mr. Speaker, every site will require that someone that is accredited to do this type of work will have to sign off on the report that is sent in to our department. Also, we are working on the standards. We’re taking a lot of the art out of the standards so that, in fact, the process is much more measurable, so that we will be able, by looking at the report, to determine whether things have been done properly. Furthermore, we are looking at how we can increase the penalty if there is an infraction. In other words, if someone sends in that a site has been reclaimed to our standards and we find out that it hasn’t, there will be a severe penalty attached to it, plus they will have to go back and do it properly.[138]

“You’ve got to catch them first,” commented Liberal MLA Debby Carlson.

Also in 1998, a reorganization of the department disbanded the Land Reclamation Division, and most of the reclamation staff moved to regional offices. Since 1972, the division had served as a central clearinghouse for reclamation policies, plans, approvals, programs, and research. This change provided more expertise to some regions, such as the oil sands area around Fort McMurray, but it was less beneficial for some other regions and resulted in the loss of the central coordinating function.[139]

Larry K. Brocke

Larry K. Brocke was born in Edmonton in 1944 and raised in Cold Lake, Alberta, where his father was a school principal. He began undergraduate science studies at the University of Alberta in 1962 but left after completing his first year. He then worked for two years at the Alberta Research Council as a lab assistant under U of A professor Dr. Fred Cook, a soil microbiologist, before returning to his studies. He received his B.Sc. in agriculture, with a soils major, in 1968 and his M.Sc. in soils in 1970. He then taught for a year at Fairview College in northern Alberta before accepting a post with the Land Use Assignment section of Alberta Lands and Forests. He also made a brief foray into work with a business systems company, unrelated to soil science.

"In that time period, from 1973 to '75, I started getting a number of phone calls from companies: 'We need some help here. We need soils inventory and help developing reclamation plans. That's the new requirement.' And so I started doing some of those, and because I was working I had to do them on the weekend, which I did, which was fine. Finally, there was so many of them that I formed a consulting company." With two partners, Don Pluth and Len Leskiw, Brocke made Pedology Consultants the first firm in the province to focus solely on soil science and reclamation planning. He left that in 1978 to establish another company, Western Soil and Environmental Services, with partner Bob Valleau.[142]

(L to R) Neil Chymko, Chris Powter, Dennis Bratton, and Larry Brocke

He joined Alberta Environment in 1982 and was named chairman of the Development and Reclamation Review Committee, the interdepartmental body reviewing reclamation plans and operations of major projects. In that role, he "wound up being the regulator and reviewing my own work," which was "interesting, to say the least." At Environment, "we worked hard with companies to understand their operations," Brocke said. "You've got to understand how it's going to fit in, how it's going to work, how they can do it within the operation … We worked very hard to do that, and we got good results."[143]

In 1993, he succeeded John King as director of the department's Land Reclamation Division. He left government after his position was abolished during the regionalization of the department in 1998. "I think their initial thinking at that time was to get the delivery of all government service, including regulatory, as close to the action as you could."

With partner Derald Starchuk, Brocke then established Millennium EMS Solutions Ltd., which became one of the major environmental reclamation consulting firms based in Alberta. "It wasn't now just a soil inventory and help putting that into the reclamation plan," Brocke said. "Now, we were the whole process. We knew what was required for everything, and we helped them put together their whole application. And worked through it all, got them through the process, and then helped implement the plan where needed. And some time at the end, hopefully, we'd be involved."

Millennium grew to provide a diversified range of services to assist organizations in meeting their environmental sciences and regulatory responsibilities.[144] Brocke retired in 2010.

The reorganization precipitated the departure or retirement of senior reclamation officials such as Larry Brocke and Dennis Bratton. "I think it was a step backwards," Bratton said. "You had the same people in the field but they had no back-up." The inspectors no longer could call on the technical expertise centred in Edmonton and lacked "the authority to back them up at a higher level." He said it was "not realistic" to have regional officials going up against the power and resources of industry.[140]

The Water Act in 2000 established requirements for conservation and reclamation affecting waterbodies. In 2002, Sustainable Resource Development published *A Guide to Surface Material Extraction on Public Land*, providing guidelines for land conservation and reclamation of sand and gravel operations in the Green Area; the guide was updated in 2008.[141]

2003–12: Audit-based Certification

In 2003, Bill 36, the Environmental Protection and Enhancement Amendment Act, fully implemented the audit-based certification system for reclamation and remediation of upstream oil and gas wellsites, industrial pipelines, and batteries. The legislation also extended the potential reclamation liability for deficiencies from five years to 25 years after issuance of a certificate. Environment Minister Lorne Taylor told the legislature the changes were necessary to deal with the enormous backlog of abandoned sites not yet reclaimed, reclaimed but not submitted for certification, or submitted and awaiting certification—about 28,000 wellsites, 14,000 pipelines, and 8,000 oil batteries. Under the old system of on-site inquiry, he said the department had been averaging 1,700 to 2,000 certifications a year, and at that rate, it would take 40 years just to address the backlog.

"Let me state very clearly that it [audit-based certification] is not self-regulation," said Environment Minister Lorne Taylor. "We establish the regulations." He continued:

> We, Alberta Environment, write the reclamation certificates. We at Alberta Environment can pull that reclamation certificate at any time for cost. We at Alberta Environment will continue to inspect sites. We will audit sites, and I can assure you that within Alberta Environment the inspectors know who the good reclamation companies are and who the not-so-good reclamation companies are. In previous legislation only a director could pull a rec certificate. This new amendment allows for inspectors to pull a reclamation certificate, so that's quite an advancement in the sense that an inspector on a site can pull a reclamation certificate. I want to be very clear. This is not self-regulation. The company, whether it's an oil company, a gas company, a pipeline company, a chemical company, whoever is doing the reclamation has to hire an outside expert.[145]

After years of consultation with stakeholders and professional bodies, in 2008 "professional sign-off" became a requirement for detailed site assessments and reclamation certificate applications. This meant documentation had to be signed off by professionals who had at least five years experience and were members of specified professional regulatory organizations. Depending on site requirements, the professionals could include registered professional agrologists, biologists, chemists, foresters, engineers, geoscientists, forest technologists, and/or engineering technologists.

The Reclamation Criteria Advisory Group (RCAG), established in 2005 to upgrade the 1995 criteria, used Alberta Environment's Sustainable Resource and Environmental Management (SREM) model (since renamed Cumulative Effects Management[146]). This model uses a systems approach to resource and environmental management: clear outcomes, integrated policies, clear standards and criteria, effective delivery of programs and services, open and transparent performance assessment, and ongoing adaptation for improvement.

The RCAG process brought together representative stakeholders, including representation from Alberta Agriculture and Rural Development, Energy Resources Conservation Board, Alberta Forest Products Association, Canadian Association of Petroleum Producers, Environment and Sustainable Resource Development (ESRD), and landowners (independent, Alberta Surface Rights Federation, and Wildrose Agricultural Producers). RCAG members attended task groups for cultivated, native grassland, forested, and peat lands in order to address the unique issues for each land type. Reclamation criteria were completed for cultivated lands, native grasslands, and forested lands. The group used ecological health and function and land operability as objective indicators of equivalent land capability after successful reclamation.

In 2010, the Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands[147] required re-establishment of trees on forest lands disturbed by oil and gas activities. Previously, most reclamation of forested areas only involved contouring, drainage, soil conservation, and sufficient vegetation (typically grasses) to stabilize the site. Companies had contended they already paid timber damage assessment fees to compensate the owner of harvest rights, so they should not have to pay again to replant the sites. The 2010 criteria made it clear that forest cover had to be re-established for certification of previously forested sites developed after 2007.

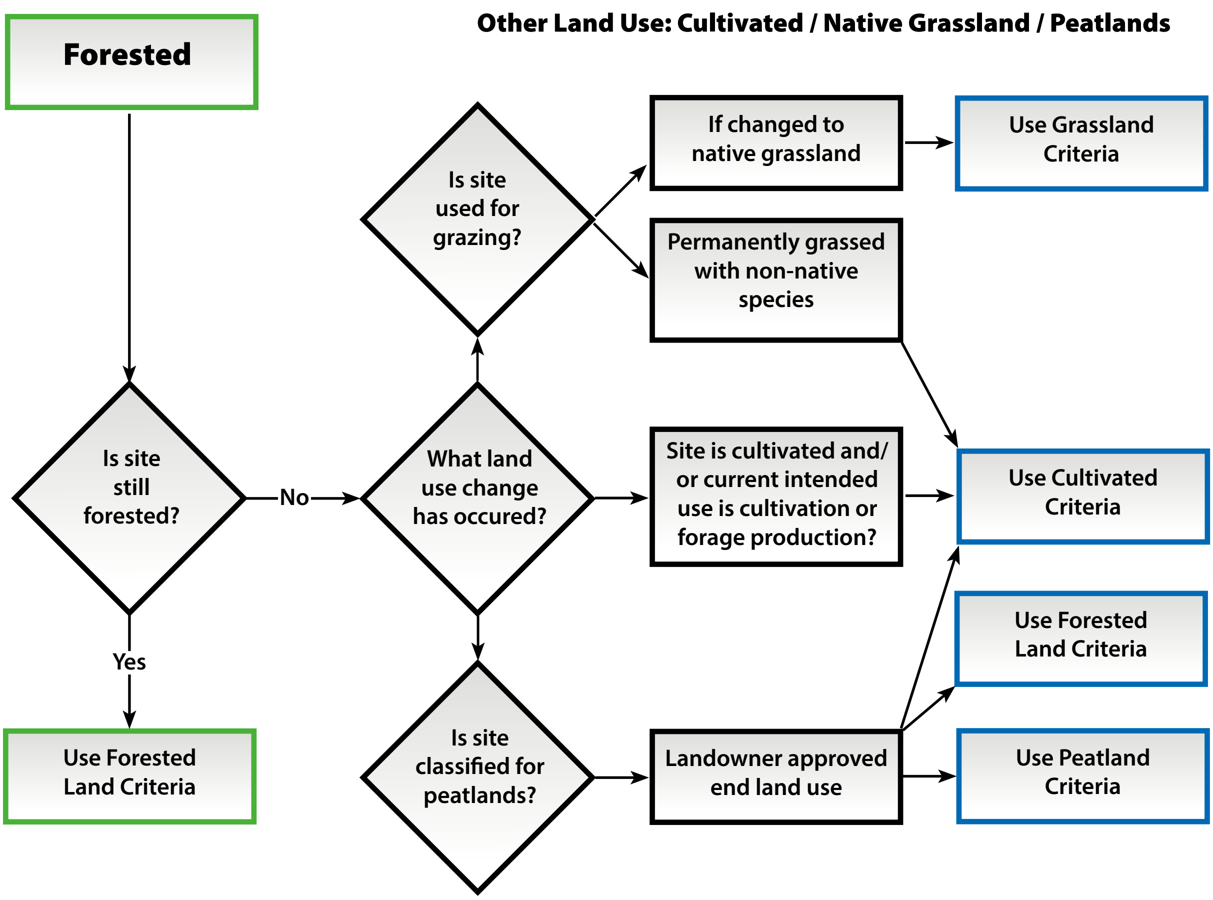
Despite these efforts to streamline the certification process, the number of abandoned oil and gas sites awaiting reclamation, reclaimed but not yet submitted for certification, or awaiting approval of reclamation certificates grew to 50,000 at the end of 2011.[149] Since 1963, a cumulative total of about 77,000 certificates had been issued. Another 24,000 sites were "exempt" because they were abandoned on private land prior to 1963, on public land prior to 1978, or on federal land.[150]

Chris Powter, who observed the evolution of regulation within Alberta Environment (1981 to 2010) and then from the University of Alberta (2010 to 2014), said that the audit-based system brought mixed blessings. While improved reclamation criteria and codes of practice continued to improve environmental performance, the loss of direct contact between inspectors and stakeholders may have eroded public confidence. "We should never, ever lose sight of the fact that there are a lot of value judgments that are required in the field of land reclamation," Powter said. "It's not just about science."[151] In another interview, he commented further about the audit-based approach:

> Is it good or bad? I guess it depends. From an environmental point of view, in theory it should be at least as good, perhaps even better because the rules had been strengthened to accommodate the new system. From a public relations perspective, I would argue that the old system was much better because you had face-to-face interaction between government and landowners and companies. That provided some assurance to

Decision Tree in the 2010 Wellsite Criteria (updated in 2013)[148]

Land use prior to oil and gas exploration in consultation with current landowner or occupant



> the public that there was oversight, that they were being protected, that they saw an honest-to-God person come out who, in most cases, showed empathy and at least a willingness to listen and try and accommodate things. That doesn't exist in a paper-based system.
>
> Was the old system perfect? No, it was very labour-intensive. It created problems because there was only a certain amount of time in the year when you can actually go out and do a proper inspection and so whatever applications were available, were crammed into that. On a paper-based system, you can do it any time of the year and then focus your efforts on the audit system. The reality is that the majority of people that applied for certificates did get certificates. So you're doing something that is routine and it doesn't allow you to focus on the ones that were problems, because you're spending all this time saying yes to a large majority of applications. So in theory, if you knew for sure which ones were yes and you could just say yes, move on and focus on the ones that were a problem that would be ideal. But, the audit system doesn't allow you to do that. It allows you to perhaps catch the ones that were problems. I don't think anyone necessarily believes that we're catching all of the problems because you're not auditing all of the sites.
>
> If your metric of success is environmental performance, then you shouldn't be all that much different than where you were before. If your metric of success is human-public interaction, public satisfaction, then I suspect you're lower. If your metric of success is efficiency in terms of manpower allocation on government's perspective, then I would say yes, you're probably much higher. Which of those metrics is the right one? It depends on who you are, I guess.[152]

Bob Onciul, who continued to work as an inspector on behalf of landowners after he left the department in 1999, said the new system is essentially complaint based—although about 15 per cent of certificates are still audited for compliance. "I don't think there's willpower in the departments now to make sure that it's being done because there's no more monitoring," he said. "It's strictly complaints. There are no inspectors that go out and monitor this stuff." Previously, there were 21 provincial reclamation inspectors and "it was our responsibility to make sure that they weren't creating a mess. Now, there's no monitoring. It's just a matter of reacting to complaints from the landowner. So, to me, it's a step backwards, major step backwards." Several lawyers now specialize in representing landowners with reclamation concerns, and Onciul has at times been hired as an independent consultant to monitor activities such as pipeline construction on behalf of landowners, paid for by the companies.[153]

In 2005, the government launched a wide-ranging public consultation and policy development process to develop a Land Use Framework for Alberta. Among other things, the framework was intended to answer the key question in determining equivalent land capability, i.e., "What is the intended land use after reclamation?" The consultation led in 2009 to adoption of the Alberta Land Stewardship Act, which called for watershed-based regional plans to spell out desired environmental outcomes. The plans would be developed with input from stakeholders, Aboriginal people, scientists, and the general public, and they would establish thresholds for environmental indicators such as air quality, water supply, biological diversity, and land conservation.[154]

The Lower Athabasca Regional Plan 2012–2022[155] was the first issued under the Land Use Framework. It described a "progressive reclamation strategy" for ongoing reclamation of oil sands sites while operations continue. The strategy based its approach on earlier collection of reclamation security funds, enhanced reclamation reporting, and clarifying the reclamation certificate program. "Reclaimed lands will be used to help achieve the region's desired economic, environmental, and social outcomes based on the region's evolving needs," the plan stated. "Opportunities will arise to reconnect lands to help achieve regional objectives relating to biodiversity, recreation, and forestry." As of 2015, much of the plan's implementation was awaiting the development of agreed-upon thresholds for environmental indicators such as biological diversity. Other regional plans under the Land Use Framework were in earlier stages of development.

The Equivalent Land Capability Workshop, held on November 26, 2010, at the University of Alberta, provided an opportunity for 60 reclamation specialists to share views about equivalent land capability (ELC) and how it is applied to oil sands mine reclamation, and to identify research and information needs. Although reclamation efforts had been stewarding to equivalent land capability since 1993, it was clear there remained considerable misunderstanding and disagreement amongst the specialists on what it meant. There was general agreement that government should develop a policy document on what ELC means today, and acknowledge that the vision may change in the future.[156]

Duty to Consult

Many strands of legal history make up the tapestry of Aboriginal rights in Canada, but the most fundamental document is the Royal Proclamation of 1763. The intent was to establish a basis of government administration in North America for the lands that France had just ceded to Britain in the Treaty of Paris. The proclamation established the constitutional framework for treaties with the Aboriginal inhabitants of large sections of Canada. The most significant words of the proclamation were these:

> And whereas it is just and reasonable and essential to Our Interest and the Security of Our Colonies, that the several Nations or Tribes of Indians with whom We are connected, and who live under Our Protection should not be molested or disturbed ... no Governor ... in any of Our other Colonies or Plantations in America, do presume for the present ... to grant Warrants of Survey, or pass Patents for any Lands beyond the Heads or Sources of any of the Rivers which fall into the Atlantic Ocean ... And whereas great Frauds and abuses have been committed in the purchasing Lands of the Indians, to the great Prejudice of Our Interests, and to the great Dissatisfaction of the said Indians; in order to prevent such Irregularities for the future, and to the End that the Indians may be convinced of Our Justice and determined Resolution to remove all reasonable cause of Discontent, We do ... enjoy and require that no private Person do presume to make any Purchase from the said Indians of any Lands reserved to the said Indians ...[157]

Canada's 1982 Constitution guarantees these rights, applying them equally by gender, and formally recognizes the country's Indian, Inuit, and Métis peoples.

In Canada, the Crown has a duty to consult with and accommodate Aboriginal communities regarding land-use decisions that affect Aboriginal rights or rights guaranteed by treaty. To a very large degree, these rights are still evolving. For example, in 2005, a Supreme Court of Canada ruling clarified the treaty rights of Alberta's Mikisew Cree.*

In its introduction to the ruling, the court made quite clear the magnitude of the lands surrendered in the applicable treaty:

> Under Treaty 8, made in 1899, the First Nations who lived in the area surrendered to the Crown 840,000 square kilometres of what is now northern Alberta, northeastern British Columbia, northwestern Saskatchewan and the southern portion of the Northwest Territories … In exchange for this surrender, the First Nations were promised reserves and some other benefits including, most importantly to them, the rights to hunt, trap and fish throughout the land surrendered to the Crown except "such tracts as may be required or taken up from time to time for settlement, mining, lumbering, trading or other purposes."[158]

The Mikisew Cree case confirmed that the Crown has a duty to consult when exercising its treaty right to "take up" surrendered land. Where government seeks to develop land in such a way that it will affect First Nations' ability to exercise their rights to hunt, fish, or trap, the Crown must engage in a process of consultation and accommodation.[159]

Citing the "honour of the Crown," the court ruled that existing Aboriginal and treaty rights in Canada's Constitution Act, 1982, reinforced government's duty to consult. Another source of this obligation is the Indian Oil and Gas Act. Also, the National Energy Board requires projects to consider Aboriginal concerns and to advise whether they are aware of any consultation undertaken by the Crown.

In addition, the Alberta Energy Regulator's *Directive 056* requires project proponents to consult with all parties whose rights may be directly and adversely affected by a proposed project, including First Nations and Métis. Requirements include early disclosure of plans, recognition of a project's effect off-site, and efforts to obtain cooperation throughout a project's life span.[160] Collectively, these rules "minimize the footprint of development and ensure that everyone has a voice."[161]

Since 2005, Alberta's First Nations Consultation Guidelines[162] have guided the interaction for approvals staff working with First Nations communities. This formalized consultation process increased the time needed to negotiate terms with First Nations. Under the revised rules, Alberta Environment staff need to "make decisions based not just on technical information and their own experience but also the views of landowners and other interested parties who can be very knowledgeable and passionate about the implications of regulatory decisions on their land and livelihood."[163]

* The Mikisew reserve is within northeastern Alberta's Wood Buffalo National Park. This is virtually the only part of the province outside the petroleum-rich Western Canada Sedimentary Basin.

2013–15: The Alberta Energy Regulator

The Responsible Energy Development Act (passed in December 2012 and fully implemented by March 2014) transferred regulation of conservation, reclamation and remediation of energy-related sites to the Alberta Energy Regulator (AER), the successor to the Energy Resources Conservation Board. The AER is the single regulator of energy development—from application and exploration, to construction and development, to abandonment, reclamation, and remediation. Alberta Environment and Sustainable Resource Development retained responsibility for establishing reclamation policy and criteria. AESRD—Alberta Environment and Parks after 2015 reorganization—was also responsible for regulating non-energy reclamation sites such as sand and gravel pits, quarries, and peat operations.

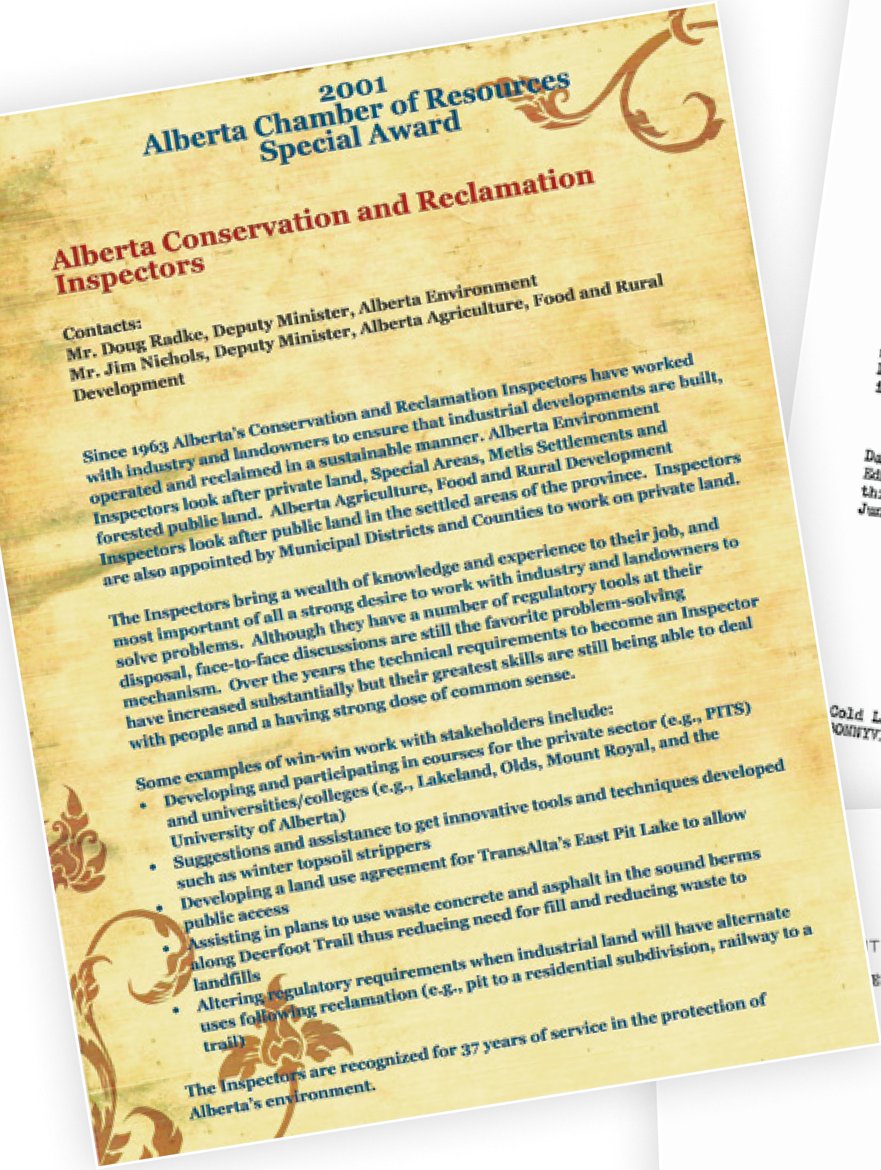
In 2013, the AER substantially increased reclamation security funding from the upstream oil and gas industry under its Licensee Liability Rating Program, and the government increased the penalties for non-compliance with reclamation and remediation regulations.

During debate in the legislature on April 22, 2014, Liberal environment critic David Swann raised questions about the adequacy of security funds to ensure reclamation of sites such as oil sands mines if they eventually became uneconomic or environmentally unacceptable. His remarks came well before the sharp drop in world oil prices in the second half of 2014:

> There's nothing wrong with the private sector. There's nothing untenable about their goals and their agendas to create jobs and to create an economy. What is the problem is a government that doesn't see its role as being the referee between the long-term public interest and the short-term corporate interests and a lack of attention to the longer-term public liabilities that many of these developments have created. Many of these industries have put down pennies on the dollar for reclamation, for example, for the largest mining operation on the planet.
>
> If things go south in terms of our oil industry, and there's reason to believe that it could given alternatives that are emerging and liabilities associated with carbon and our environmental crisis in relation to climate change, it is very foreseeable that our primary resource may become less valuable on the planet than it is today, leaving tremendous stranded assets for us now and in our future to deal with. A few hundred million dollars will barely touch the oil sands in terms of reclamation. If these folks walk away, we and our future generations are stuck. That's a tremendous contributor to what we are calling intergenerational theft on this side of the House.
>
> Unlike an upstream orphan fund for conventional oil and gas abandonment, we have no downstream oil and gas orphan fund for refineries and sites that are developed for various petrochemical operations and gas station operations, no ability to hold people accountable if they walk away from these, again a huge public liability; a failure to really address what is an appropriate scope and scale of development in our oil and gas sector, again resulting in a total imbalance between resources coming in and the potential liabilities for the future.[164]

In its *Business Plan 2014-2017,*[165] Alberta Environment and Sustainable Resource Development included "timely reclamation and remediation of lands" among the elements of environmental stewardship. "Stewardship actions are critical to achieve sustainable forests, fish and wildlife populations and habitats, productive and sustainable lands, and water supplies that meet environmental, economic, and social needs for generations to come." First among the department's "priority initiatives" for sustainable natural resource development in 2014–17 was this: "Develop a land reclamation framework, including strategies to address abandoned energy infrastructure."

Pipeline corridor east of Conklin. *Robert Bott*



2001
Alberta Chamber of Resources
Special Award

Alberta Conservation and Reclamation Inspectors

Contacts:
Mr. Doug Radke, Deputy Minister, Alberta Environment
Mr. Jim Nichols, Deputy Minister, Alberta Agriculture, Food and Rural Development

Since 1963 Alberta's Conservation and Reclamation Inspectors have worked with industry and landowners to ensure that industrial developments are built, operated and reclaimed in a sustainable manner. Alberta Environment Inspectors look after private land, Special Areas, Metis Settlements and forested public land. Alberta Agriculture, Food and Rural Development Inspectors look after public land in the settled areas of the province. Inspectors are also appointed by Municipal Districts and Counties to work on private land.

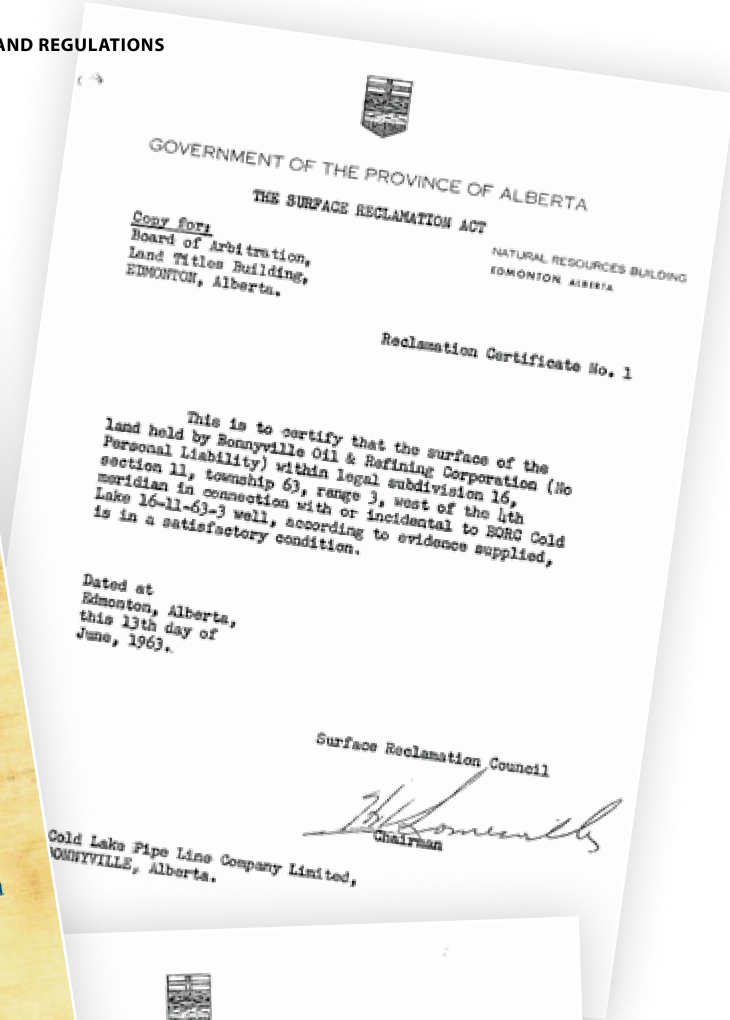
The Inspectors bring a wealth of knowledge and experience to their job, and most important of all a strong desire to work with industry and landowners to solve problems. Although they have a number of regulatory tools at their disposal, face-to-face discussions are still the favorite problem-solving mechanism. Over the years the technical requirements to become an Inspector have increased substantially but their greatest skills are still being able to deal with people and a having strong dose of common sense.

Some examples of win-win work with stakeholders include:

- Developing and participating in courses for the private sector (e.g., PITS) and universities/colleges (e.g., Lakeland, Olds, Mount Royal, and the University of Alberta)
- Suggestions and assistance to get innovative tools and techniques developed such as winter topsoil strippers
- Developing a land use agreement for TransAlta's East Pit Lake to allow public access
- Assisting in plans to use waste concrete and asphalt in the sound berms along Deerfoot Trail thus reducing need for fill and reducing waste to landfills
- Altering regulatory requirements when industrial land will have alternate uses following reclamation (e.g., pit to a residential subdivision, railway to a trail)

The Inspectors are recognized for 37 years of service in the protection of Alberta's environment.

Reclamation Inspector Citation. *Arnold Janz*



GOVERNMENT OF THE PROVINCE OF ALBERTA

THE SURFACE RECLAMATION ACT

Copy for;
Board of Arbitration,
Land Titles Building,
EDMONTON, Alberta.

NATURAL RESOURCES BUILDING
EDMONTON ALBERTA

Reclamation Certificate No. 1

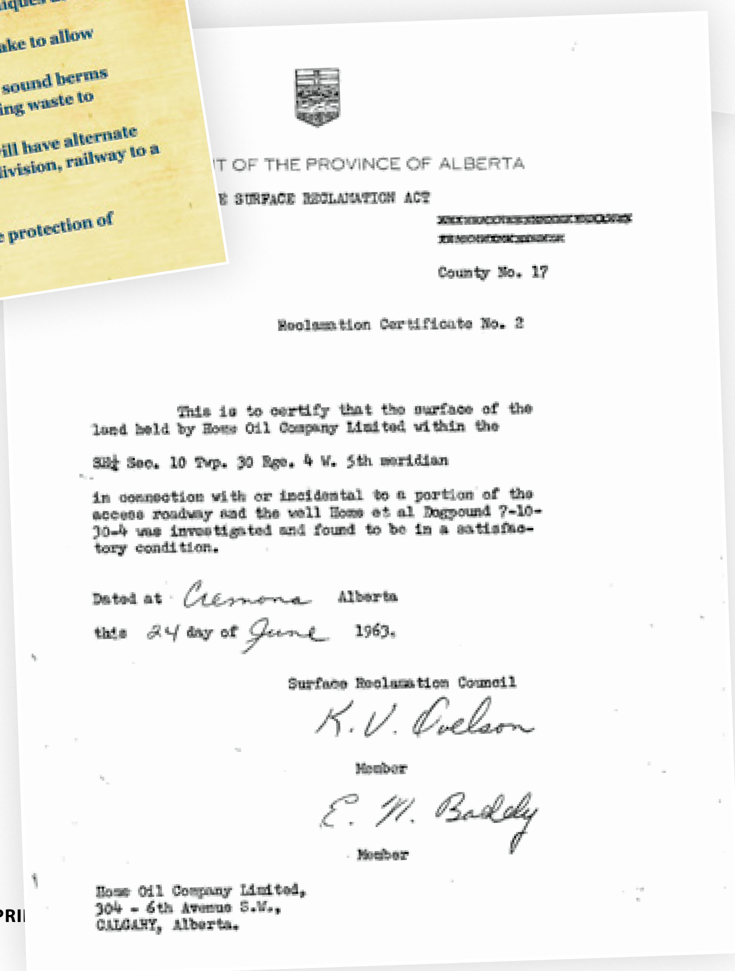
This is to certify that the surface of the land held by Bonnyville Oil & Refining Corporation (No Personal Liability) within legal subdivision 16, section 11, township 63, range 3, west of the 4th meridian in connection with or incidental to BORC Cold Lake 16-11-63-3 well, according to evidence supplied, is in a satisfactory condition.

Dated at
Edmonton, Alberta,
this 13th day of
June, 1963.

Surface Reclamation Council

Chairman

Cold Lake Pipe Line Company Limited,
BONNYVILLE, Alberta.



...T OF THE PROVINCE OF ALBERTA

...E SURFACE RECLAMATION ACT

County No. 17

Reclamation Certificate No. 2

This is to certify that the surface of the land held by Home Oil Company Limited within the

SE¼ Sec. 10 Twp. 30 Rge. 4 W. 5th meridian

in connection with or incidental to a portion of the access roadway and the well Home et al Dogpound 7-10-30-4 was investigated and found to be in a satisfactory condition.

Dated at Cremona Alberta

this 24 day of June 1963.

Surface Reclamation Council

K. V. Ovelson
Member

E. M. Baddy
Member

Home Oil Company Limited,
304 - 6th Avenue S.W.,
CALGARY, Alberta.

Chairman's Certificate No 1 and Reclamation Certificate No 2

Knowledge

Research and Education

The only source of knowledge is experience.

Albert Einstein

The early decades of the nascent land reclamation movement in Alberta saw operators and government alike suffering from a lack of useful experimental data and knowledge to guide reclamation schemes. The gaps hampered an efficient advancement of the art and science of reclamation in the province. Remedying this, a massive collaborative research effort began in the 1970s, funded by both government and industry. Still ongoing, the resulting knowledge is shared through a number of organizations and has proven invaluable to reclamation practitioners. Moreover, the knowledge has contributed to building academic and field school programs, from graduate degrees to on-the-job training for the next generation of practitioners, consultants, regulators, and researchers.

Introduction

The extent of reclamation knowledge in Alberta has been described as next to nothing following the earliest legislation in the 1960s and has since evolved into an immense body of science, data, and experience. Early practitioners talk of scrambling to find sources of information to help with their plans: regional inventories, scientific principles, borrowing from agriculture or forestry experience, literature reviews, expert opinion, US research, etc. The collaborative aspect in particular was important as it helped with information exchange and buy-in to solutions.

Conservation and reclamation research has been instrumental in supporting the development and refinement of government regulations and policy, and industry practices. Research was conducted for a variety of reasons, including:

- setting or refining regulatory requirements—for example, optimizing depth and type of soil to be salvaged and replaced
- understanding how reclaimed landscapes will behave—for example, how quickly groundwater will return in abandoned coal mines or predicting future performance of forested sites
- examining opportunities to use waste products for reclamation—for example, coal bottom ash, peat, or straw as soil amendments
- developing or refining equipment for conservation and reclamation use—for example, modifying dozer blades to salvage soils over pipeline trenches
- developing state-of-the-art documents to increase awareness of conservation and reclamation issues and solutions, and providing guidelines—for example, the *Manual of Plant Species Suitability for Reclamation in Alberta*[1] (Reclamation Research Technical Advisory Committee or RRTAC), and *Best Management Practices for Conservation of Reclamation Materials in the Mineable Oil Sands Region of Alberta*[2] (Cumulative Effects Management Association or CEMA)

Alberta-Pacific Forest Industries tests samples from 550 balsam poplar clones for growth rates and hardiness at a research site north of Wandering River in 2015, one of six such sites in central and northern Alberta. The aim is superior stock for revegetation of reclaimed oil sands mines, wellsites, forestry roads, and other land disturbance in the boreal forest. Experience at Syncrude has demonstrated that balsam poplar is relatively tolerant of the elevated salt levels found in the soil of reclaimed oil sands mine sites. *Robert Bott*

Cooperation between government and industry in identifying research needs, funding, and directing projects has been one of the key reasons for successful adoption of research results. Additional contributing factors include:

- a desire by all parties to use science-based information
- significant research capacity in universities, colleges, government research organizations, and the consulting community
- committed and well-funded companies and industry organizations

Examples of companies that funded or conducted significant research programs include NOVA Gas Transmission Ltd. (now part of TransCanada Corporation), Syncrude Canada Ltd.,[3] Suncor Energy Inc., and Smoky River Coal Ltd. Karen Etherington of TransCanada provides an insight into why industry would get involved in research:

> In my tenure, I got to see a lot of [experimentation] with different techniques and tools and the underlining theme in all of those cases was what I saw as a real partnership between government, the regulatory agencies, and the pipeline industry. We all had the same needs to get to the same end goal and we were able to work on them together. There were many times where there would be representatives from Alberta Environment and Public Lands standing out there on the right-of-way with our folks as we tested equipment or we tested techniques … we had that flexibility and there was that trust to actually test out these techniques.[4]

NOVA Gas Transmission undertook extensive research on soil salvage and replacement equipment, seed mixes and seeding techniques, and bio-stabilization of stream banks. NOVA also partnered with Alberta Environment, Alberta Agriculture, Food and Rural Development, PanCanadian Petroleum Ltd, Talisman Energy Inc., Can-Ag Enterprises Ltd., J. D. Burke and Associates Ltd., and Pettapiece Pedology to lead the development of the Reclamation Assessment Criteria for Pipelines – 2001 Draft document.[5] Many others made similarly significant contributions. These are just a few examples of collaboration among stakeholders with the common aim of generating reclamation data that could be used by all.

Major Collaborative Initiatives

The following sections highlight other major collaborative research initiatives that have shaped reclamation policy and practice in Alberta. In most cases research projects tend to be short-lived efforts (one to five years) with lifespans tied to funding and/or researcher availability. Such a short time frame can be a problem for assessing reclamation success of vegetation communities that take decades to develop. There have been instances, however, where funders and researchers have been able to establish study sites and monitor them over long periods. In 2001, the Alberta Chamber of Resources recognized two such projects with reclamation citations: the Alberta Research Council's work on Smoky River Coal Ltd.'s mountain coal mine site and AMEC Earth and Environmental Ltd.'s work on Suncor's oil sands mine site.

Reclamation Research Technical Advisory Committee

The Reclamation Research Technical Advisory Committee (RRTAC) was established in 1978 to manage the government's reclamation research program, sponsored through the Alberta Heritage Savings Trust Fund's Land Reclamation Program. The research program focused initially on plains coal mining, mountain and foothills coal mining, and oil sands mining, and later expanded to include oil and gas. In addition, the program funded general research applicable to all industrial disturbances. The program ran from 1978 to 1994 and produced numerous research reports, approximately 40 of which were digitized and made accessible through the University of Alberta's Oil Sands Research and Information Network.[6] In 1993, RRTAC received the Alberta Chamber of Resources's reclamation citation for its contribution to the reclamation community.

The committee first met in March 1978 and comprised eight members representing the Alberta Departments of Agriculture, Energy and Natural Resources, and Environment, and the Alberta Research Council (now Alberta Innovates–Technology Futures). The committee got together regularly to update research priorities, review solicited and unsolicited research proposals, arrange workshops, and otherwise act as a referral and coordinating body for reclamation research.[7]

Industry played a key role in RRTAC. Representatives participated on various research steering groups. "The industry provided a lot of in-kind funding including the sites and the manpower and equipment to build the sites," recalled Terry Macyk.[8] The philosophy was that RRTAC would do the research on what might be called the bigger scale that would affect all operators—research specific to companies would be handled by themselves. "For instance if [RRTAC] was working on plains coal they would look at issues common to them all, like salinization," said Macyk. "But if there was a specific issue that was associated with one operation then [the company] basically undertook that on their own."

Oil Sands Environmental Study Group

In 1973, 16 major oil sands operators and leaseholders formed a collective called the Oil Sands Environmental Study Group (OSESG). Their purpose was to operate as a cooperative venture, with each of the members financing group environmental research projects in the Athabasca oil sands area.[10]

With respect to land reclamation, the organization had two major functions. First, it was to maintain "an awareness of pertinent reclamation information and, if necessary, respond to it." Second, it would identify reclamation problems and initiate research to resolve those problems. For example, in 1977 the group formed a soil reconstruction steering committee to focus on the "reconstruction of soils in oil sands tailings."[11] In 1983, a joint research report funded by OSESG, RRTAC, and four oil sands companies was released defining the physical and chemical soil properties required to support the forest ecosystems that are the targets of oil sands tailings reclamation research in the Athabasca region.[12]

Alberta Oil Sands Environmental Research Program

In early 1975, the governments of Alberta and Canada entered into a joint Alberta Oil Sands Environmental Research Program (AOSERP) to conduct environmental research on the oil sands regions for the purpose of maintaining an acceptable environmental quality in recovery, transporting, and processing oil sands products.[13] Its objective was to find practical solutions to the environmental problems stemming from oil sands developments. The program ran from 1975 to 1985 (the first five years were jointly funded at a cost of approximately $17 million; the last five years were funded by Alberta alone through Alberta Environment's Research Management Division) and produced numerous research reports, 219 of which were digitized and made accessible through the University of Alberta's Oil Sands Research and Information Network.[14] Recognizing the difficulties of conducting research in a remote area, the program took the innovative step of establishing a research facility and camp across the highway from Syncrude's Mildred Lake Settling Basin, complete with its own helicopter landing pad to facilitate quicker staging to remote sites.

The majority of the terrestrial research focused on

Plains Hydrology and Reclamation Project: An RRTAC Initiative

The Plains Hydrology and Reclamation Project (PHRP) was initiated in 1979, a time when major questions about the environmental impacts of mining and reclamation remained unanswered. A significant concern was in the plains area of Alberta, where most of the land underlain by mineable coal was in agricultural production. Groundwater, commonly derived from coal beds, supplies nearly all the region's water needs.

This important project was sponsored by the Reclamation Research Technical Advisory Committee (RRTAC) of the Alberta Land Conservation and Reclamation Council, with financial support from the Alberta Heritage Savings Trust Fund, Alberta Power Ltd., Luscar Ltd., Forestburg Collieries Ltd., Manalta Coal Ltd., and TransAlta Utilities Corporation. Local landowners assisted the study by providing access to lands and/or available data for research work.

The goal was to develop a framework that would permit projection of success for reclamation and determine the long-term impact of mining on water resources. Differences in physical and chemical properties of the pre-mining soils, overburden, and subsurface water were used as keys to project post-mining conditions.

The project initially had two main objectives: to evaluate the potential for reclamation of lands to be surface mined and to evaluate the long-term impact of mining and reclamation on water quantity and quality. Initial investigation focused on the Battle River mining area in

A researcher measures bulk density and moisture content of soils and underlying geological materials at a reclaimed site. These sites were established in both reclaimed and undisturbed areas and measurements were completed daily or weekly depending on the specific parameters being measured. *Terry Macyk*

east central Alberta. Researchers investigated a second study area near Lake Wabamun to determine the degree to which the project results could be generalized throughout the plains region of the province.

The initial step involved characterization of the study area in terms of climate, surface-water hydrology, geology, hydrogeology, and soils of both mined and unmined landscapes. This involved a comprehensive program of test-hole drilling, coring, sampling, and installing instrumentation at numerous long-term monitoring sites for the groundwater component. Soils of the area were mapped at a scale of 1:10,000. Physical, chemical, and hydrological properties of the important soil units and reconstructed soils in the reclaimed landscape were determined through monitoring, sampling, and laboratory testing.

Hydraulic conductivity of the mine spoil was determined using field recovery testing techniques and laboratory permeameter techniques. The characteristics of spoil groundwater chemistry were determined by sampling and analyzing groundwater from piezometers installed in reclaimed areas.

The results indicated that cast overburden spoil has hydraulic conductivity values considerably lower than those of pre-mining coal aquifers. Hence the spoil is not capable of supplying water to wells. Furthermore, the major ion chemistry of groundwater in mine spoil was found to be considerably degraded compared to pre-mining aquifers. High Total Dissolved Solids (TDS) and salt levels rendered the water unfit for consumption by humans and livestock. The brackish nature of groundwater in mine spoil appears to be an inevitable consequence of mining in the region.

PHRP stands as a landmark project: the study concluded that there is no known method of materials handling that would alter either the hydraulic conductivity of mine spoil or the chemical makeup of groundwater in mine spoil in this region. Disruption of shallow groundwater supplies within and above coal is an unavoidable result of mining in the plains region. The project provided valuable information about the direct impacts of mining and reclamation. In many cases, however, there are alternate aquifers below or surface sources that can be developed to meet potable water needs.

An overall summary of the program was prepared,[9] and the results of specific components of the project are presented in a series of 22 papers published in conference proceedings and refereed journals, as well as 18 reports published by RRTAC.

establishing an adequate baseline of soils and surficial geology, vegetation, and wildlife.[15] Additional efforts targeted understanding the potential implications of soil acidification arising from industrial emissions. With respect to reclamation, Objective 5 for the terrestrial research was to "undertake studies directed toward restoration of biological productivity to terrestrial ecosystems disrupted, damaged, or destroyed in the course of oil sands development."[16]

From its inception, when industry was represented on all Technical Research Committees, AOSERP maintained a close liaison with both Suncor and Syncrude, the only two oil sands mining companies in production at that time. To delineate more precisely the major research interest of AOSERP and oil sands corporations, as well as to identify areas where joint sponsorship of research might prove advantageous, a model for AOSERP-industry joint research was drafted in 1978 within AOSERP and approved by Suncor, Syncrude, and other companies with active oil sands interests. The model provided that either AOSERP or a corporation could initiate a research project and invite co-sponsorship from the other. This model promoted the frequency of joint research sponsorship by government and oil sands corporations.[17]

Canadian Oil Sands Network for Research and Development

In 1992, the Canadian Oil Sands Network for Research and Development (CONRAD)—a strategic alliance among Suncor, Imperial, Shell, Syncrude, and the Alberta Oil Sands Technology and Research Authority (AOSTRA)—was established. The organization's objective was "to improve the performance of the oil sands industry through superior new technologies, improve the effectiveness and quality of oil sands research, and develop technologies that will further improve industry's environmental performance."[18]

In its initial years, CONRAD included two reclamation groups. The Terrestrial Reclamation on Challenging Materials Committee focused on land reclamation; it provided vegetation and soils analysis associated with reclamation programs. An aquatic technology advisory group focused on research and development in aquatic ecosystems. Different CONRAD groups reported results from these research programs in a series of symposia.[19] CONRAD was later absorbed into COSIA (described below).

Cumulative Environmental Management Association

Formed in 2000, the Cumulative Environmental Management Association (CEMA) focused on the protection of the environment in the Regional Municipality of Wood Buffalo—the area surrounding the mineable oil sands region.* CEMA is currently comprised of more than 50 members who sit on one of four caucuses: Aboriginal, Government, Non-Government Organizations, and Industry. The membership includes First Nations and Métis groups; municipal, provincial, and federal governments; environmental advocacy groups; educational institutions; and mining and in situ oil sands operators.[20] CEMA's role is to produce recommendations and management frameworks pertaining to the cumulative impact of oil sands development in northeastern Alberta, which are, once complete, forwarded to the provincial and federal government regulators.

CEMA evolved in part from the original Athabasca Oil Sands Reclamation Advisory Committee[21] as well as recommendations from the Regional Sustainable Development Strategy,[22] to form a Reclamation Working Group focused on recommending better ways to reclaim forests, wetlands and muskeg, lakes and streams, and wildlife habitat. The group defined land reclamation as "the rebuilding of the land including stabilization, contouring, and revegetation so that, over time, the land may blend with the surrounding landscape."[23]

CEMA's reclamation efforts were initially coordinated by the Reclamation Working Group, which provided recommendations to ensure reclamation in the region meets regulatory requirements, and the Sustainable Ecosystems Working Group, which provided recommendations to address the impacts of development on ecosystems and landscapes in the region.[24] The two groups were subsequently merged into the Reclamation Working Group.

Canada's Oil Sands Innovation Alliance

Formed at the request of chief executive officers of oil sands companies belonging to the Canadian Association of Petroleum Producers, the most recent of the environmental research organizations is Canada's Oil Sands Innovation Alliance (COSIA). COSIA is an alliance of oil sands producers focused on accelerating the pace of improvement in environmental performance in Canada's oil sands through collaborative action and innovation. The alliance began on March 1, 2012, when representatives of 13 companies signed a charter "signifying their agreement with COSIA's vision, their support of the alliance's beliefs, and pledge to uphold the commitments put forward in the charter."[25]

Three research focus areas are relevant to reclamation: land, water, and tailings. Companies work together to fund research projects through joint industry ventures in each of the focus areas. There are notable parallels in objectives and funding models among COSIA and OSESG and AOSERP.

Government Research

In addition to the major collaborative partnerships, the Alberta government was responsible for several significant research initiatives. For example, Alberta Environment's Land Reclamation Division established a soils specialist position to provide advice to reclamation inspectors on difficult sites. Over the years those specialists also initiated research projects. The Alberta Environmental Centre at Vegreville, originally part of Alberta Environment, and more recently a component of Alberta Innovates – Technology Futures, undertook a variety of research programs in areas such as soil physical properties, sterilants† reclamation, and development of native species for use in reclamation. The latter work resulted in the release of 15 cultivars of native grasses for use in the mountains, foothills, and plains regions.[26]

In the 1980s, Alberta Energy and Natural Resources undertook a variety of research projects in forested regions of the province, including work on native and agronomic species seed germination and propagation.[27] Later, Alberta Sustainable Resource Development continued research efforts into conservation and revegetation of native prairie landscapes.

Alberta Agriculture conducted studies in the early 1970s of revegetation of industrial disturbances such as mines, pipelines, cut lines, power lines, and roadsides.[28] Alberta Agriculture also led development of the *Soil Quality Criteria Relative to Disturbance and Reclamation* in 1981, and its 1987 revision.[29] This document served as a core reference for reclamation planning and assessment for decades.

The Alberta Research Council undertook a wide range of reclamation research for a variety of the agencies discussed above and for individual industry and government clients. Core focus areas included mountain and plains coal mine and oil sands mine reclamation, drilling waste characterization and disposal, and use of industrial wastes (e.g., pulp mill waste) for reclamation, with emphasis on long-term monitoring. Many of the projects were conducted for periods of 10 years or more with some in excess of 20 years.

* At the time of writing CEMA's standing was uncertain due to a reduction in funding and discussions around potential change in mandate.

† Sterilants – long-term, residual herbicides applied to control vegetation establishment and growth at oil and gas sites.

Alberta Heritage Savings Trust Fund – Derelict Lands Program

This program began in 1976 and had an initial five-year time frame with the option for annual renewal. Five million dollars was available each year: $3.5 million for operational reclamation work and $1.5 million for reclamation research.[30] All municipalities received information on the Derelict Lands Program and were invited by the minister of Environment to apply. Eligible abandoned derelict sites included coal mines or quarries; gravel pits; garbage dumps and sewage lagoons; refinery sites or other mineral processing plants; industrial sites; irrigation canals or man-made water reservoirs; and roads, airports, and railways.

The three most popular derelict sites for reclamation were old garbage dumps that were being closed in favour of regional landfills, old sewage lagoons, and old gravel pits. For the first two or three years, some heavy equipment operators were trained at Keyano College in Fort McMurray in the belief that they could be employed within the Derelict Lands Program. The cost of training and lodging and the lack of extensive work experience made it impractical to continue with this educational/training component.

Local contractors were initially hired on an hourly basis with supervision by Alberta Environment staff. The program was oversubscribed in the first few years, and it became necessary to develop a yearly work plan that took into consideration the unique characteristics of each candidate site.

Safety of abandoned mine sites was given priority and closure of mine shafts and other unsafe openings were undertaken at Redcliff, Drumheller, Crowsnest Pass, and Canmore. Gravel pits and borrow areas were also reclaimed on lands under the jurisdiction of Alberta Transportation and on Crown lands administered by Forestry, Lands, and Wildlife.

Lawrence Kryviak, manager of the Derelict Lands Program for many years, said that "the success of the reclamation program depended heavily on the skilled supervisory staff who had extensive practical knowledge and experience with heavy equipment such as Cats and scrapers."[31]

Experimental techniques were employed in the early projects undertaken for the program. When RRTAC was established in 1978, it became responsible for defining the research work that should be undertaken on these abandoned areas as well as the current operations.[32] Much of the research—especially for issues arising as coal mining expanded in settled agricultural areas on the plains—was piggybacked with the operational work.

Kryviak oversaw the operational component and Paul Ziemkiewicz (first RRTAC chairman) oversaw the RRTAC research component.

The program, popular with MLAs, municipal councillors, and the general public, continued until 1994.

Knowledge Sharing

To be effective, all of the knowledge growing from research initiatives needs to be disseminated and made available to all land reclamation practitioners, governments, and inspectors. Communicating and discussing research findings, policy issues, and public concerns have been key components of the collaborative approach to reclamation in Alberta. Several organizations led the way.

The Coal Association of Canada

The Environment and Reclamation Committee of the Coal Association of Canada (CAC) played an important role in bringing together representatives of mining companies and utility operators to exchange ideas and approaches to reclamation. The committee was established in the mid-1970s to address environmental and reclamation issues common to coal mining operations. The CAC became a focus for coordination of industry cooperation with government research, particularly through the RRTAC program from 1978 to 1994.

The Canadian Land Reclamation Association

The Canadian Land Reclamation Association (CLRA) celebrates its 40th anniversary in 2016. Long a force in Alberta, the organization held its second annual meeting in Edmonton in July 1977, with subsequent meetings in Calgary in 1984 and 1989. The Alberta chapter of the CLRA was formed in 1982 and has hosted annual reclamation conferences since then.[33] Originally technical in nature, these morphed into forums for discussing new government policies and procedures, focused mostly on the upstream oil and gas industry. More than 600 people attended some sessions. Proceedings from national conferences are available for all years; provincial proceedings are available only for the early years.

The Alberta Pipeline Environmental Steering Committee

Government and industry recognized the difficulty in addressing reclamation issues of interest to the entire pipeline sector during the review of a project application by a single company. The Alberta Pipeline Environmental Steering Committee (APESC) was formed in the early 1990s[34] to address environmental issues in pipeline development and operation outside of formal review processes. The key to its early success was the commitment of senior government and industry decision-makers to attend the meetings as active participants.[35]

The Oil and Gas Remediation and Reclamation Advisory Committee

The Oil and Gas Remediation and Reclamation Advisory Committee (OGRRAC) was formed in June 2003 to review and provide recommendations to the minister of Environment on implementation of the revised program for certification of remediated and reclaimed upstream oil and gas sites.[36] Chaired by Alberta Environment, committee members included a wide range of interests: Alberta Sustainable Resource Development, Farmer's Advocate, Canadian Association of Petroleum Producers, Alberta Conservation Tillage Society, Alberta Energy and Utilities Board, Alberta Association of Municipal Districts and Counties, Surface Rights Federation, and Canadian Energy Pipeline Association. The committee provided the Environment minister with a series of recommendations under 10 subject areas. Two of those—fee structure and stratified remediation—included different perspectives of the participant organizations, indicating general consensus on the recommendations but some lingering concerns.

The work of its successor organization, the Reclamation Criteria Advisory Group (RCAG), established in 2005 to upgrade 1995 wellsite criteria, is described in Chapter 3.

BC Mine Reclamation Symposia

Alberta practitioners often attended and presented papers at the Annual Proceedings of the BC Mine Reclamation Symposium to take advantage of another forum where information and ideas are exchanged on land reclamation practices. Papers are archived and readily available to the public.[37]

Education and Training

As the reclamation industry advanced over the decades, educational institutions gradually began offering studies in the related disciplines as more data and practical experience became available. Several educational institutions in Alberta have a history of preparing future reclamation practitioners through college and undergraduate and graduate university programs; field research is often part of the training process. In addition, many high schools now offer instruction and awareness activities to stimulate interest in land reclamation earlier in the educational continuum.

The University of Alberta

At the undergraduate level, the University of Alberta's Land Reclamation major in the B.Sc. Environmental and Conservation Sciences degree began in 1993. This major combines the natural and applied sciences to understand, assess, and minimize the impacts of human activities on natural resources, with emphasis on soil, plant, and water components of the ecosystem.[38] At the graduate level, the university has produced many M.Sc. and Ph.D. graduates with reclamation-related specialties over the years.

As interest in the field picked up, in June 2011, Dr. M. Anne Naeth took the next big step and created the Land Reclamation International Graduate School (LRIGS). Its aim is providing interdisciplinary and international training to create highly qualified land reclamation professionals with the education and experience necessary to take on leadership roles in academia, consulting, government, and industry. In 2013, the Canadian Land Reclamation Association awarded LRIGS with the Edward M. Watkin Award* in recognition of innovation and excellence in graduate student education and promotion of land reclamation internationally.[39]

U of A's undergraduate mining engineering program includes a mine reclamation engineering direction related to design and monitoring of reclaimed landscapes.[40] An annual guest speaker to these classes in the 1980s was mining reclamation specialist Robert Logan, who provided students with an industry perspective on environmental and reclamation requirements. "It was time well spent to help build a conservation/reclamation mentality in future engineers," he said.[41]

Land reclamation graduate students building anthroposols at Diavik Diamond Mine, NWT. *Diavik Diamond Mines (2012) Inc.*

Olds College

Olds College in Olds began teaching reclamation courses in the late 1980s as part of other majors. In 1995, the college first recognized the significance of reclamation training by creating the Land Classification and Reclamation major in the Land Resource Management Program to give students the background to reclaim disturbed lands and to minimize the impact of industrial activities including oil and gas, mining, and forestry.

Since then, the program has evolved in response to industry and government needs and been renamed to reflect these changes: from Land Classification and Reclamation to Land Reclamation, and most recently to its current name, the Land Reclamation and Remediation major within the Land and Water Resources Program. In today's major the college delivers four courses, two of which are specific to land reclamation and two specific to land remediation. It also delivers a number of ancillary courses in soils, vegetation, and water, plus the standard "soft skills" courses that are threaded through other courses.

Recently the college implemented a "field school" where the students can apply their learning in a real world environment. During approximately 30 years since the inception of reclamation/remediation training at Olds College, 30 to 40 students have graduated annually in this specialty area. The college also delivers overview courses in land reclamation to other programs on campus as well as delivering a series of very successful reclamation/remediation courses to industry.[42]

Lakeland College

Lakeland College in Vermilion first developed environmental-related programming in 1973 called Renewable Resource Technologies. It was part of Agricultural Technology, and derived from agriculture programming and

* The Dr. Edward M. Watkin Award is named after a founding member of the Canadian Land Reclamation Association / Association Canadienne de Réhabilitation des Sites Dégradés (CLRA/ACRSD) in recognition of his significant service to furthering land reclamation in Canada. Watkin was a research scientist at the University of Guelph in Ontario.

retained much of that background in the initial years.[43] Formal programming in Environmental Sciences began in 1978, with the establishment of a separate Conservation and Reclamation diploma. By the late 1980s, as reclamation industry practices evolved, the Conservation and Reclamation Program shifted from an agricultural-based program to a focused environmental reclamation program. Introduction of the Reclamation Criteria for Wellsites and Associated Facilities by Alberta Environment in 1995 increased the development of regulations and practices in Alberta, and Lakeland's programming has followed the industry and government practices and expectations since then.

In 2010, one Environmental Sciences diploma was created with a common first year and four majors from the previous four separate diplomas. The current offerings of Conservation and Reclamation, Conservation and Restoration Ecology, Environmental Monitoring and Protection, and Wildlife and Fisheries Conservation provide training in applied environmental sciences and natural resource management. The common first-year courses develop a broad base of technical skills, moving to more program-specific courses in second year.

Students in Conservation and Reclamation focus on returning industrial land disturbances to productive capability, and they learn about the major types of land disturbances from mining, pipelines, oil and gas, sand and gravel, and other industrial applications. The Conservation and Restoration Ecology Program focuses on the evaluation and repair of disturbed natural areas including wetlands, native prairie, and forested areas.

Medicine Hat College

The newest of the Alberta reclamation academic programs, Medicine Hat College (MHC) began offering its Environmental Reclamation Technician diploma in 2008.[44] The two-year diploma program was designed following extensive consultation with industry, government, professional organizations, and potential employers. The MHC Environmental Reclamation Program includes specific academic and technical training essential for careers as environmental technologists along with a practical, hands-on approach to learning involving regular applied fieldwork. Where possible, the students in the program are involved in carrying out applied research in collaboration with organizations such as Alberta Parks, the Nature Conservancy, CFB Suffield, or Alberta Environment and Parks (formerly Alberta Environment and Sustainable Resource Development). Only 20 students are admitted to the program each fall with the intent of maximizing the students' experience and potential for success. The success of this strategy can be seen both in the high retention numbers and employment rates for graduates.

The MHC diploma program requires a work experience practicum following the capstone semester and features a strong focus on the unique environmental conditions of southern Alberta and Saskatchewan, where ecosystems include montane, prairie, wetlands, sand dunes, and badlands. While there is emphasis in the MHC program on land reclamation relating to the oil and gas industry, there is equal weighting in the areas of agrology, range health, and riparian assessment. Graduates of the MHC Environmental Reclamation Program can apply for professional membership in the AIA (Alberta Institute of Agrologists) or SIA (Saskatchewan Institute of Agrologists) with the designation of RTAg (Registered Technologist in Agrology) and have the option to transfer to the University of Lethbridge or University of Saskatchewan to complete a B.Sc. Environmental Science degree after receiving their diploma.

Northern Alberta Institute of Technology

Located in Peace River, the NAIT Boreal Research Institute (NBRI) is an applied research centre with partnerships in the forest and oil and gas industries, academia, and the regional community. NBRI is an 840-square-metre, state-of-the-art research facility, which includes a three-bay-greenhouse, soil and clean laboratories, and office space.

NBRI is committed to the development of applied technologies that fill gaps and build industry capacity in ecological management. While its niche is anchored in its historic relationship with the forest industry, NBRI expanded its partnerships in 2008 to address environmental and regulatory pressures for the reclamation of oil and gas wellsites in forest settings. NBRI research topics include boreal upland forest and peatland reclamation and restoration, plant and seed technologies, as well as tools to measure and mitigate forest fragmentation.

NBRI is organized into five program areas: forest reclamation, peatland restoration, plant and seed technologies, boreal education, and technology transfer.[45]

Southern Alberta Institute of Technology

SAIT's Environmental Technology (EVT) Program includes basic instruction in land reclamation theory as part of its overall package. The courses offered in the EVT Program consist of theory, laboratory, and field components to provide students with the skills needed in the lab or in the field as an environmental technologist. The theory component introduces the students to courses in remediation

Students can study Environmental Technology at SAIT. *SAIT* and reclamation, risk assessment, auditing and management systems, sustainable urban design, environmental impact assessments, sustainability, law and regulation, GIS, sampling and analysis, waste management, and environmental chemistry.[46]

Scholarships and Early Education

The Alberta Chapter of the CLRA has been providing undergraduate and graduate student scholarships to these institutions at its annual conference for many years. These scholarships are aimed at supporting deserving student members who show outstanding initiatives in the field of reclamation.

Post-secondary education is seen as critical to developing future reclamation specialists for government, industry, and the consulting community. To that end, in 1992 Alberta Environment recognized that the best way to get people interested in the subject is to introduce it early in students' curricula. The department partnered with 13 teachers from across the province to develop the *Land Conservation Education Program Teacher's Resource Manual* for Grades 7 to 9. The program provided a comprehensive package that addressed the topics of land formation, soils, land use, and land management in Alberta.[47]

Finally, on-the-job training and practical experience cannot be overlooked as part of education. Practitioners must acquire the all-important hands-on feel for the process. "Reclamation comes down to the operator running the equipment. Believe me some operators are really darned skilled and take pride in their final creation," said reclamation specialist Rick Zrobak. "Have some fun, create—make something go on because you're creating the final product. Therefore you end up with some operators creating some amazing, innovative landscapes. They are important. They are an essential part of what you're writing about."[48]

Conclusion

We opened the chapter with Einstein's quote, and it seems in our case he was right. Without all of the foregoing experience gained in reclamation over the past half century, the knowledge base would be non-existent, along with much of Alberta's successfully reclaimed landscape.

PART TWO

MINING

Truck-and-shovel mining, shown here at Syncrude in September 2008, greatly improved the economics of oil sands projects in the early 1990s. ***Syncrude Canada Ltd., CC 2.0***

CHAPTER FIVE

Coal

There is more to coal mining than mining coal.

Source unknown

Past contented bighorn sheep grazing with an eye on their escape terrain—a mined rock face—you arrive at a peaceful lake reflecting the summer sky of the Rockies. Not more than a few hundred metres across, Sphinx Lake is nestled in hills of evergreen and grass, and home to rainbow and bull trout. It stretches the mind to picture what this blissful scene was just a few decades ago: a noisy, dusty, hustling open-pit coal mine known as Cardinal River Operations. Land conservation and reclamation efforts have become an important part of coal mining.

Recreational lake in former coal mine pit at Teck's Cardinal River Operations, 40 kilometres south of Hinton. *Bob Logan*

Alberta contains 70 per cent of Canada's coal reserves and is the country's largest producer and second-largest exporter of coal. Coal-bearing formations underlie about 300,000 square kilometres or about 48 per cent of the province's land area. Coal mining has been a long-running and significant component of energy production in the province. The goal of coal-mining reclamation is to ensure that mined land is reclaimed in a timely manner and has a land capability equivalent to its former state.[1]

Alberta Coal to 1963: Proud History with a Legacy

Since the late 19th century, Alberta's coal was integral to western Canadian population and railroad expansion. Through boom and bust markets, scores of pure coal-mining towns sprang up in the plains, foothills, and mountains. Until passage of Alberta's Surface Reclamation Act in 1963, the province and its coal industry paid little heed to the environmental impacts of coal mining, especially land conservation and reclamation. Production had been the driving force. Environmental matters gradually gained momentum, but took decades to evolve into concrete action.

According to oral tradition, the Blackfoot and the Cree knew of the "rock that burns." Although direct evidence of coal's prehistoric use as a fuel has evaded Alberta archaeologists, the Royal Alberta Museum has an exquisite fist-sized bison effigy sculpted from smooth, even-grained bituminous coal discovered in 1949 in a farmer's field at Beauvallon, near St. Paul.[2]

First European records are those of Hudson's Bay explorer and fur trader Peter Fidler, who reported coal along Rosebud Creek near Drumheller in 1792; he also mentions Aboriginal coal use in his journals. David Thompson writes of collecting bushels of coal on the North Saskatchewan River after high water, and in 1800 he reported his discovery of a bed of "pure coal" about 100 metres below Rocky Mountain House. Later reports came from James Hector of the Palliser Expedition in 1857, George Dawson in 1878, and Joseph Tyrrell in 1884.[3]

Early settlers and traders often hand-picked coal for their own use but it was adventurer and entrepreneur Nicholas Sheran who opened Alberta's first commercial coal mine, launched in 1874 on the western bank of the Oldman River near present-day Lethbridge.[4] From that start, Alberta's coal industry embarked on a roller coaster of growth, fluctuation, and decline between the 1880s and 1950s.

The late 1880s saw the first real coal boom in western Canada. It paralleled the massive immigration and settlement in the region, propelled by new railway construction. Railways were large consumers of coal for steam locomotives, and spur lines enabled opening up new coalfields.

Early coal mine, Tofield, Alberta, circa 1910. *Private Collection*

Coal resource development generally followed the order of new settlement, exploited as the need for power, light, and heat grew.

In the mountains, the earliest pivotal developments happened in the Crowsnest Pass that stretches between Elko, B.C., and Burmis in what was to become Alberta. Starting in the late 1890s, mines were established at Frank, Lille, Blairmore, Coleman, Bellevue, Hillcrest, Passburg, Burmis, and Lundbreck.[5] The Bow Valley near present-day Canmore saw Alberta's first anthracite coal development a few years earlier, in 1883 by the Cascade Coal Company.[6]

By 1913, the Crowsnest Pass was producing 2.9 million

The vast Drumheller field eventually became Alberta's leading producer of domestic coal. By 1925, it was churning out 1 million tonnes per year, a level maintained well into the 1950s. Pictured here in 2014 are the remains of Atlas Mine #3, near Drumheller, shut down in 1979 and now a National Historic Site. *Graham Chandler*

tonnes of coal a year—fully 70 per cent of Alberta and southeastern British Columbia's output. On the Alberta side, the Canadian Pacific Railway (CPR) was the mines' biggest client. Coke ovens at Coal Creek, Michel, Hosmer, and Morrissey fuelled booming smelters in British Columbia and the northern United States.[7]

As immigration rose, the industry took off along with the economy. Activity in the foothills south of Edson and Hinton, dubbed the "Coal Branch" after the railway spur off the main line, led the charge. Coal Branch production peaked in 1929 with approximately 1.4 million tonnes—22 per cent of Alberta's entire output. Not all of it went to the railways. Much production from the more eastern arms went to home consumers and thermal power plants in Saskatchewan.[8]

Also serving the new transcontinental railways was Nordegg, about 70 kilometres south of the Coal Branch. Nordegg's primary customer was the Canadian Northern Railway. Brazeau Collieries was the largest and its first coal rode the new rail link in 1914. Nordegg production rivalled other mountain mines, growing to nearly a half million tonnes at its peak in 1923. It produced until 1955.

On the plains development centred around Lethbridge, Edmonton, and the Drumheller Valley; most growth came after the turn of the 20th century. Prairie seams were relatively flat and near the surface, lending themselves to greater use of mechanized methods, thus reducing labour costs. Taking advantage of these conditions, the typical plains company was much smaller than its mountain counterpart.

The pre-war economic boom began to slow considerably as the massive immigration and settlement of those years tapered off. Some stimulus was provided during the war from increased wartime needs—troop and supply trains, smelters for armament production—but 1913 marked a turning point in the fortunes of Alberta coal mining. The impact was felt first in the Crowsnest Pass, where a number of mines shut down before 1914.

The merger of Canadian Northern and Grand Trunk

Pacific Railways to form Canadian National Railways (CNR) in 1919 did not help matters. Adding to the misery, in the 1920s both the CPR and the CNR refused to guarantee the level of coal purchases. Moreover, there was energy competition from hydroelectric power and petroleum fuels like Bow Island, Viking, and Turner Valley natural gas. Both mountain and plains production plummeted. By 1925, more than 500 mines were operating in Alberta, down from about 1,200 mines that had opened since 1874.[9] Of the more than 1,200 mines that had existed to 1925, 93 per cent were underground mines, while the few surface operations generally had very low production levels.

Steam coal production hit a new low in 1931, albeit with a slow recovery during the Great Depression. The outbreak of World War II saw renewed demand. Coal was considered a war-critical industry. Production soared from 5 million tonnes to 7 million tonnes.

The postwar economic boom in Canada carried that momentum for a few more years. Large reserves of crude oil were discovered at Leduc in 1947, and quickly the railways recognized the clear advantages of diesel power. In the short span of eight years, both transcontinental railways had switched their locomotive fleets to diesel, gutting Alberta's steam coal industry. Meanwhile, electrical generation plants began shifting from coal to natural gas, and domestic consumers moved to petroleum products for home fuel. During the 1950s, coal dropped from over half of Canada's energy supply to 20 per cent.

Blairmore, Alberta, underground mine tunnel, circa 1941.
Glenbow Archives NC-54-2899

But it did not spell the end. Toward the late 1960s increased demand for Alberta's growing population meant not all electrical power could be met with hydro and natural gas. Plains coal provided for new thermal electric power plants in Alberta. Coincidentally, demand was climbing for metallurgical coke to power the steel mills of Japan and other Asia-Pacific nations. Exports started with thermal coal to Ontario in the 1970s from the Coal Valley area, and expanded with metallurgical coal to foreign markets.

Booming demand for both coal types stimulated new mining developments in the Crowsnest Pass, the Coal Branch, and Grand Cache. On the plains it was Wabamun, Battle River, Genesee, and Sheerness east of Drumheller. In some cases it was old mines reopening, but much of the activity was in new areas, by newly formed companies using surface-mining techniques. While surface mining had been practised in Alberta since World War I, after 1945 the development of large draglines and other machinery made it practical, in many cases for the first time. Small mines were consolidated into relatively few, much larger mines, increasing potential for land disturbance. Large firms like Manalta Coal and Luscar could extract vast quantities of coal without the attendant high labour costs of underground mining. By 1980, only one underground mine was producing coal.

Environmental Concerns

Over the decades following Nicholas Sheran's first Alberta mine, the impact of coal mining on the land had been largely ignored. There were a few exceptions, especially near cities. One early example is the City of Edmonton's restrictions on coal mines, aimed at minimizing urban environmental damage. In 1931, after Alberta assumed control of its natural resources from the federal government, the province enacted legislation to prohibit mining in towns and cities, in areas underlying or adjacent to any street or public place—a forerunner to environmental regulations.[10]

In the coal industry, as well as other industrial sectors, reclamation was considered a common-law duty and often incorporated to various degrees in the surface lease between company and landowner.[11] The only requirement was to leave the site in a safe condition.

For the plains coal mines there was no requirement to remove and stockpile topsoil before excavating the several metres of overburden that usually overlaid coal seams. All that was needed after abandonment was to round off the

Reminders of over a century of coal mining activity are found throughout Alberta. Shown here are slack coal and cribbing from a load-out structure along the McLeod River south of Cadomin, remnants of a mine operated at Mountain Park from 1911 until its closure in 1952. *Bob Logan*

overburden piles and seed them with forage to minimize erosion. Spoil piles and pits were frequently abandoned and left untouched, along with much of the non-reusable surface infrastructure. In the mountains, where most early coal-mining operations were underground, they too were frequently abandoned.

The 1960s saw growing public awareness of the need to preserve, protect, and reclaim. Industrial expansion and fast-growing petroleum exploration and development were making landowners anxious. The Alberta government responded with the Surface Reclamation Act of 1963, which established an administrative and field enforcement program to set minimum standards for practices like hazard reduction, cleanup, and re-contouring. The act also provided for the issuance of reclamation certificates to mining companies.

Reclamation's Formative Years

In 1963, the limited state of scientific and practical knowledge of surface reclamation of disturbed environments was mainly in the mining companies' realm. Concentrated and well-coordinated research programs on establishing native plant species, groundwater quality, soil chemistry, microbiology, and wildlife relative to reclamation were as yet nowhere near the level needed to properly reclaim the land.[12] Meanwhile, pressure was growing as government, academic, and public sectors asked questions and offered recommendations and suggestions at public hearings. Government was developing legislation, evolving and restructuring to create policies that would influence reclamation going forward. It appeared the future of surface coal mining in Alberta would be tied to successful reclamation.

An early example of citizen concern over inadequate reclamation came in the late 1960s when Drumheller area landowner George Buchta launched a lawsuit against Fox Coulee Coals Ltd. and the Surface Reclamation Council. The latter was the government organization responsible for issuing reclamation certificates under the 1963 Surface Reclamation Act. The judge, H. S. Rowbotham, issued a stinging decision against the two respondents in November 1970 after personally viewing the lands in question:[13]

> After hearing the evidence, after viewing the surface of the lands and inspecting them thoroughly by walking over them and after viewing adjacent and comparable lands in the area, it is my opinion that the condition of the surface of the lands in question is totally unsatisfactory. None of the topsoil was saved. The overburden was simply pushed over the hillsides into the valleys and streams below. The bare hardpan clay was left exposed for erosion after the coal had been removed. Run off water laden with silt and coal dust was allowed to foul the streams. Much of the surface was covered with a heavy growth of Russian thistle and other noxious weeds which were allowed to blow and spread to adjoining lands. A token attempt to sow grass by broadcasting seed failed to produce any grass cover. Briefly, the lands were left in a mess.

He wasn't about to let them off with a simple fine. Judge Rowbotham ordered that the respondents carry out additional work:

> All noxious weeds are to be eradicated and all rubble and overburden is to be cleaned up from the hillside and the stream beds; the flat lands are to be levelled with a slight slope or gradient to the hillsides; sufficient topsoil is to be returned to and spread on the flat lands to establish and support a grass cover; grass seed of an indigenous variety is to be sown on the flat lands and the growth of indigenous grass is to be nurtured and watered until it is established; and the valleys and stream beds are to be cleared of silt and coal dust so that they will permit the flow of uncontaminated water fit for drinking by livestock.

He gave them one year to complete the work and recommended provision be made in the Surface Reclamation Act for posting of a financial bond by operators to ensure reclamation costs would be covered.

It was a landmark decision. The general public and the scientific community were increasingly concerned over the prospect of a drastically disturbed environment. Most agreed that reclamation planning must become an integral part of production planning.[14] However, in these early years, lack of industry experience and inadequate knowledge of the rates and size of mining disturbances compounded the problem. New reclamation activities must therefore include several disciplines, including plant and soil scientists and foresters as a minimum.

The Forest Research Laboratory of the Canadian Forestry Service recommended in a 1970 report, *A Background for Disturbed Land Reclamation and Research in the Rocky Mountain Region of Alberta,* that industry—and government—might initially draw on the proceedings of a seminal symposium for reclamation guidance.[15] The International Symposium on Ecology and Revegetation of Drastically Disturbed Areas, held in Pennsylvania in 1969, included more than 60 technical papers from several countries on the environment of disturbed lands, the adaptability of plants to disturbed environments, and modification of lands; it covered the entire gamut of state-of-the-art reclamation science in 1969. The Forestry Service report supplemented its guidance with other bibliographies.

The report's authors conducted field trips to abandoned, active, and reclaimed mining sites in Alberta in 1969 to assess viability of reclamation there. They noted that lands at or above treeline—about 2,000 metres—presented particular revegetation problems because of steep slopes, unstable overburden, adverse climatic conditions, and lack of topsoil. They recommended research to determine if these could be easily reclaimed. At Luscar, the authors visited the operations of Cardinal River Coal Ltd. and reported it "appears promising for pilot research to determine the best combination of plants, fertilizers and mulches to revegetate slopes of various aspects and elevations." They observed the effectiveness of natural revegetation at abandoned spoils between Coalspur and Foothills, Alberta. As an early example of voluntary reclamation on the plains, they visited the Whitewood Mine west of Edmonton, part of the Wabamun Lake operations of Alberta Coal Ltd., a subsidiary of Mannix Co. Ltd., and reported "excellent reclamation has been achieved at Wabamun Lake by Calgary Power Ltd. with the advice of the District Agriculturalist by contouring the overburden and revegetating it to alfalfa."[16]

Practical experience indicated that the earlier in the mining process reclamation plans were made, the more feasible reclamation could become. Experts concluded that documentation of the existing topography, geology, and vegetation prior to disturbances was of prime importance. Reclamation according to an advanced mining end land-use plan would move beyond the sole objective of rapid establishment of green cover. Subsequent vegetation management would be necessary to achieve the projected land use.[17] Such management could allow opportunities to develop the disturbed land into a more valuable end use.

Recommendations and guidelines emerged in those early years, despite the dearth of reclamation research. For example, the aforementioned 1970 Canadian Forestry Service report suggestions for Alberta's Rocky Mountain coal region included:

- advance documentation of land and water resources
- a pre-determined end land-use plan
- establishment of botanical species mixtures
- establishment of a dense stocking of planted species and seedlings on spoil banks
- reclamation of roads and road cuts
- consideration of potential for recreational uses associated with man-made lakes in reclaimed areas

Major physical steps to achieve suitable topographies were placement of spoil at desired slopes, contouring or terracing, and setting drainage patterns. Slopes greater than 35° were to be avoided as they are subject to rapid water erosion, do not hold moisture well, and are difficult to vegetate. Management of drainage patterns could be critical: stream rerouting and development of new drainage channels with moderate slopes could be needed.[18]

The Forestry Service report recommended establishing a network of plant roots in the surface to stabilize slopes and promote soil conservation.[19] In mountainous regions, revegetation should be undertaken as soon as possible after a disturbance and before the finer soil particles are washed downhill. It was noted that at higher elevations there is often insufficient suitable material to surface the overburden before revegetation. Applying mulch at seeding would increase the water-holding capacity, reduce wind erosion, moderate soil temperatures, and improve the chemical properties of the surface. Common mulches were straw, wood cellulose, calcareous fly ash from coal-burning power plants, and limestone. The report served as a comprehensive set of guidelines in the early years.

What was needed in the early 1970s was a solid set of reclamation standards, approval processes, and research priorities for coal-mining enterprises. Another pressing need was for a survey of all types of surface disturbances. The impacts of large-scale surface mining of coal in agricultural areas were uncertain and initially hindered coal resource development. The government was not prepared to finalize definitive reclamation guidelines and standards for surface mining without further research.[20] By the mid-1970s, there were still many unanswered questions. For example, the Alberta Research Council asked:

- Can surface mined areas be successfully reclaimed to support agricultural operations at all?
- Will surface mining of prime agricultural land permanently destroy the capability of the land to grow crops?
- Can solonetzic soils be reclaimed?
- How much subsoil buffer material is required?
- Are there amendments that can be added to reclaimed soil to enhance its agricultural potential?
- Will capability degrade over time?
- Can degraded capabilities be prevented with thickness of buffer material?
- What is the best way to compare pre- and post-mining landscapes' productivity or capability?
- Will mining destroy regional groundwater supplies?
- Will groundwater levels recover within mined-out areas?
- Can aquifers be reconstructed within mined-out areas?[21]

The broad range of coal deposit types and ecological regions in the province complicated establishment of comprehensive regulations. In a 1971 report submitted to the newly established Environment Conservation Authority (ECA) during public hearings on surface mining, the Geology Division of the Research Council noted the province's vast coal resources and potential.[22] Addressing the environmental impact of surface mining in the province, the geologists wrote that near-surface coal deposits have a wide distribution throughout the Alberta plains and foothills and they exhibit great diversity in quality and rank, geologic setting, surface and groundwater conditions, elevation and topography, and climatic, vegetative, and faunal zones. As a result, they said, "no all-encompassing detailed regulations should be set up which purport to deal with all phases of surface reclamation of land disturbed by strip-mining operations." They suggested the government enact a set of broad principles or guidelines for the restoration of disturbed land that would permit a reasonable degree of flexibility in planning and implementing reclamation procedures for specific operations. Such a general approach would be best "in view of the lack of knowledge which exists with respect to the preferred reclamation procedures in many cases."

The same report authors grappled with early definitions of reclamation with respect to coal-mining operations. They noted that reclamation implies either that the land be returned to its original natural state as closely as possible, or be reclaimed for some alternative use such as recreation, game management, or agriculture. Especially when it comes to the foothills, "too much stress has been placed on the first item." Simply filling an abandoned mine with rock rubble, replacing the topsoil, and reseeding might be fine in some areas of the foothills. But for many other areas, excavations could, for example, hold water and possibly be stocked with fish to provide a recreation area where none existed before, the report stated. That is, mining operations presented unique opportunities to add different or special features to the landscape.

Reclamation was not just a concern for the public and the regulators. Some operating companies were growing aware of a need to reclaim—despite the embryonic state of legislation and regulation in the province. Ignoring an environmentally concerned general public could have a potentially detrimental effect on a company's and the industry's future.

Terry Macyk spent a distinguished career with the Alberta Research Council in reclamation research. In 1971, he was part of a team contacted by McIntyre Porcupine Mines to plan and implement a reclamation program for their mountain mine at Grande Cache.

> We started the field work in 1972, and all we could get was a few bits and pieces of the mined land that we could work on for plot establishment, and essentially we had to go with what we felt; there was nothing we could follow in terms of precedent or anything that people had done before that would help. There was some reclamation work that was done in places like Kentucky and others, but it certainly wasn't relevant for us. So we went in, and we started with our plot. The first thing we recommended to the company was to start saving soil. This was before it was a requirement.[23]

He said the company started stockpiling soil in 1971 before field trials began. "I think at that point they knew that they would have to do this; they knew as part of their approval to go ahead [that] these kinds of changes were coming."

Canmore Mines Limited, east of Banff National Park, set a good example, too. After decades of mining in Canmore and ignoring the impact on the land, by 1969 Canmore Creek had been rendered essentially unrecognizable. "[Due to] dumping along one bank of the creek, the creek had been pushed over," recalled Gerry Stephenson, chief engineer and assistant general manager of Canmore Mines Limited at the time.

> The vegetation had vanished. The brook trout that inhabited the creek had gone, and the bottom was all silted. So, I could see that unless something was done we were going to cause a great deal of environmental damage and also importantly for the company, permissions for surface coal mines in the future would not be given until we started a real program of reclamation. So, I talked to the president of the company and he was very keen to get started.[24]

What Stephenson and the company did was a good example of using intuition and reason to formulate a reclamation strategy. He recalled there were very little research data to draw upon, but "we hydro-seeded it and, with fertilizer, we then mulched it. And, for mulch in those days, on advice from Jim Wallace, [Alberta] Department of Forests, we used chopped straw with a light mixture of bitumen." The idea was that the chopped straw would land above the seed and the bitumen would hold it in place and join the stalks together. "Beneath this three or four inches of mulch we would create a micro-climate," he said.

> We used to do this in the fall knowing that it would not germinate that year, usually in late September/early October. The idea being that snow would fall and when winter was over, the ground would be saturated with the melted snow and the heat would start with the sunshine. Beneath the chopped straw we'd get this micro-climate, which would warm the soil, the seeds would germinate, and the grass would grow. Well, strangely enough it worked. And within two years we had a good foot to 18 inches of grass on the bank. So, that was a first successful effort.

The 1971 Alberta Research Council report also introduced the important idea of doing work before operations were allowed to commence at a mine site.[25] No legislative requirement existed for this under the 1963 Surface Reclamation Act. The report recommended that an independent body of experts reporting directly to the Alberta government conduct a survey of the proposed mine site, access routes, plants, and townsites in advance of mining and development operations. The survey should consider the distribution and properties of bedrock and surficial materials, surface and groundwater regimes, and flora and fauna. It would be up to the government to issue approval to the operator.

The same report commented on some specific aspects of environmental control; most of these had previously received little formal attention. One recommendation addressed removal and replacement of overburden and topsoil. Overburden consists generally of bedrock (mainly sandstone and shale) and unconsolidated surficial deposits (mainly of glacial origin). Topsoil refers to the upper few feet or inches, typically 3 to 100 centimetres, of weathered mineral or organic material that is capable of supporting vegetation growth; it is much more erratically distributed in the foothills than the plains. They pointed out that in the foothills, especially at the higher elevations, soil cover is often just a few inches of rock rubble mixed with small amounts of sand and clay. "Where possible this material should be preserved and replaced after mining to provide some sort of soil-like rubble for revegetation of the area," the report recommended.

A second aspect of environmental control discussed in the report was design of spoil banks and erosion control.[26] Following recommendations of the Canadian Advisory Committee on Rock Mechanics, it recommended development of a design guide for the investigation, design, and construction of stable waste embankments. The report encouraged more research in this area.

At the time of the 1971 Alberta Research Council report, there was considerable uncertainty about the effects of coal surface mining in Alberta and the related reclamation processes. The authors noted that the lack of research data was hampering implementation. Some knowledge could be obtained from results in other jurisdictions such as Europe and the United States, but generally they were of little use in Alberta. Moreover, "even within Alberta, the diversity of settings in which coal-bearing strata are found indicates that reclamation procedures that have proved successful in one area of the province will not necessarily be successful elsewhere." The report recommended that the provincial government set up a task force to survey the need for research into problems of surface coal mining in Alberta.

In 1971, the Environment Conservation Authority also issued the report *Environmental Impact of Surface Coal Mining Operations in Alberta.* It was an outline of environmental problems associated with provincial surface coal mining operations, intended as a comprehensive basis for discussion at public hearings. The report included recommendations for further study.[27]

Legislation and Hectic Change

In 1973, the provincial government passed the new Land Surface Conservation and Reclamation Act. A series of regulations developed under the act provided an integrated environmental framework for coal operations. The Environment Conservation Authority's public hearings on land use and resource development in the Eastern Slopes continued throughout the province. Its report and recommendations[28] were placed before the government in 1974. The follow-up report on its findings for coal exploration was published later in 1976.[29] This was a decade defined by a lack of trained reclamation professionals, increasing public influence, landmark legal decisions, stepped-up research, and long-awaited coal policies. Lively discourse on the merits of various reclamation techniques took place amongst key parties: industry, provincial government, landowners, and stakeholders.

The 1970s was a hectic decade in the coal-mining arena. Rapid expansion of the industry forged way ahead of efforts to craft reclamation standards, regulations, policies, and programs under the recently passed act. Some Alberta news media suggested that upcoming major land-use decisions might preclude effective legislation coming out of the ECA's report, which was to form the basis for government policy. Many people advocated a moratorium until the government had time to consider the report's recommendations.[30] The adjacent State of Montana proclaimed a strict mining and reclamation act in 1973 on the heels of a one-vote defeat of a moratorium against coal mining there.[31] The Alberta government took note and froze land development in the Eastern Slopes in the summer of 1973 pending the ECA's report.

It was a necessary move. "In some ways, the early 1970s were the perfect storm," recalled Robert (Bob) Logan, career environmental planner and reclamation specialist with Manalta Coal, Luscar, Cardinal River, and others.[32] "There was growing awareness about environmental issues and pollution. The world economy was booming. So there was a lot of activity—whether it was coal or oil and gas. Increasing demands for electricity, so more mining." On top of that, he added, the Organization of Petroleum Exporting Countries (OPEC) had quadrupled the world price for crude. Petroleum companies jumped into the coal business—Union Oil's Obed Mountain mine near Hinton was one example.

Logan recalled being hired in his first job with Manalta in 1976:

> It was really only about 1975 when coal and power utility companies started hiring [environmental specialists]. From a corporate standpoint, you very quickly got covering a wide range of things. Whether it was water issues or how you're handling water on a site or archaeological investigations or wildlife or whatever. You become quite general, but at that point in time, there was a real big issue about soils and how much soil had to be saved, and that had enormous impact on the economics of mining.

Opposition to development by farmers, landowners, and the public continued as coal mining activity expanded. For example, the Round Hill–Dodds Agriculture Protective Association, incorporated on November 12, 1974, consisted of local farmers who pooled their resources and expertise in opposition to Calgary Power's proposal for a coal-fired electrical generating plant in the area and CanPac Minerals' plan to strip-mine coal to fuel the plant.[33] Eventually, the Alberta government turned down the application, as too much agricultural land would be disturbed without sufficient assurance of satisfactory reclamation (see Chapter 3, pages 37-38). This was a major step for the government; however, it attributed the non-approval to a lack of suitable data to accurately assess the risk, and so directed the Earth Sciences and Licensing Division of Alberta Environment (AENV) to acquire additional information on soil characterization of the area.

The division's findings provided basic information for future planning and contributed to overall policy direction on strip mine reclamation and environmental protection.[34] Significantly, the report recommended topsoil and 3 metres of subsoil/till be retained for reclamation to viable agriculture to ensure at least initial viability. While this was a pivotal idea, the 3-metre requirement would become the source of much industry-government disagreement.[35] The report, along with a parallel assessment by the Environment Council of Alberta,[36] kick-started joint research to determine the optimum soil depth, such as the Reclamation Research Technical Advisory Committee (RRTAC) plots at Battle River and Wabamun and the Plains Hydrology and Reclamation Research projects discussed in Chapter 4 and later in this chapter. These were some of the early efforts to integrate research into regulatory requirements.

Logan remembers the impact on industry of such a broadly defined soil salvage requirement:

> When the Land Surface Conservation and Reclamation Act came out in 1973, it required pre-planning and pre-approval of all your operations. So, you had to think out how you were going to mine and reclaim. The costs were significant, because you had to assess how much soil was out there, do inventories … These costs had not been seen before.

These mined lands at the Diplomat Mine in the Battle River coalfield were spread with topsoil in the late 1970s and continued in productive agricultural use some 35 years later. *Bob Logan*

How to move such a large volume of soils became a leading question, too. "So now there were questions of what equipment do you use. There had been a dabbling with the existing equipment, like a dragline and trying to selectively take the layers and put them back on top instead of at the bottom of the pit." The new reclamation costs were a major concern for coal mining companies, which were essentially competing with one another in the marketplace. "Certainly that was a factor then and I would say it's a factor today too," said Logan.

Many of the environmental issues around coal mining were brought to a head at public hearings held by the Energy Resources Conservation Board. The ERCB held hearings for large coal mines associated with new or expanding coal-fired electrical generating stations proposed for agricultural areas. New mining developments at Battle River (including the Paintearth Mine), Sheerness near Hanna, and in the Wabamun coalfield (Genesee and Keephills/Highvale) west of Edmonton were subject to this regulatory process, which brought together affected landowners, mining and utility companies, and several government agencies. The impact of mining on the environment and the ability to reclaim the land were of high priority.[37] The decision reports coming out of these proceedings reinforced the need for more research and new effective reclamation practices.

At the same time, the government was under pressure despite the aforementioned land development freeze in the foothills and mountain region. To keep the process going, the Department of Mines and Minerals announced in late October 1973 that it would resume accepting applications for mineral rights for coal in the Eastern Slopes. The final decision on issuing mineral rights would be subject to government policy decisions on resource development in the area.[38] Land-use zones under the 1976 Eastern Slopes Policy would provide policy guidance.

New conditions were continually added for coal exploration proposals and developments; many were related to environmental protection as well as land reclamation. In 1969, nine conditions (to be fulfilled prior to approval) were normally attached to all applications ranging from the size of access roads and campsites to adit proximities to watercourses. That list was amended four times over the next six years. In 1972–73 these conditions were expanded to 30. By 1975, the number grew to 45. This was prior to implementation of regulations drafted under the 1973 Land Surface Conservation and Reclamation Act. The coal industry asked for more cooperation from government and flexibility in regulatory requirements as they adjusted to these changes.[39]

It was clear that current reclamation techniques were still inadequate. On foothills sites, for example, revegetation had not shown the progress expected.[40] The vast majority of revegetation projects involved grass seeding only, with non-native species. The technique produced a monoculture vegetation cover, which lacked the long-term stability of native plant species. The 1976 ECA report strongly recommended planting native species.[41]

Plains Soils

On the plains to the east, reclamation challenges were different. "The major surface mines at that time were in prairie areas with marginal agricultural capability at times, or they had significant limitations involving sodium-rich subsoil materials that if not properly handled would contaminate the topsoil," said Bernd Martens, Manalta Coal's 1980s environmental services manager. "There was a lot of debate [between regulators and industry] about separating topsoil from these high sodium materials and high clay materials."[42]

In the mid to late 1970s, Martens and his team visited older mined areas that hadn't been reclaimed. "Some of those dating back to the '20s and '30s, if the draglines only recovered the coal seams just below the till there, they were basically re-working the till, they naturally reclaimed fairly well," he said. However, with the advent of modern draglines, the excavation went much deeper: 80 to 100 metres, where "hostile" clay-based and sodium soil materials were left in spoil piles that were difficult to deal with. "There were bentonitic-type clays and they looked kind of horrible," said Martens. "So there was a lot of attention—I think within Manalta and Luscar—to look at ways of reclaiming those. They were part of the legacy of the companies."

Bob Logan recalls that in those days, the coal industry scrambled with a variety of approaches to develop reclamation practices for the plains region. For example, industry hired experts to review the basic principles of soil science: How do soils form? How does salinization happen? It contracted consultants to review literature in these areas, conducted field examinations of rooting depth, and borrowed techniques from agriculture. An example was the use of "deep ploughing" techniques for solonetzic soils, techniques developed by scientists at federal research stations in the province and being demonstrated through Alberta Agriculture. Technical reports were another source of information as were reclamation conferences in North Dakota and Montana. Industry also consulted with American research scientists and Canadian university professors for expert input on reviewing site soil information. Operators established field demonstration and research plots. Logan said it was an unprecedented effort, aimed at answering the question of how to reclaim these challenging sites.[43]

Seeing Daylight: Creative Solutions through Cooperative Dialogue in the Early 1970s

By Robert (Bob) Logan

A procedure that became known as "daylighting" protected the natural environment while maximizing coal recovery. It was developed in the Battle River coalfield at the Diplomat Mine in the late 1970s and later used at the nearby Paintearth Mine. It illustrates both the increasing level of conservation in mining activities and the benefits of discussion, cooperation, and planning among all involved in conducting and regulating coal mining.

Some of the first surface mining operations at the Diplomat Mine in the 1950s started adjacent to the Battle River valley. In this area, the mineable coal seam outcrops in the valley wall. In attempting to recover as much of the coal as possible, initial mining operations involved opening up a mine pit along the valley break, with subsequent mine cuts moving along, and then away from the valley. In places, the excavated overburden (or spoil) from the initial cut was disposed on or over the valley break. There was also potential for slope instability and erosion to damage the watercourse, not to mention the aesthetics of the natural landscape. Fortunately, at the Diplomat Mine most of the overburden was relatively conducive to plant growth. Broadcasting seed over the slope enabled some vegetation cover to be established in most of the area. The results of these early 1950s practices remain visible along the Battle River valley, west of Secondary Highway 855 and north of Big Knife Provincial Park.

In 1974, Land Conservation Guidelines established protective setbacks to restrict disturbance near valley breaks. The setback distance varied, increasing with the depth of the valley. While these served to protect the valley, the setback would "sterilize" or prevent recovery of significant coal reserves between the valley outcrop and the setback limit. This was the case when operations were again scheduled to approach the river valley in the late 1970s.

The guidelines not only potentially put the mine operators and the Reclamation Council at odds, but also placed the environmental conservation principles of the Land Surface Conservation and Reclamation Act in conflict with the Province's Coal Conservation Act, which strives to wisely use Alberta's energy resources.

This dilemma was resolved through much discussion among mine staff and the Reclamation Council's

An example of some early surface mining practices of the 1950s. To maximize coal recovery, overburden was spilled over the river break at this site at the Diplomat Mine, producing environmental and reclamation challenges. *Bob Logan*

Development and Reclamation Review Committee. It led to a creative solution whereby the mining operations would progress toward (rather than, as in the past, starting alongside) the valley break, moving excavated materials away from the valley.

This plan allowed for (1) significant coal resources that otherwise would have been "sterilized" to be recovered; (2) land reclamation activities to re-contour the disturbed lands, return the topsoil, and revegetate to tie the reclaimed land into the natural conditions; and (3) the integrity of the valley break and slope to be protected. Plans to this end were submitted by the mine and approved by the council.

Reclamation Council inspectors and company personnel closely monitored the field implementation. The end result was that the objectives of the mine operator and the council, as well as the principles of the Land Surface Conservation and Reclamation Act and the Coal Conservation Act were achieved.

This "daylighting" approach was used more extensively, with similar positive effects, in the 1990s south of the Battle River at the Paintearth Mine for operations along the Paintearth coulee.

An example of reclaimed daylighting area along the Paintearth coulee, 2014. Mining operations maximized coal recovery, progressing from the right side of the photo. Excavated materials were then contoured to integrate the mined area with the natural landscape on the right, minimizing the disturbance footprint and conserving native trees and grassland.
Bob Logan

Forestry Concerns

During the 1970s, forestry companies had their own concerns: reclaiming coal mines back to forest lands in mountains and foothills settings. In 1950, R. G. H. Cormack, in a report he wrote for the Department of Lands and Forests, reported that several strip mines in the Coal Branch, Morley, and Crowsnest Pass regions were "blots on the landscape" and that "natural recovery was decidedly unlikely."[44] The attitude continued throughout the 1970s. The director of Alberta Forest Service's Forest Land Use Branch in 1977 concluded, "Much of the reclamation done on forest lands, especially in areas of steep terrain and high elevation, has not been to a satisfactory standard."[45]

The forest industry concerns carried on for many years. Even in areas where timber growing was the prime use of a Forest Management Agreement (FMA) area there were claims that neither the Government of Alberta nor the coal industry had demonstrated that afforestation of a mined area to its natural coniferous species is possible, much less to be capable of sustaining timber growth to natural maturity. The discussion question posed at a 1983 environmental biologist panel was: How can the government justify permitting continuing development of the coal resources of the same area through surface mining without considering its effect on the future timber supply?[46] The forest industry's concerns were unique—they included a much longer time frame than, say, agriculture. J. C. Wright, chief forester for the company holding the Hinton FMA, explained at the panel discussion, "It is not sufficient to merely determine whether or not seedlings will survive on reclaimed mined-over areas. It is necessary to see if these seedlings can still survive and sustain acceptable growth rates once their roots penetrate the top one foot of soil in search of a more permanent water table. Such will not be determined until the trees are at least 20 years old."

Wright was right. It is now seen that mining and forestry have been compatible when it comes to reclamation. Logan observed in recent years that 20- and 30-year-old trees on several blocks of reclaimed land at Coal Valley have been assessed to meet even today's establishment and growth performance standards—standards that have moved from simply establishing trees (to government stocking standards) to measuring establishment and growth performance standards that are the same as the forest industry.[47] A 1985 Coal Association of Canada/RRTAC study and report was a key step in this process.[48] Towards the end of this era the coal industry began working more closely with the forestry industry to coordinate harvest plans and mine development.[49]

A major program initiated in 1983 as part of the reclamation research at Grande Cache compared the growth of conifer species on un-mined (natural) and reconstructed soils. Researchers compared annual tree height measurements in the natural areas, which included regenerating cut-blocks and seedlings in natural stands, with trees planted in the reclaimed areas. Initially, emphasis was on height because the trees were relatively small. Basal diameter measurements began in 1999 and continued annually thereafter. The growth data over a 24-year period indicated that the reconstructed soils supported tree growth equal to or better than achieved on undisturbed soils.[50]

Researchers also completed dendrology (tree ring) measurements on trees from the reclaimed and natural areas and obtained disks from the base and 1.3 metres above the base of the trees in 2004 and 2009. The tree-ring data indicated that the trees from the reclaimed sites were producing about the same amount of fibre on an annual basis as the trees from the natural sites.[51]

Evolving Policy

Growing out of the new 1973 legislation and supported by results of the Environment Conservation Authority hearings, in 1976 the province produced a landmark document entitled A Coal Development Policy for Alberta.[52] This comprehensive policy was designed to strike a balance between resource development and environmental protection, providing broad direction and processes for the coal industry. "The 1973 act blends together with the 1976 coal policy," said Bob Logan. "It defined what that act meant, how it was to be applied to the coal industry. That was by far the largest impact in terms of how mining was done." He believes these two documents stand out as a turning point in the coal mining reclamation industry. "Many of the techniques and procedures that came out of the years following that act are still applied."[53]

Significantly for reclamation, the policy stated, "Detailed exploration and development operations will not be permitted in areas where the environment and plant and wildlife cannot be properly protected and where reclamation of disturbed land is not possible." The onus for the cost of this protection and reclamation was to fall squarely on the shoulders of the developer.

The need to demonstrate potential reclamation success forced cooperation among operators. Companies shared techniques and data for economic reasons as well as the overall good of the industry. "Even though industry was very competitive, that legislation forced us to work together to try and resolve questions," recalled Logan.

Guidelines

Regarding coal mining's compatibility with other land uses, the coal development policy said: "Only where the temporary withdrawal of the land from agricultural, recreational, or other use for coal development is judged to be in the public interest, and where full reclamation is assured, will the Government authorize developments which would cause land disturbance."[54]

The new policy spelled out well-defined goals for coal mine reclamation. It stated that the primary objective is to ensure that the mined or disturbed land will be returned to a state that will support plant and animal life or be otherwise productive or useful to man at least to the degree it was before it was disturbed. There was a proviso, however: "In many instances the land can be reclaimed to make it more productive, useful, or desirable than it was in its original state; every effort will be made towards this end."

The 1973 legislation and the coal policy required operators to file an environmental impact assessment (EIA) as well as acceptable detailed plans for mining and reclamation. The first coal EIA completed under the new legislation was for the Nordegg Coal Mine, on March 6, 1974.[55] The act required a security deposit from coal operators, based on the degree of disturbance and the anticipated quantity of produced coal. The coal policy also outlined the roles of various government agencies in coordinating the applications and reviews of proposed mine development, particularly those of Alberta Environment and the ERCB: an attempt at a "one-window" approach.

The 1976 Coal Development Policy addressed the physical side of reclamation as well. Land reclamation was to include (1) contouring of the mined or disturbed lands; (2) replacement of the topsoil; (3) revegetation for soil stabilization, biological productivity, and appearance; and (4) suitable maintenance of the vegetation or, where appropriate, the conversion of the land to agricultural or other desirable use. Since each reclamation project would be specifically designed to suit the projected use of the land, it was necessary to establish this future use early in the review process. For those lands mined prior to effective reclamation legislation in 1973, the government would "accelerate its current reclamation program with the objective of rendering the lands suitable for further beneficial uses. It will expect the coal industry to assist in this program."[56]

In the public interest, the policy recognized there are areas where mining should be restricted or not permitted. To that end, it classified Alberta into four land categories with respect to coal exploration and development:

- Category 1: No exploration or commercial development permitted.
- Category 2: Where limited exploration was desirable, permitted only under strict control.
- Category 3: Where exploration was desirable but development by surface or underground mining approval subject to proper assurances respecting environmental protection and land reclamation. Significantly, assurance in these cases to be given that the lands would be reclaimed to a level of productivity equal to or greater than what existed prior to mining.
- Category 4: Covered the parts of the province not included in the first three categories; generally exploration and operations would be permitted in these lands.[57]

The policy stated which materials applicants were required to file with the ERCB for a coal development to be considered. They included (1) a detailed technical application under the provisions of the Coal Conservation Act; (2) for major development proposals, a detailed cost-benefit and social impact analysis; (3) an environmental impact assessment under the provisions of the Land Surface Conservation and Reclamation Act; and (4) a Development and Reclamation Plan under the provisions of the same act. For major or environmentally sensitive developments, the ERCB would call a public hearing, where the applicant would have to be prepared to deal with questions and concerns. The Alberta Cabinet would decide whether to grant final approval.

The coal policy was comprehensive and far-reaching, but its provisions and requirements—especially with respect to reclamation—presented new challenges for both industry and government. The guidelines needed clarity of interpretation. "Equal or better" productivity, for example, did not necessarily mean replacing the root zone exactly as it was before mining. Industry wanted the flexibility to prove it could meet the guideline without replacing the root zone in the same order. The government view was that you must at least save the topsoil and restructure the root zone with suitable material. On agricultural land especially, the inputs required to produce a crop should be the same following complete reclamation as they were before mining.[58] This was a precursor to the concept of land capability as opposed to land productivity as a target.

Granting approvals before the most suitable reclamation procedures were known with certainty required that companies conduct on-site field trials during the early stages of mining. In many cases, sufficiently advanced research did not exist until years later. Despite this, operators had to ensure the surface and internal drainage, the root zone, and the revegetation were as good as or better than prior to disturbance. The government's interpretation of reclamation was that it primarily dealt with the soil profile and the overburden; the treatment of these materials following reclamation could vary according to use but should always endeavour to achieve as good a growth medium as there was before.[59] According to Ted Davy, executive assistant to the president of the Coal Association of Canada in 1979, industry advocated government leaving judgment of methodology to the mine operator, as long as the reclamation objectives were achieved.[60]

In 1977, the Reclamation Council issued Reclamation Guidelines, rather than enacting regulations. The council's view was that "regulations at this point in time would be too inflexible for satisfactory application and that more flexible guidelines would be more applicable." The coal industry appreciated this approach as it addressed the evolving nature of reclamation technology.[61]

To obtain a Development and Reclamation Approval coal mines were now required to submit detailed reclamation plans. The guidelines outlined seven components normally required in a reclamation plan:

1. site analysis and post-disturbance land use determination
2. a surface hydrology analysis
3. overburden analysis
4. mining plan analysis
5. a post mining land-use plan
6. a materials handling plan
7. a revegetation plan

In appropriate situations, additional reports on soils, groundwater, and geotechnical conditions could be required.

This information was to be prepared by appropriately qualified professionals.[62]

The implications of these new requirements were immediate and serious. One example arises from the 1978 public hearing for the Paintearth Mine application, proposed for the Battle River coalfield by the Luscar group.[63] There was considerable uncertainty as to whether the Torlea soils could be reclaimed. The company planned operations in these soil areas using existing mining equipment. Demonstration plots and a major research program were to be initiated immediately. But Logan recalled it was not known if reclamation of these soils could be assured in time, so the company revised its mining plans away from these areas. This change was expensive: the new starting area had deeper overburden and required a new, multi-million-dollar dragline.

Cattle graze on reclaimed grasslands at the Paintearth Mine (formerly Sherritt Coal, now Westmoreland Coal) in the Battle River coalfield, 2014. Since landmark legislation and policy in the 1970s, large landscapes in the Alberta plains region have been mined and reclaimed to productive use following coal extraction for electrical generation. *Bob Logan*

Reclamation Research

In 1978, the government established the Reclamation Research Technical Advisory Committee (RRTAC) to address research shortcomings and aid in policy development and implementation (see Chapter 4). Industry played a role, too. Representatives participated on various research steering groups.

The Dodds-Roundhill decision had, in large part, prompted the formation of RRTAC, so its research initially focused mainly on plains coal-mining issues. The committee invested in three major projects: the Battle River Reclamation Research Project (BRRRP), Plains Hydrology and Reclamation Project (PHRP), and Highvale Soil Reconstruction Project (HSRP), as well as numerous smaller projects, to determine a regulatory framework that was both environmentally and economically responsible. Over the ensuing two decades, many successful research projects addressed the earlier questions. Results were published in 36 RRTAC reports[64] and scientific papers.[65]

For plains coal, these reports generally focused on salinity, groundwater, and soil characterization issues. PHRP, for example, was needed to critically examine what happens to aquifers after the coal has been mined out. Because the aquifer would have been in the coal seam and the sandstone above it, the remaining material would weather, and most of the water supply would come from rainfall or seepage from below; this often resulted in poorly watered soils. "That was when people could effectively say you're not going to be able to re-establish an aquifer in mine spoil that's equivalent to what was there before mining," said Terry Macyk.[66]

Many research projects, like the PHRP, were expensive. The project included a groundwater hydrology component, and a geological component examined weathering and differential subsidence. The studies also needed lengthy time horizons to generate useable data. "After you replace it, you need time to let the system re-establish or come to some little bit of equilibrium and its new state," said Macyk, who managed the soils component of the Alberta Research Council's involvement in the project. "You have some pretty good ideas in three or four or five years, and you could go on forever but that's not realistic either. The key thing is you need more than a year or two." How the site is managed afterwards is also critical, he said.

Results from the initial research studies assisted in developing a scientific technical manual for reclamation of all types of land disturbances. The process was initiated in 1977 by a subcommittee of the Alberta Soils Committee. The acceptance and adoption of *Soil Quality Criteria for Disturbance and Reclamation* provided a universal approach to measuring the suitability of undisturbed and reconstructed soils.[67]

In foothill and mountain mines, research concentrated more on wildlife habitat, erosion, and ways of encouraging tree growth. Researchers included university scientists, reclamation consultants, and Alberta Research Council staff. The Coal Association of Canada funded some of the collaborative research, with industry providing access to sites and representatives participating on steering committees. Regular workshops gathered experts together to present papers and hold informal discussions.

Building an experimental research database could not be hurried. Research topics had to be prioritized. Ten years after passage of the 1973 Land Surface Conservation and Reclamation Act, industry was still calling for more clarity on certain aspects. Generally, industry thought it was a good piece of legislation—particularly well regarded was the act's provision for the Land Conservation and Reclamation Council to include local field experts to act as eyes and ears at the mine site.[68] However, problems persisted. For example, there were too many definitions for the potential of land after reclamation: "productive," "useful to man," "desirable," and "capable." Standards defining acceptable quality of soil were sometimes changed late in the approval stage after considerable time and funds had been spent on soil surveys and cost estimates.[69]

Assessing End Use

Operators were also finding the 1977 Reclamation Guidelines inadequate.[70] Toward the 1980s, reclamation was undergoing a technical revolution, and there was a better understanding of the costs involved. For example, a universal requirement for slopes of 10 per cent or less in the plains would often ignore the potential benefits of steeper slopes: as slope angle decreases, more earthmoving is needed and is thus costlier. Soil handling, specific to individual sites, was becoming a significant, integrated part and cost of coal mining on agricultural lands in Alberta.[71] Moreover, operators said that requirements for a reclamation certificate remained something of a mystery. Many of them still asked the key question: If all the conditions of the approval have been met, is the certificate granted, or are there further unwritten conditions that must be met?

Doug Beddome, an Edson-based reclamation officer of the Land Conservation and Reclamation Council, explained that the mountains and foothills regions pose operational difficulties that have a direct impact on the final product. "In many instances, the accepted final reclamation may be completely different to what was there in the beginning," he told the 1985 Alberta Reclamation Conference.[72] "The basis

of mining, open pit versus strip, creates hills out of flat land and lakes out of hills. The blending in of these 'new features' to the surrounding terrain and having something that is useful, even if the end use will be different than the original, is one of the challenges. The altitude and climate play a large role in the availability of topsoil for salvage and plant growth and vigour due to the short growing season." He said that these factors are accepted, dealt with, and overcome with minimal impact noted to date on the reclamation of the area. Open pit mountain operations have the ability to most drastically change the landscape, he said, whereas strip mining in the foothills lends itself well to being re-contoured to match the surrounding terrain.

Coal Valley Mine before (below) and after. In March 1985, a dragline was uncovering coal at this site in the foothills south of Edson. Twenty-eight years later, in July 2013, a pine forest surrounds the shoreline of the lake in the reclaimed mine pit. *Curtis Brinker*

Operations in the foothills and mountains had different reclamation challenges from the plains. In the Green Area, which consists of non-settled forest lands of the province, the Alberta Forest Service (AFS) was charged with ensuring a sustained yield of forest products and benefits while maintaining a forest environment of high quality.[73] This meant mine operators needed to coordinate planning and reclamation with AFS, which in 1985 was in the process of looking at ways of accurately assessing sites to support forest growth. It was important that decisions be made on land allocation for commercial timber production against other uses such as agriculture or wildlife habitat. Operators and regulators had to ensure that timber and topsoil were salvaged, erosion was controlled, and reclamation proceeded on schedule. Generally, those lands AFS considered productive had to be reforested to the same percentage as existed prior to mining disturbance.

The Coal Valley Mine (80 kilometres southwest of Edson at about 1,400 metres elevation) approved in 1976, was the first Alberta mine with a prescribed post-disturbance, forest end-land use. As a result it was an early pathfinder. Techniques for reforestation of forestry cut-blocks were tried and true, but because initial site conditions on newly reclaimed land differ from those on cut-blocks—no vegetation, for example—it was necessary to modify standard reforestation operations.[74] That might present a challenge: when reclamation regulations in Alberta were being developed in the early 1970s, it was unclear whether trees could even establish on mined lands. The Coal Valley

Rocky Mountain bighorn sheep at Teck's Cardinal River Operation's Luscar Mine, 2014. Opportunities to enhance or create new wildlife habitat are considered as part of the coal mine development review and approval process. *Bob Logan*

prototype reclamation efforts proved otherwise. The trials showed that although further research was needed, success is attained primarily by minimizing stress to establishing seedlings and providing adequate time for rooting in the first growing season. Several recommendations that came out of the trials would enhance the initial success.[75]

However, forestry was not always the preferred and practical end use at the mountains sites, as Cardinal River Coals Ltd. determined in the late 1970s.[76] Although its proximity to the mining area brought pressure from the forest products industry to reclaim to commercial forest standards, the altitude of the mine (1,650 to 1,830 metres) made that end use unrealistic—harvest rotation periods would have been over 100 years. Adjacent mountain ranges had been classified as critical winter range for Rocky Mountain bighorn sheep, and biologists saw an opportunity to dramatically increase wildlife potential of the area through a reclamation program. Also, on a site-specific basis, planners determined it would be possible to form a stream-fed lake with sport fishing potential.[77]

Wildlife habitat and recreational end uses dictated a different approach to soil salvage. Topsoil and regolith (a lower quality material mined from the upper benches of each pit and typically high in coarse content) was removed and stockpiled. During mining operations, overburden was dumped at the natural angle of repose (37°) and re-sloped by bulldozers to 27° as required by regulations. (RRTAC carried out some studies on waste dump erosion at different angles.[78]) Following mining activities, the re-contoured overburden was spread first with the regolith then the topsoil in patches or "islands." Revegetation followed immediately. This "topsoil island concept" meant reforestation could be isolated to moist low-lying sites, where it is most likely to succeed. Such terrain is consistent with preferred wildlife travel corridors between natural forest lands. The formula for island spacing was drawn from a US study.[79] By 1982, success had been noted: a constant increase in the resident Rocky Mountain bighorn sheep herd, but Gerry Acott, then Cardinal River Coals' environmental supervisor, recommended continued monitoring.[80]

Predicting Outcomes

By the mid-1980s, a serious technical gap remained between reclamation planning and approval requirements, largely due to lack of research data. This shortage hindered the goal of both government and operators: basing reclamation approvals on detailed plans and then basing eventual certification on whether the plans had been properly implemented.[81] The key to making this work was an adequate database that could successfully predict how a given reclamation technique will perform.

The Alberta government and industry had recognized this research need when the 1973 act was proclaimed. Shortly afterwards they took steps to acquire a strong technical information base to identify reclamation techniques that all parties felt would meet provincial objectives at minimum cost—the aforementioned RRTAC. For plains coal operations these would fall into three main categories: soil reconstruction, landscaping, and revegetation.[82]

There was also a need to better understand the issues and the technical language of reclamation, of mining, and of the science being used by both government and industry. Co-operative research programs like RRTAC provided a forum where this could and did happen. For example, mining engineers learned about environmental science approaches, while regulators learned about the realities of mining operations. The collaborative research programs built dialogue as people learned together to generate practical solutions.

Soil reconstruction was a major factor when evaluating reclamation certification; particularly challenging was development of the soil reconstruction plan—which is where pre-mining soil conditions are matched to reconstructed soil profiles. The largest problem here was the unavoidable mixing that occurs as soil horizons are removed and replaced. Due to varying thicknesses, perfect separation of horizons is virtually impossible. Hence reconstructed soils and subsoils will necessarily be different from their unmined structure. Moreover, moving unnecessary volumes of soil is expensive; it is difficult to adequately upgrade poorly reconstructed soils; and the need remained to define the relationship between soil reconstruction techniques and crop productivity. So the ultimate focus was to restore not what was originally growing on the land but rather its capability to support an intended end land use. A 1983 presentation by Larry Brocke (then chair of the Development and Reclamation Review Committee of Alberta Environment) to the Canadian Land Reclamation Association summarized the new direction.[83]

The Plains Coal Reclamation Research Program (PCRRP), managed by RRTAC and industry, launched two main projects to develop a picture of how mined landscapes work and how they can be designed to ensure the return of their original values. One was the Plains Soil Reconstruction Project (PSRP), to reveal how to rebuild agricultural soils after mining, and the other, the PHRP—mentioned earlier—to describe what happens to groundwater during mining and after reclamation and how to rebuild the landscape to maximize agricultural potential.[84] The project, designed for five or more years of data gathering, began at Battle River in 1979 and subsequently at Highvale.

The government-industry participation in the plains research was unprecedented, and industry hoped results would bring better understanding to the issues and settle disagreements over what depths of subsoil and topsoil were needed to ensure required productivity on reclaimed lands. TransAlta Utilities Corporation, for example, contended that 1 metre was adequate, but the government at the time recommended 3 metres if that depth was present before mining.[85]

On a series of soil reclamation plots at the two locations, test treatments included depth of subsoil (0 to 3 metre thicknesses) over sodic soil, use of bottom ash* as an impediment to upward salt migration, use of coal ash and gypsum as soil amendments, and reconstruction of solonetzic topsoils using different horizons and mixtures. Researchers also investigated lateral salt migration.

Studies compared the first few years' post-reclamation yields with five-year average yields within the same counties. A 1986 report showed mixed but generally positive results: at Battle River, grain yields were well below those averages, but forage yields in the experiments were nearly double those of local solonetzic soils. Bottom ash incorporation in the reconstructed soil had a strong positive effect after just two years.[86] Grain yields at the Highvale plots showed increases with up to 1 metre of subsoil. Researchers concluded, not surprisingly, that crop yields are a function of soil treatment method, and that manipulation of material selection and quantities in soil reconstruction will allow mine planners and regulatory staff to establish a wide range of agricultural capabilities, with much less soil required than the original 3-metre target. It was a big step towards shortening the certification period and added appreciable objectivity to the certification process.

Cost of Reclamation

Meanwhile, the Environment Council of Alberta voiced concerns about the size of areas being disturbed by surface coal mining in the agricultural lands of the plains region. In 1982 about 3,150 hectares had been disturbed, most of it good agricultural land, and the council reckoned coal mining could eventually affect 155,400 hectares.[87] The council said that full reclamation of mined lands is difficult because strip mining reduces the capacity of soils to accumulate water and reclamation is more difficult when spoil materials

* Residue from coal combustion.

containing salts end up near the soil surface after the mine pits have been refilled. The council said in 1982 that reclamation was costly, but the heavy costs of mine reclamation could easily be covered by relatively small increases in the cost of electricity.[88]

The costs included the rebuilding of soil in the reclamation process, especially where saline soils are being placed near the soil surface. Also, the act of carefully removing each soil layer prior to mining and replacing it in exactly the same order after the coal has been extracted adds considerable expense.[89] The more often materials must be handled, the greater the cost—in 1982 a range of $1,000 to $22,000 per acre was cited at various mining sites in the United States and Canada. However, the council deemed it worthwhile: at an average cost of $3,700 per acre estimated for Alberta mines, the average domestic electricity consumer would pay an extra $2.00 per year and the average industrial user, $44.30.[90] The Coal Mining Research Centre undertook engineering and cost studies of the technical feasibility and comparative costs of six different methods of soil handling.[91] It would help determine the most economical methods consistent with the regulations.

Philosophical Change

In the 1980s, government and operators were encouraged by the progress in research and development. New ideas, such as regulating reclamation requirements through a "land capability" approach, emerged through collaboration and experience. Solutions like end-pit lakes and more wildlife end-land uses became more common, along with advanced research in areas such as native plant species.

By 1983, it was obvious that government needed a new philosophy for reclamation. As head of the Development and Reclamation Review Committee, Larry Brocke presented a summary of this need for a new direction, partly in response to coal and other mining industry concerns.[92] The committee members visited several field operations, but it was not a formal field program. One major industry concern addressed was the aforementioned "3-metre dilemma" for subsoil replacement at plains mines. The process demonstrated the benefit of adopting "land capability" as a method of measuring reclamation rather than productivity and land use. The concept had been around since the 1960s,[93] i.e., that the goal of reclamation should be to minimize the effect of the surface disturbance and to assure the re-establishment of "equivalent land capability." This provides more flexibility in reclamation planning.

It was a genuine turning point for all players. Continued close dialogue between industry and government was key to working the new definition into the Development and Reclamation approvals process for coal mines. Eventually, it would be incorporated into legislation and regulations introduced in the early 1990s. The shift demonstrated that the cost of assuring that the land could support various land uses after reclamation is to be borne as a capital investment in the land rather than an operating cost by the end land user.[94]

End-Pit Lakes

An example of the need for a new approach to equivalent or better land capabilities was the creation of "end-pit lakes." The reclamation technique in common use for surface coal mining was (and is) to move topsoil, subsoil, and overburden from one pit to the next in sequence as coal is mined, working its way along the permit landscape. When the last pit is depleted of coal, it is usually not cost-effective to then truck the soils and spoil the entire distance from the first pit to the last. From an operator perspective, a better idea—particularly in the larger mines where these distances were great—became to construct a lake at this "end cut."

TransAlta Utilities constructed one of the first end-pit lakes at the Whitewood Mine, which supplied three coal-fired generating plants adjacent to Wabamun Lake, 80 kilometres west of Edmonton. The mine opened in 1962, and by 1982 the last coal had been removed from the east end of the mining area, leaving an open pit 100 metres wide by 800 metres long. As a condition of approval to drain two existing lakes to recover the coal, the operator was required to develop a replacement lake.[95] This end pit became that lake; it had been determined early in the approval process to have potential uses as recreational fishing, beach area, picnic area, camping, and nature viewing. It was a model of cooperative effort. The design and construction involved the provincial departments of Forestry, Lands and Wildlife; Recreation and Parks; Environment; the County of Parkland; and the company.

"Whitewood Lake [one of those drained] had been used by the Edmonton Water-skiers' Association for competitions and practice, and TransAlta let them use it," recalled John Railton, who worked the project for TransAlta.

> Then as we got closer to it, we had to remove it. So, we went through all sorts of studies to find out: Does it leak water? Doesn't it leak water? How old is the water? We ended up opening up another pit in the Whitewood Mine, which was over near some gravel pits. So I started talking to a number of the consultants I was working with trying to figure out how to go forward. Then we came up with this idea of taking the end-cut lake, putting in some [safety] benches and putting in some shallow areas, planting some Typha and things like that. So we had a lake where the fish could spawn and the young could hide and not be eaten too soon.[96]

The Stony Plain Fish & Game Association eventually took over management of the newly created East Pit Lake. "People are catching trout out of it now," said Railton. "It became a functional lake."

Wildlife Habitat

The mountain regions also revealed unexpected bonuses. Cardinal River Coal Ltd.'s successful development of wildlife habitat as a land end use prompted a wildlife study in response to the voluntary occupation of its surface lease by bighorn sheep.[97] Initially, the high, steep post-mining rock faces that could not be reclaimed were not part of the study, but the bighorn sheep became attracted to them even during active mining operations. It was not until the animal and its requirements were studied against the backdrop of an operating coal mine that obvious recommendations regarding the maintenance and placement of high steep excavated rock faces adjacent to "foraging areas" were made and accepted by the Alberta government. It was truly a "design with nature" concept.* Steep, tall rock walls—man-made or natural—are vital to the security strategies of the sheep, providing escape terrain. The exposed mineral seeps also provide vital metabolic salt. The study showed lamb production and survival rates were high.[98] The success of this approach was demonstrated by the export of sheep to the United States for "reintroduction" or "recovery" programs in western states.

East Pit Lake at TransAlta's Whitewood Mine, 2014. Developing recreational areas and wildlife habitat are opportunities commonly granted by coal mine development and reclamation plans. *Bob Logan*

* The "design with nature" concept was initially described by Ian L. McHarg and Lewis Mumford in *Design with Nature* (New York: American Museum of Natural History, 1969). McHarg developed not only a cosmology and an ethic that supported the idea of humankind as stewards of the biosphere, but also applied a practical technique for landscape planning.

Wildlife habitat is created at mountain coal mines. Reclamation plans in this setting include the provision of key habitat features for Rocky Mountain bighorn sheep: escape terrain (such as mine highwalls and rock dumps) adjacent to open grazing areas; thereby establishing the two basic components of bighorn sheep habitat. *Bob Logan*

Reclamation Matures

The Environmental Protection and Enhancement Act (EPEA) came into force September 1, 1993. It governed reclamation activities for all non-renewable resource development. In 2014, operational responsibility for such activities transferred from Alberta Environment to the new Alberta Energy Regulator, successor to the ERCB. By the early 1990s, basic reclamation methods were becoming more set and routine. Research had been advancing handily with most high priority goals accomplished. The government's role in research was decreasing as it and operators got better at reclamation. Landform requirements, soil handling, and revegetation practices had become integrated and accepted parts of mining operations. Refinements were now taking place, and ecosystem approaches being introduced. However, some difficulties remained.

In the foothills and mountain regions, a lingering problem had been finding ways of coaxing vegetation growth to a point where it could be self-sustaining before heavy rains or harsh climates beat it back. Especially on some of the steeper slopes, operators were pushing topsoil down the slope, which had not been particularly effective. It resulted in a relatively uniform, and somewhat compacted soil cover. Reclamation practitioners believed that a rougher surface would provide diversity, with forest soil organics and even salvaged tree roots and limbs included, allowing for improved microsites for various seeded and planted species. While the immediate product would not be as trim or clean looking, it would offer greater opportunity for reaching ecologically sound reclamation goals.

Len Leskiw, a long-time soils consultant active in coal mine reclamation, recalled the discovery of a solution at the Cardinal River Luscar Mine in the early 1990s; "rough mounding" has been adopted to this day. He recalled a bulldozer operator trying something new: starting at the bottom of the graded slope and backing up the slope in steps. It created a different pattern. In each step, he said, the operator "just dropped the blade, pushed a few metres, backed up onto the smooth ground, dropped the blade, pushed a few more metres. You ended up with mounds about the size of a blade, about a foot to two feet deep or high, trough to crest. And they're about two to three metres apart."[99]

The resulting mounded slope worked much better than the smoothly graded, compacted one. The soil was fluffed up, allowing water to penetrate and stay in place more effectively. The technique provided numerous microsites suitable for different types of vegetation to establish themselves. "In time, as the vegetation in the trough dips takes off and grows up high enough, it stops the wind and traps snow and so on," Leskiw said. "And then on the little crests, plants can get started there." Background and detailed procedures were presented at the 2011 Mine Closure Conference of the British Columbia Mine Reclamation Symposium.[100] Cardinal River operations, now owned by Teck Coal, uses the technique today at its Cheviot Mine and has taken it a step further to promote native plant re-establishment.* While totally logical, this type of creative engineering plays havoc with a regulatory system based on uniform soil placement rules and requires a different (and more complex) mechanism for describing soil placement requirements (averages with possibly a minimum) and of verifying compliance.

Rough mounded and revegetated rock dumps at Teck's Cardinal River Operations. This refinement to the reclamation process reduces compaction and erosion as well as providing microsites for vegetation establishment. *Bob Logan*

Answering Questions

In 1994, research funding provided by the Heritage Savings Trust Fund for Alberta's Reclamation Research Program, established in 1978, came to an end.[101] Carried out in consultation and collaboration with the coal industry, the program had guided research into coal reclamation, addressing the questions posed earlier. Results for the plains region were presented in a comprehensive 1996 PHRP summary document prepared by RRTAC in the form of answers to questions surrounding reclamation research, encompassing both the land resource and the groundwater resource.[102] The value of the research programs was not just in the resulting products, but also in how the process grew understanding all around: shared ideas, joint solutions, and understanding of issues, limitations, and needs.

The 1996 report offered definitive answers to most concerns but left some uncertainties and lack of consensus in a number of key areas. It summed up much of the extensive research undertaken since the 1970s. As such, it is a guide and sourcebook for anyone involved with or interested in coal mining land reclamation. It began by clarifying the meaning of "land capability" and "equivalent land capability" as defined in the Environmental Protection and Enhancement Act of 1993 and the accompanying Conservation and Reclamation Regulation (AR 115/93) and how capability differs from "productivity," which had been a source of confusion. As well, the report explained how capability is measured, in terms of three methods: Land Capability Classification for Arable Agriculture,[103] Agricultural Capability for Reclamation,[104] and Soil Quality Criteria.[105] Capability embraced a holistic ranking of soil, landscape, and climate factors. The plains coal land capability system was exported to the oil sands, resulting in the Land Capability Classification for Forested Lands.

Highlights included the question: Can reclaimed landscapes in plains coal mines support the same range of land use as the pre-mining landscape? The answer: "Research and operational experience has shown that in the majority of situations, reclaimed landscapes can support the same/similar land use as that which existed prior to mining," with an important note that time is probably the most important factor in evaluating the impact of land disturbances.[106]

* Syncrude Canada Ltd. tested a similar method on its Mildred Lake oil sands mine.

(Above) Reclaimed landscape at the Gregg River Mine south of Hinton. Minimizing the mine disturbance footprint to retain mature forest cover for wildlife habitat and movement became an important conservation consideration in mine planning. *Bob Logan*

An important step to decreasing the disturbance footprint is to sequence development to maximize the backfill of existing pits thereby reducing the size of external rock dumps. Here, backfill of a mined-out pit at Teck's Cheviot Mine nears completion and awaits landform grading, soil replacement, and revegetation activities. *Bob Logan*

In a similar manner, research data were summarized for foothills and mountain settings. The long-term research project conducted for the Grand Cache mine operators by the Alberta Research Council, started in 1972 when reclamation research in Alberta was in its infancy, was summarized 23 years later.[107] The project took place continuously over a 40-year period at the Grand Cache area mine in conjunction with McIntyre Porcupine Mines, Smoky River Coal, and Grande Cache Coal Corporation Ltd. It produced a wealth of valuable data. Erosion control was one of the initial considerations along with the re-establishment of forest cover with some capability for wildlife. The studies placed importance on achieving a self-sustaining cover of grass and legume species. Field observations in early stages indicated that native species were encroaching into the disturbed areas where a grass/legume cover had been established. The presence of native species was attributed to the germination of seed and sprouting of vegetative material present in the replaced soil cap and dispersion of seed by wind and animals.

A comprehensive assessment of the herbaceous cover completed in 2006 demonstrated the "succession" from the initial introduced species cover to a cover with a broad range of indigenous species similar to the adjacent undisturbed area. The program also went a long way in demonstrating that trees and shrubs can be established in surface mined areas in the subalpine region, even under severe climatic conditions such as high winds, extreme temperature fluctuations, and loss of snow cover during the winter. Tree growth data collected over a 35-year period indicated that the reconstructed soils support tree growth that is equal to or better than that achieved in the adjacent undisturbed areas.[108]

Monitoring End Use

The process of designing a reclamation plan for the mountain coal mining area with wildlife habitat as the primary end land use had matured by the early 2000s. Ever since the success of the Cardinal River Coals project of the late 1970s, wildlife habitat was accepted as an end land-use reclamation objective for open-pit coal mines in the mountains. Adjacent to Cardinal River's Luscar Mine is the Gregg River Mine and Teck's Cheviot Mine—both were approved for wildlife habitat as one of their end land uses. As results were monitored over time, best practices evolved.

Reclamation planning initially gave priority to re-establishing critical habitat such as ungulate winter range or raptor nesting habitat. These were addressed by the use of "umbrella species." "Ungulates are often identified as umbrella species because their habitat will cover off a lot of habitat for other species," wildlife biologist Beth MacCallum said.[109] Ungulates are "prey for the large predators. Their habitat requirements force the [reclamation] planner to work at a landscape level because they need a variety of vegetation; [and] a variety of topographic features so they automatically force you to look at a larger area rather than wildlife [types] that its life requirements may be filled in one habitat, like certain birds or whatever." Moreover, because ungulates respond quickly to reclamation, the umbrella species can serve as a useful monitoring tool.

In wildlife-oriented reclamation planning in the mountains region, operators and regulators recognized the importance of maintaining mature landscape elements within mining disturbance areas.[110] Mature forest cover plays an important habitat role and takes decades to re-establish due to the slow growth rates at higher elevations. Mine planning to minimize the disturbance footprint became an important consideration, involving conserving forest cover for wildlife movement and habitat,[111] and reducing external rock dumping by maximizing pit backfill.

With landform, soil replacement, and initial vegetation completed, reclaimed coal mine landscapes are monitored for a variety of factors. These may include vegetation performance such as tree growth and ecological conditions like biodiversity, along with forage value and surveys of wildlife usage patterns for a range of indicator species. Reports are prepared and reviewed with government agencies and support reclamation certification applications. These programs help manage the reclaimed lands and direct furture plans to achieve desired goals, including the re-introduction of human use to the areas—be it recreation, forestry, or others. *Bob Logan*

The Culmination of Reclamation's First Half Century

The five decades leading up to 2013 built a comprehensive base of information and knowledge, experimental results, and development of reclamation techniques from scratch. The period's fifth decade saw further evolution of technical development in soil salvage, adaptive management, and post-certificate land management. A solid means of measuring success was still needed. Some longer-term studies helped, but a definitive answer to this question remained evasive.

"Somewhere along the line somebody has to make a decision that reclamation is successful so that you can do certification," said Terry Macyk. It requires more than simply the passage of time.

> You have to look at what parameters you want to measure to determine that indeed you met that success. If you're going to use soil parameters—which is a very critical one—you need to look at your reconstructed, reclaimed soil. If you know you've put the right depths back and you've got the right chemistry, and you look, for example, at moisture regime and density and these kind of parameters, which we studied for many years, if you know you've achieved similarity then you've successfully reclaimed.

Judging success in the boreal forest means a lot of different things, according to Macyk. "The kind of ground cover you have with the different shrubs and tree species is one, but if you look just simply at trees, it takes about 75 years to grow a tree from a seedling stage to what you would harvest. You can't wait that long, so what you have to do is look at how that tree is performing and make a prediction."[112]

In the mountains mining region, gauging success requires targets be set for returning ecosystem structure and function. The return of commercial forest productivity is one. Current standards for the forestry industry apply to coal mines—including not just the establishment of seedlings, but also growth performance standards.[113] Another indication of reclamation success in the mountain regions is if wildlife recolonize, forage, rest, reproduce, and survive on reclaimed areas.[114] To this end, from 2008 to 2010, a team of university, government, and industry researchers captured and collared 12 adult grizzly bears in the Cheviot, Luscar, and Gregg River coal mine areas and tracked their movements. The study found the bears did indeed make themselves at home: bears selected reclaimed mines and areas near mines extensively in late spring and early summer to forage on vegetation sown as part of mine reclamation and to depredate ungulate calves and lambs. In the fall, bears moved primarily outside the mine areas to forage on berries. They often bedded in dense tree cover, demonstrating the importance of maintaining some forest patches undisturbed during active mining. The study also showed that the bears tended to avoid active mining zones at sites such as the Cheviot Mine—safe behaviour for both the bears and humans.[115]

As well as wildlife, return of vegetation biodiversity was emerging as an important goal, too. One important study in 2010 at the Coal Valley Mine showed that even 20 years after seeding with both agronomic and native species, that goal was not yet fully met.[116] The report recommended continued monitoring.

Experience over the decades showed that each mountain/foothills mine is unique and needs particular reclamation tailoring. At Teck Resources, for example, the company's reclamation team has developed unique soil salvage and placement techniques at its Cardinal River Operations Cheviot Mine, in operation since 2004.[117] This is a good example of how evolving requirements have driven reclamation practices. In 1969 when its Luscar Mine opened, reclamation objectives focused on erosion control and wildlife habitat: typically aggressive agronomic seeding and fertilizer application after stabilizing slopes. Soil conservation did not become a practice there until the mid-1980s when establishment of forest cover became a requirement.

By 2004, when the Cheviot Mine opened, it had 10 years of assessment and regulatory/stakeholder review behind it, substantially more than had the earlier Luscar Mine.[118] By then, reclamation objectives had grown to include forest re-establishment, watershed protection, wildlife habitat, fisheries habitat, biodiversity, and recreational use within the rubric of equivalent land capability. Soil management is a fundamental part of achieving those. Soils handling has thus evolved considerably over one operation's four decades of mine reclamation.

A paper presented at a 2011 reclamation symposium reviewed how the company's evolution encapsulated some key aspects of reclamation. In the early stages at the Luscar Mine, soil management was simply the re-sloping of waste rock materials to a stable angle, followed by quickly establishing vegetation to minimize erosion, stabilize slopes, and provide forage for wildlife. In the 1980s when soil conservation became an operational practice, salvage operations were conducted by first piling and burning all of the vegetation, followed by stripping the soil horizons and stockpiling the material for later replacement. Replacement was by the standard "dump and level" method using bulldozers or scrapers for a uniform and smooth surface layer. The method accommodated establishment of agronomic grasses and legumes but challenges with compaction and uniformity inhibited establishment of trees, shrubs, and other native plant species.[119]

Reclamation often involves up to three separate "lifts" where possible: topsoil, subsoil, and overburden in order to save it for replacement in its original order. Following assessment of overburden in the Cheviot area as a suitable root zone material, coversoil salvage evolved into a single-lift operation to recover all salvageable suitable soil materials prior to mining disturbance. As trees in the subalpine area are generally too small to salvage commercially, they are cut into small sections and salvaged with the soil.

The single-lift operation, different from the two- or three-lift methods employed on plains mines, works well in the foothills. The soil is loaded onto trucks and either hauled to a stockpiling site or, if pit sequencing allows, directly placed at its destination site. Len Leskiw notes, "I think one of the keys for that [single-lift recovery] working so well is that, in a lot of the kind of natural seepage areas, lower slopes, even the valleys, you have some organic soils or peaty, gleysolic, wetland soils and that extra organic matter in there all gets incorporated in the mix. So this final soil has 3 to 4 per cent organic carbon, which is really quite a decent growing medium."[120] While adding such debris to the surface soil may not be aesthetically pleasing, the microsites created promote a more natural, diverse reclaimed site.

Organic material in the mixed soil makes a big difference according to Leskiw. "I think the organics are the secret to making it work. If it didn't have the organic I think there'd be a lot more difficulty because there would be more erosion, runoff, and so on. The organic is high enough to give it a nice structure, to be a good rooting medium, and then with the organics you get some decomposition and nutrient release and so on. So it's a good functioning system." Leskiw said that because of the topography, "it would be really difficult to do a two-lift and be effective. And so they started with one and it's been working well and they haven't changed."

In placing the soil while minimizing the problems of compaction and uniformity, the company continues to employ the "rough mounding" method described earlier. The mound configuration practice has evolved over the years and has proven effective in providing abundant micro-relief to offer shelter and moisture retention for re-establishing vegetation while avoiding soil compaction.[121]

At the Grande Cache operations the depth of salvageable soil was generally the depth to bedrock, which varied considerably over short distances. Because the surface or organo-mineral horizons were minimal or nonexistent and the upper levels of the soil profile were quite variable in thickness, segregation or selective handling of soil material was not considered. The soil material was removed as a single lift and subsequently replaced following site grading.[122]

Teck's Cardinal River Operations reclamation research continues to refine techniques. One site, near the Cheviot pit, was rough-mounded in 2007 and then tree seedlings were planted, without any associated application of seed (agronomic or native). The objective was to reduce plant competition with tree plantings—it provides a chance for the trees to get established without grasses and shrubs blocking sunlight and soaking up moisture. Similar to Leskiw's single-lift explanation above, "there was enough seed in the original topsoil," explained reclamation scientist Marc Symbaluk, who leads the company's reclamation operations at the mine.[123]

Adaptive Management

The direct tree-planting trial typifies an approach known as adaptive management informed by applied research. (It is a more focused and effective form of "trial and error.") The trial followed a previous seeding effort where faster-growing agronomic grass and legume species effectively crowded out the naturally growing tree seedlings. "There was rough mounding there, but they were still using the seed mix that included red fescue, alfalfa, and alsike clover," recalled Curtis Brinker, a registered professional forester and also a consultant to the project. "And, so even with the rough mounding, the grass and legumes came in so thick that it just overcame, overwhelmed the tree seedlings. So, you had great soil but the vegetation competition was too much for them. Again, it's not a research thing but you just start seeing enough sites over a period of years and some guys have set up demonstration plots where they've recorded exactly what's happened. So, you start to think you're piecing things together."[124]

On a bright July afternoon, Marc Symbaluk, Teck's environment superintendent (right), and guests stand on top of a small hill at the Cheviot Mine where direct soil replacement with tree planting, but no forage seeding, so far has been deemed highly successful. Native flowers, grasses, and shrubs abound; young pine trees flourish; and bumblebees buzz around them as they study a flat spot where an ungulate had been resting—all evidence of effective reclamation. *Graham Chandler*

Bob Logan noted the significant evolution in data from the 1970s into the late 1990s as he worked with Brinker on the Cheviot Mine plan. "In the '70s we were scrambling to find information. You would use regional soils and groundwater reports," he said. "By the time you're into the late '80s and certainly by the late '90s you're doing detailed surveys yourself. You're doing the groundwater studies, all that kind of information, as a company. You're collecting that and an even broader team of experts to help you pull together a plan."[125] Meanwhile, Logan noted, the reclamation goals shifted—from simply making it "green" and controlling erosion, to re-establishing biodiversity and ecological processes. At the same time, as mining areas expanded, a broad variety of public interest groups were asking for access to the reclaimed area, particularly in the

Decades of coal mining and effective land reclamation have produced expansive landscapes with unique land management needs. In the case of the Gregg River and Luscar Mines south of Hinton, government, industry, and public stakeholders have come together to prioritize goals and objectives by which the government will manage the public lands upon completion of mining. *Bob Logan* mountain and foothill region—generally for the pursuit of a range of recreational activities from hiking and hunting to fishing and off-highway vehicle use.

The decade also saw increased challenges in managing multiple end land uses in mountains and foothills settings. Conflicting land-use goals confounded the planning process. With the Cheviot Mine, for example, three overarching end land-use goals dominated the planning debate: maintaining and enhancing focal species habitat and populations as per the original Cheviot project mandate, preserving either pre-disturbance or modified recreational land-use opportunities, and approximating pre-disturbance native biological diversity conditions.[130] In meeting these challenges jointly, operators and regulators learned some important lessons:

- Be wary of predictive regional models.
- Avoid underestimating the resilience and tolerance of wildlife species and their attraction to quality reclaimed habitat.
- In multiple land-use scenarios, understand your resource development project's own incremental impacts before getting into cumulative land-use planning.
- Mine operators' influence on land management may be lost after closure.
- Mines at closure may not be able to maximize all values for all desired land uses.
- Conditions at closure will probably not optimize all benefits for focal species, recreational users, and biodiversity.[131]

As reclamation techniques were honed over the decades, those closely involved and dedicated to the processes expressed concern about what might happen to the lands after a reclamation certificate had been issued; a sort of a "pride of ownership" developed. The industry and government people worried that the lands might be abused in some way after reverting to the Crown.

After reclamation in the mountain mines, "the wildlife has come in, the sheep and goats and elk and grizzly bears and everything else. It's a wildlife park," enthused Leskiw. "They love it; there's good food supply and there's no hunting. It's beautiful to be out there. You hear the elk bugling; you see the goats fighting and the rams butting heads … And when you're up on the mountainsides, there are no other people, no tourists. It's quiet. It's all yours."[132]

Such enthusiasm and pride, along with the public pressure, led in 2003, to several stakeholders identifying the need to provide direction for proper post-reclamation management in the Luscar and Gregg River Mines areas.[133] By 2011, about 100 per cent of the Gregg River Mine and about 50 per cent of the Luscar Mine's disturbed areas had completed reclamation, with wildlife habitat and watershed protection the main foci. Reclamation had created a landform and vegetation pattern that re-established the area as part of the home range of bighorn sheep, elk, and mule deer and threatened species such as grizzly bears and Athabasca rainbow trout. After years of restricted public access during active mining, the leased area had become a wildlife sanctuary of sorts. A plan was needed to protect that land before it reverted to the Crown and exposed it again to public use.

In recent years, Alberta Sustainable Resource Development, in collaboration with Teck Resources (Luscar Mine operator) and Coal Valley Resources (Gregg River Mine operator, at that time), developed an end land-use plan for future management of the reclaimed public land. The goal was to provide clarity regarding future uses and access. A working group, including participants such as Jasper National Park and Alberta Tourism, and Parks Recreation, and Culture, gathered supporting information. Focus groups engaged a broad diversity of interest groups from equestrian to snowmobile clubs to trappers associations and conservation organizations. Overall, the participants affirmed a vision that would see the continued protection of habitats and populations of wildlife.

The vision findings guided the land management plan to a balance between managed human use and environmental resources conservation, including watershed protection. The plan included five goals and 14 objectives. The Alberta government approved the plan in 2012,[134] and it is to be implemented as reclaimed lands are certified and released by the coal operators—guiding the province's land managers and public land users toward maintaining the area's unique features.

Although all mine applications in the province must include an end land-use plan, a 2011 paper suggested that a land management plan for post-certification offered a more holistic approach on a landscape level.[135] Such planning looked beyond the mining and reclamation activities, and allowed for adaptive management—adjusting operations as mining and reclamation proceeds, to do certain reclamation work differently than planned, with regulatory approval. Moreover, in confirming re-establishment of healthy, robust, safe, and self-sustaining landscapes, post-certification planning affirms that mining is an interim and transitional land use. In future, the paper said, mines may seek to engage in this more holistic approach to land-use planning earlier in the process.

One Site, Three Eras

The Diplomat Mine in east-central Alberta provides a good representation of the changes in reclamation practices over the decades. Three distinct eras of reclamation can be seen today.[126] The mine was operated by Forestburg Collieries Limited, headquartered in Edmonton. Mining commenced in 1950 and coal extraction was completed in 1986. The coal mined at the site supplied domestic home heating, railway, eastern industries, and Alberta's power generation needs, in particular supplying the adjacent Battle River Generating Station since its start-up in 1956. Some 14.2 million tonnes of coal were produced over the mine life.[127]

During the first reclamation era, prior to the 1963 legislation, directions of the Department of Mines and Minerals guided reclamation. Economic constraints, based on the low coal prices of the day, limited the mine's ability to reclaim lands. The objective was that the mined area be

(Above) The pre-1963 mining era involved minimal reclamation. Spoil ridge tops were levelled, forage seed broadcast, and trees planted. Land capability and usefulness was greatly restricted. *Bob Logan*

This fence-line photo contrasts the reclamation practices typical of the first and second reclamation era at the Diplomat site. Behind the fence, cattle graze on early mined lands. In the foreground, the mined land has been levelled and seeded to a grass-legume forage mix capable of hay production because of the relatively good quality of the spoil materials at this site, even without topsoil being returned. *Bob Logan*

In the era since 1975, topsoil materials were conserved and replaced, levelling operations were increased, and farming practices similar to those on adjacent farms were implemented. *Bob Logan*

left in a "satisfactory" condition. At the Diplomat site, the spoil ridges left after coal removal consisted primarily of glacial till materials that were found capable of supporting plant growth, even without levelling the spoil ridges.

The reclamation program in the 1950s and early 1960s consisted of seeding the spoil ridges with a forage mixture, along with some tree and shrub planting. Minor levelling of the ridges was done in some locations; a single pass of a dozer along the ridge top flattened the ridge peaks. The resulting landscape is rugged, but has use for cattle grazing and wildlife habitat. Approximately 65 hectares of this pre-1963 legislation reclamation standard remains, visible west of Secondary Highway 855 and from the Diplomat Mine Interpretive Site (operated by the Diplomat Mine Museum Society of Forestburg) off the highway. It continues to be used for cattle grazing and serves as a reminder of an era when land reclamation was not a priority of the mining industry nor society in general.

A further 154 hectares of this landform was subsequently

Diplomat Heritage Park stripping shovel and bucket from larger shovel, 2014. *Bob Logan*

reclaimed in the 1970s through a levelling plan that included an operator-training program conducted by Alberta Environment and the County of Flagstaff. The Alberta Heritage Savings Trust Fund provided the funding. These lands are found immediately adjacent to, and primarily east of, Secondary Highway 855.

The second reclamation era commenced after proclamation of the Surface Reclamation Act of 1963. At the Diplomat site, the Surface Reclamation Council (established under the act) ordered increased levelling of the mining lands disturbed after January 1, 1966. The spoil ridges were reduced to a maximum of 1.5 metres between valley bottom and ridge top. The result is a rolling landscape, more in line with the surrounding lands. The productive capability of these lands depends much upon the quality of the spoil materials that forms the new root zone. Where the higher-quality glacial-till materials predominate, grass-legume forage is well established; whereas if poor-quality, soft bedrock materials are present, forage production is sparse.

Mine operators attempted to selectively handle the poorer bedrock materials—found immediately above the shallow coal seam—using the large stripping shovels to bury these materials deep in the pit backfill, away from the root zone. This resulted in lands useful for grazing and some forage hay production. Approximately 300 hectares of the Diplomat Mine are reclaimed to this standard.

The third reclamation era found at the Diplomat site relates to the standards from the enactment of the Land Surface Conservation and Reclamation Act of 1973. In 1974, under regulations in this new act that designated the mine a "regulated coal surface operation," then Minister of Environment W. J. Yurko requested the company to develop, in consultation with the Land Conservation and Reclamation Council, a land reclamation plan to begin in 1975. The goal was for the mined land productivity to be "equal to or greater than" that of the adjacent, un-mined lands.

The 1975 changes started a new era of pre-development assessment and planning to integrate reclamation into the overall mine operations. Bob Logan noted, "At the Diplomat Mine that I observed in 1982, this translated into a program of topsoil salvage and replacement and the careful, deep burial of unsuitable bedrock materials that are occasionally encountered. Additionally, the degree of levelling was increased such that lands are returned to contours similar to those originally existing and capable of intensive, cultivated agriculture."[128]

The post-1975 reclaimed lands were initially seeded to a grass-legume hay mix to help rebuild soil conditions. Encouraged by the results, in 1979 the company tried putting some of the new lands directly into cereal crop production. These lands, under management inputs (e.g., fertilizer applications) guided by standard soil test recommendations, gave yields similar to the adjacent farmlands. This program was expanded in following years with similar good results.

In 1980, the company applied to the Land Conservation and Reclamation Council for reclamation certificates for several parcels of land at the Diplomat Mine, including areas that represented the three reclamation eras. The council reviewed these applications for almost two years, a process that included several inspections of field conditions, provision of additional information on soil quality, ordering of additional minor touch-up work, interviewing of farmers operating the lands, and holding of formal "inquiries" for each parcel.

Following these steps, in November 1981, the council issued reclamation certificates on three parcels of land at the mine, approximately 110 hectares (270 acres). The chairman of the council noted that these were the first reclamation certificates issued to a surface mine in Alberta under the 1973 act. He commended the cooperative corporate and field efforts of the company. This was particularly noteworthy, as portions of the lands were reclaimed to the latest standards, signifying that mined lands can be returned to their previous level of productivity and usefulness.[129] More than 30 years later, these lands continue in agricultural production; they are used for pasture, hay, and cereal or oilseed crops.

New Issues Evolve

With Alberta coal reclamation's first (formal) half century complete, concerns continue to evolve. Leading the pack in 2015 are unavoidable delays in approvals, partly due to new approaches like adaptive management. Applications have become more complex with increased criteria, such as higher levels of public and First Nations consultations. One impact has been a continuous reduction in hectares certified reclaimed as a percentage of total hectares mined and reclaimed.

An adaptive management approach can have risks. "I agree with the perspective that, okay, you say what you're going to do," said Curtis Brinker. "And, if you do it, you should get a reclamation certificate at the end of the day."[136] Brinker and his team had spent the previous two and a half years preparing an application for Coalspur's flagship Vista thermal coal project near Hinton. Initial production from the 10,000-hectare lease was anticipated by the end of 2016 at a rate up to 6.5 million tonnes per year. It was the newest major coal-mine application in the province, and Brinker was in a good position to summarize, from an industry perspective, the current state of experience in applying for approval of a reclamation plan.

He was acutely aware of the time it now takes and the risk of changes over the project's life contributing to problems in securing a reclamation certificate at the end—especially where adaptive management is enlisted as a tool for better reclamation. "You submit your mining and reclamation plans; you also say 'we believe in ecosystem management and the approach where we're willing to learn and revise our mining and reclamation plans as we plan, do, measure, refine,'" explained Brinker.

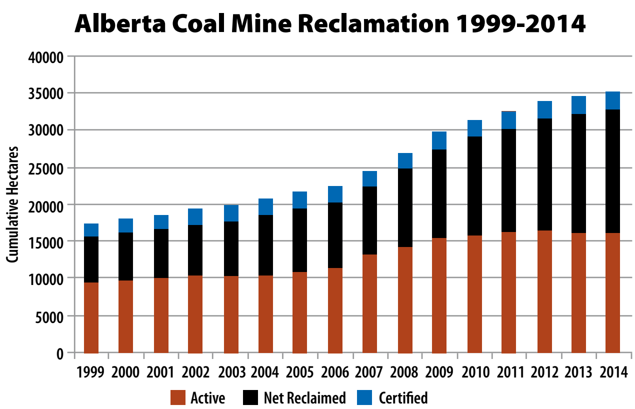
> So I think we get caught up in that aspect where the regulator says, "Yeah, okay, well you guys said you'd do this and you did it. But, it didn't work. And, you also told us that you were willing to learn from and change what you do." There are some things you can change as you go through your mine and reclamation process, but there are some things that you can't.[137]

Brinker gave an example of promising to place 30 centimetres of soil, which might turn out to be not enough. Then, 20 years later the trees might be in early growth stages, and it would be too late to change. "Are you going to start from scratch and try and find another 15 centimetres of soil to put on?" asked Brinker. The lesson can be applied to the next set of pits. "But, on that area you said you'd do this and you did it and now you're wanting a reclamation certificate? There's a strong argument that you should get it," he said.

Ryan Puhlmann, Science Specialist (Closure & Liability, Land Conservation & Reclamation) at the Alberta Energy Regulator (AER), is aware of the dilemma. "The process does contemplate and allow for changes," he said. "But if there's something that comes up through the process, through the application and/or approval cycle, it's the obligation of the applicant to provide how they're managing that."[138]

Adaptive management is based upon a form of research. Experienced industry practitioners know research is necessary, but it needs to be separate from operational requirements.[139] Research should not complicate what was agreed on in the past. Research is always providing new information and direction. But it is commonly felt that if the initial requirements have been met, a reclamation certificate should be due, regardless of research conducted during the project.

Some practitioners felt criteria changed in recent years. "There was a period of time in the '80s and early '90s where there was a willingness, actually I'd say a strong willingness,



Coal mine disturbance and reclamation trends in Alberta. Disturbance and reclaimed areas are growing, but certified areas remain limited. *AER* on the part of the government to show that coal mines are successfully reclaiming their lands," said Brinker. "They were willing to issue these certificates based on what I would call fairly simple reclamation criteria. You got soil on it. There's no active erosion, and you've got tree growth. The tree growth meets the reforestation standard of the day." Today, he said, questions have become more complex: "What's your species diversity? Did you have several different layers of vegetation in your re-establishing forest? Does your soil have all these different properties and depth and chemical characteristics? Does the water that's coming out of the base of your pit or the toe of your dump have any issues?"

The duty to consult with First Nations is a more recent government requirement, too, he noted. "When I was out at Coal Valley from 1980 to 1991, that term wasn't in the definitions," said Brinker. "It just didn't enter into mine development or reclamation; the government didn't have policies that anyone was aware of back then. The first formal policy on First Nations consultations was, I think, 2005."

Moreover, information requirements for certification now are more detailed. Bob Logan recalled the late 1970s when inputs to a reclamation plan generally involved sourcing existing documents, regional soil surveys, and minimal field samples of overburden. "Now it's sending a team of a variety of scientists out to the field to collect baseline information. It's a very different level of detail and science going into it."[140]

All these factors add up to increased time needed for pre-mining approval of reclamation plans. The requirements and time lags often affect a project's economics. For example, Coalspur expects its Vista project will produce high quality thermal coal at a cash cost of less than US$60/tonne over the first five years of production.[141] Recent prices have sagged well below that figure; but in late 2011 when the company made the decision to go ahead with the mine, prices were hovering above US$70.[142] A number of market analysts see the price at $60/tonne by end of 2015 with little upside over the longer term.[143]

However, Brinker pointed out that reclamation is only one of the many aspects of coal mining that garner a lot of regulatory and stakeholder scrutiny. Others include water management, tailings management, and social licence.

Ryan Puhlmann recognized the difficulty. The AER as a new organization still had a considerable backlog of applications and issues in 2014, and there were "a complex number of factors that really still confound the timeline problems," he said.[144]

Brinker commented on where coal mine reclamation is heading in Alberta, and what he believed needs to be done. "There needs to be clarity," he said. "As part of that, because the public and First Nations both have much more influence on the regulatory system, both are going to have to be brought into that discussion on what the reclamation criteria are going to be. And how successful reclamation is going to be measured at the end of the day. Certainly, for example, traditional uses are going to have a higher level of importance in plans going forward than 10 or 20 years ago."[145]

Logan agreed. "The one issue that stands out right now, I find, is reclamation certification," he said. As the graph on page 100 illustrates, the percentage of reclaimed land with certification is relatively small. "That whole process needs to be resolved to get it to be a manageable thing. I was asked a few years ago, in 2008 and 2009, to look at applications on a couple different sites, one in the foothills and one in the plains, and they are stalled out for a variety of reasons." He said it was partly government process and ongoing reorganization, and partly questions about how released lands are going to be managed. In some instances, the operator has not finished reclamation to the point where an appropriate land parcel can be defined and applied for, so the application has not yet been submitted. AER's Puhlmann confirmed there are a considerable number in this category.[146]

Industry and government experts said that while the past five decades have produced a considerable amount of research data—much of what is needed has now been done—questions remain. For example, at the time a reclamation certificate is issued, operators and the government are in theory fully confident the mined lands have been returned to satisfactory levels commensurate with the approved plans. But do we really know if land capability goals have been met; that conditions are equivalent to pre-mining capabilities? What might happen over the coming decades to change that?

Terry Macyk offered an approach to this issue. He said there are always areas that need further examination, but what may be forgotten is that people do not take advantage of the work that has already been done. "There's a need to do more in terms of learning from past experience or going back to some of the older sites that were established and monitored, and getting a good evaluation of them," he said. Ten or 20 years after a project wraps up, new volumes of learning can be derived from a site. "Many studies will stop after five years or whatever, and you really don't know which direction things have gone, or how much more good information you could have got from them," said Macyk. "Go back and revisit and get that history of how things are evolving. That to me is one of the keys."

Conclusion

The contrasts between the coal industry of the 1960s and today are dramatic; perhaps nowhere more so than in land conservation and reclamation. Fifty years ago the industry was struggling to survive as mining operations and production levels plummeted. Abandoned operations left small but significant scars on landscapes across the province. Forces such as more productive surface mining techniques changed the nature of the industry, and markets for domestic electric power generation and the export of coking coal for metallurgical steel production were on the rise. At the same time, a more environmentally aware public raised concerns about the potential ecological and social impacts of increased coal mining.

Many of these pressures came to a head in public hearings held throughout the province in the 1970s. The Alberta government responded with new legislation and by the mid-1970s coal was the first industry to have its operations regulated under the new conservation and reclamation requirements. Since the coal industry was in transition, the timing was right to implement new programs. It had consolidated into relatively few operating mines and companies and being in the public spotlight and on the environmental hot seat meant it looked toward a revival. Coal became the initial and particular focus of the new Land Conservation and Reclamation Council's efforts to change practices.

The question remained: Could an old dog learn new tricks? Could Alberta's coal industry adjust to these new demands? It could, and it did, change through the combined efforts of government and industry. Government, on behalf of Albertans, demanded improvements through legislation yet worked in a flexible manner with industry to implement these goals. It committed people and resources to develop and research solutions. The coal industry came to recognize the need for change—that there was more to coal mining than mining coal—to make mining a temporary use of land and return disturbed areas to productive usefulness. It hired the people and developed the expertise to help understand and address the issues. It sought innovative methods and invested in equipment to modify plans and operations. Change resulted through collaborative efforts, not just in research but also through dialogue, debate, and at times tough negotiation over plans and procedures. Change came about through a common commitment to improvement. The result? Land conservation and reclamation have become an integrated part of Alberta's coal mining operations.

Quarries

As a biologist I am very happy being part of the solution.

Chris Wellwood

The Dominion of Canada issued permits for Lafarge Canada Inc. limestone quarrying operations in Exshaw in 1906—nearly six decades before the first reclamation legislation in Alberta. Current plans are to continue quarrying at the site for another 50-plus years, which presents a problem for reclamation: "We are entirely on Crown land, and you can't get partial certificates, unlike private lands where you can," said Jennifer Weslowski, Lafarge's land manager, Cement Properties Western Canada.[1] The solution? Reclaim specific areas as quarrying is completed. The photo below shows one such area at the company's Exshaw operation.

Lafarge Canada's reclaimed limestone quarry near Exshaw, 2015. The reclaimed area is in the foreground where the mountain sheep graze. The Baymag plant can be seen in the distance.
Graham Chandler

Modern quarrying has been ongoing in Alberta for well over a century. Salt and limestone continue to be the leading non-fuel minerals produced.[2] In 2014, stone production in the province, not including amounts shipped to Canadian cement, lime, and clay plants, amounted to 7,231,000 tonnes—4.9 per cent of Canada's total; it was worth $88.4 million—5.9 per cent of the country's total.[3] Alberta has two major cement plants with 2,466,000 tonnes of clinker capacity, representing 15 per cent of Canada's output.[4]

Quarry reclamation had a slower start in the province than some other industries, but quarry operators rapidly picked up momentum. At quarries on the flatter lands of the Athabasca oil sands region, some techniques currently under application now lead the reclamation industry—and not just for quarrying applications. Continuing initiatives like these promise to carry Alberta's quarry reclamation schemes into a progressive future.

History

First Nations have been harvesting material to manufacture stone tools in what became Alberta for thousands of years. In more recent years, Alberta sandstone was employed extensively as a building material, including the Legislature building in Edmonton. Early sandstone quarries included the Glenbow near Cochrane and the Edworthy Quarry in Calgary. The other major stone quarried in Alberta, limestone, had an early start, too, with the Western Canadian Cement & Coal Company plant near Exshaw; now part of Lafarge Canada, Inc.[5] Its production helped fuel western Canada's pre-World War II expansion of infrastructure. Today, major quarry production in the province remains sandstone and limestone.

One of the oldest rock quarries in Alberta is the recently designated Quarry of the Ancestors, discovered during heritage impact assessments in the oil sands area of the province. The complex of archaeological sites and natural features sits east of the Athabasca River in the Muskeg River valley about six kilometres northeast of Fort McKay. It consists of a series of surface and near-surface outcrops of bedrock, along with a vast array of associated artifacts representing extraction and processing of Beaver River silicified sandstone, the main tool stone found in archaeological sites throughout the region.[6] Time-diagnostic specimens recovered to date suggest that the principal use of the quarry occurred between 9,800 years and 5,500 years ago.[7] Another prehistoric quarry, of chert, is found in the Livingstone Range in the Crowsnest Pass area, where people of the Pelican Lake culture quarried the fine crystalline stone tool material 3,000 years ago.

Outcrop of Beaver River sandstone at the Quarry of the Ancestors.
Lifeways of Canada Ltd.

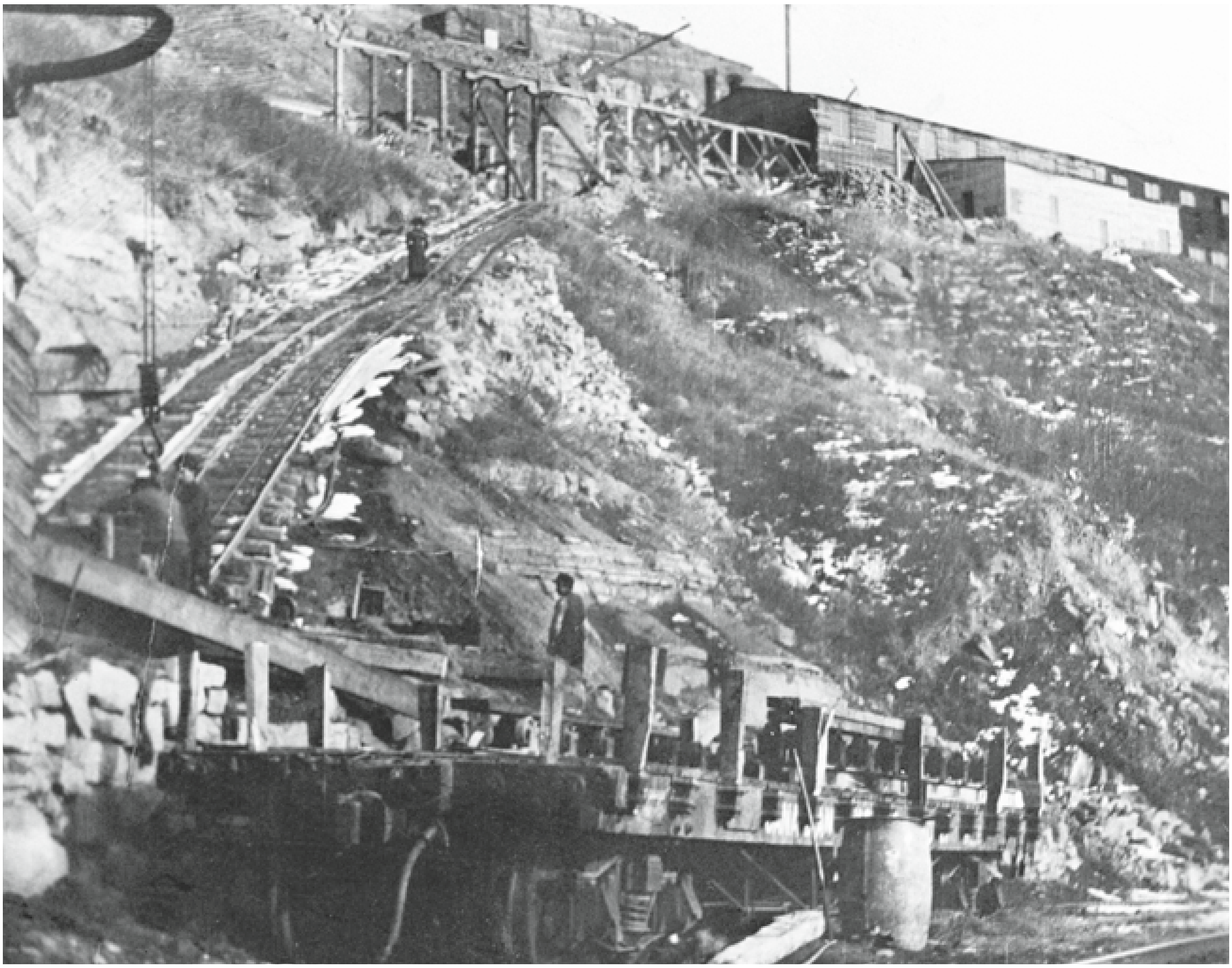
In the historic era, sandstone was employed extensively as a building material in the province. Several prominent buildings constructed in early years are made of sandstone; examples include the Alberta Provincial Legislature building in Edmonton, Calgary's Old City Hall, and Lethbridge's courthouse. Of the approximately 250 sandstone buildings constructed during Calgary's early boom years, many are still in use today, including the Grain Exchange Building, Hudson Block, and the Palliser Hotel. Sandstone was chosen purposely early in Alberta's history, even before it became a province: after Calgary's great fire of November 1886, a decision was made to employ more sandstone as a building material.

The quarry that supplied sandstone for the Legislature building is now part of the historical Glenbow Ranch Provincial Park just east of Cochrane. Prior to 1907, the quarry was operated on private land and became the Glenbow Quarry Company, originally with the intention of supplying British Columbia. It was sold in 1908 to the Alberta government and produced its Porcupine Hills Formation sandstone profusely through 1909, employing more than 100 men at its peak.[8] By 1912, the best stone had been produced, and the quarry was closed. Never reclaimed, it has instead now become an excellent example of a quarry being used as a historic site—explained in detail at the Glenbow Ranch Provincial Park interpretive centre.

Several smaller quarries operated in those early years, too. For example, prominent Calgary citizen Tom Edworthy came to the city in 1883 and operated a sandstone quarry at its western edge. It produced quality building stone for many of Calgary's Stephen Avenue buildings including the Bank of Montreal and the Lougheed Block, as well as several schools and churches.[9]

Most of the early sandstone quarries were along rivers, scarped banks, buttes, coulees, escarpments, and the weathered side of small knolls. What these landforms have in common is that the rock is exposed, and with minimal overburden.

Limestone quarrying had a similarly early start in Alberta. In 1906, the Western Canadian Cement & Coal Company opened what would become one of the most innovative and modern cement plants in the world. Located at the eastern edge of the Rocky Mountains near the present town of Exshaw, the plant site was chosen for the abundant quantity and quality of limestone, the availability of nearby power sources, and its proximity to the CPR rail line.[10] The half-million barrels of cement produced annually helped fuel western Canada's booming expansion of roads, railways, and industrial buildings prior to World War I.



The sandstone quarry at Glenbow, near Cochrane, operated from 1906 to 1912. *Glenbow Archives NB-17-29*

The quarry today as part of Glenbow Ranch Provincial Park. *Glenbow Ranch Park Foundation*

Although described as a technological wonder, slow markets, railway strikes, and a flawed sales strategy forced a shutdown in 1908. But it restarted a year later with the amalgamation of 10 Canadian cement companies to form the Canada Cement Company. In 1970, that company merged with Lafarge Canada to form Canada Cement Lafarge Ltd. The new entity soon became the largest supplier of cement in Canada, supporting the rapid expansion of Calgary and Edmonton in the new oil boom years. In 1988, Canada Cement Lafarge Ltd. became Lafarge Canada Inc., which operates the plant to this day.

Main Quarry Operations in Alberta Today

Currently, limestone, sandstone, and shale are the major quarry operations in Alberta, together with ammonite and various decorative rock types. No metallic minerals are quarried at present, although several are under exploration in different regions of the province. As explorations progress and data and samples are processed, some of these may well evolve into commercial development and eventual production. A small number of exploration companies have excavated for sample acquisition; although reclamation is required, it should be relatively minor in scope and scale given the small footprint.

The table below presents those industrial minerals currently quarried in Alberta, not including ammonite. These companies and operators are subject to the same reclamation legislation and regulations as the major coal and oil sands mining operations as outlined in other chapters of this book, but not subject to the Alberta Energy Regulator.

Limestone

Limestone is a sedimentary rock composed primarily of the mineral calcite, or calcium carbonate ($CaCO_3$). Because limestone is expensive and heavy, it is not economic to transport it over long distances, so local sources are important. Unprocessed, it is used as a building stone, for landscaping, or crushed for use as aggregate for road construction. In its raw form it has a wide variety of industrial uses from aggregate to neutralizing acid soils. The most important

Operating industrial mineral quarries in Alberta at end of 2014.
***Coal and Mineral Development in Alberta: Year in Review 2014*, Alberta Energy, 2015.**

Industrial Mineral Quarries

Mine/Quarry	Commodity	Location	Operator
Calling Lake*	Salt	North of Athabasca	Calcium Inc.
Clearwater	Limestone	Rocky Mountain House	Burnco Rock Products Ltd.
Cougar Ridge	Limestone	Rocky Mountain House	Prairie Creek Quarries Ltd.
Exshaw	Limestone	Exshaw	Lafarge Canada Ltd.
Fish Creek	Limestone	Nordegg	Graymont Western Canada Inc.
Fort Hills	Limestone	North of Fort McMurray	Hammerstone Corporation
Fort McMurray West	Limestone	Fort McMurray	Suncor Energy Inc.
Gap	Limestone	Exshaw	Graymont Western Canada Inc.
McLeod	Limestone	Cadomin	Lehigh Hanson Materials Ltd.
Mitsue*	Salt	Slave Lake	Tiger Calcium Services Inc.
Muskeg	Limestone	North of Fort McMurray	Hammerstone Corporation
Peace River Silica	Silica Sand	Peace River	Contractors Leasing Corp.
Riverview*	Salt	Riverview	The Canadian Salt Company Ltd.
Rundle Stone	Dolomitic Siltstone	Canmore	Kamenka Quarries Ltd.
Seebe	Shale	Kananaskis	Lafarge Canada Ltd.
Sprayfalls	Sandstone	Exshaw	Thunderstone Quarries Ltd.
Steepbank	Limestone	North of Fort McMurray	Hammerstone Corporation
Summit Lake	Limestone	Coleman	Graymont Western Canada Inc.
Sunnynook*	Salt	Drumheller	Jarodon Resources Ltd.
Vicory	Sandstone	Coleman	Pat Dwyer Construction Inc.
Yamnuska	Sandstone	Kananaskis	Lafarge Canada Inc..

* Salt is produced through in situ leaching from the Elk Point group.

compounds from processed limestone include hydraulic cement, which reacts with water to form a hard crystalline mass. Mixed with water, sand, and gravel, or other aggregates, cement hardens to form concrete, indispensable to the construction industry. Smaller amounts of limestone are quarried to produce quicklime (CaO) and hydrated lime ($Ca(OH)_2$) used in many chemical, papermaking, and agricultural applications. Limestone is also frequently used as a decorative stone for landscaping. In the oil sands area, Suncor uses limestone in the bitumen upgrading process.

Alberta is well endowed with limestone; most sources are exposed in the Rocky Mountains along the province's southwestern margins. Major producers there are the extensive operations of Lafarge Canada and Graymont Western Canada Ltd. at Exshaw, and Graymont's Summit lime plant located in the Crowsnest Pass area. Farther north in the foothills, Lehigh Hanson Canada operates a limestone quarry near Cadomin, 300 kilometres west of Edmonton. Large deposits of limestone are also found near the surface in the province's northeast, along the lower Peace and Athabasca Rivers and their tributaries.[11] One of the largest in that locale is the Hammerstone Project in the heart of the Athabasca oil sands region, operated by Hammerstone Corporation in a joint venture with the Fort McKay First Nation. The Hammerstone Project was built on the Muskeg Valley Quarry by expanding its footprint from 95 to 486 hectares as a result of acquiring some of the assets of Birch Mountain Resources Ltd. after it was placed into receivership. The purchase extended accessible reserves to over 750 million tonnes.[12] Another limestone quarry in the area, the Parson's Creek Aggregate Project, is scheduled to start production in 2016.

Limestone from the two major quarries at Exshaw produces refined products, such as quick lime, or calcium oxide (CaO), a key ingredient in cement production.[13] Limestone from the Hammerstone deposit is used for building mine haul roads and well pads in the oil sands area. The Parson's Creek Aggregate Project also proposes to produce limestone for use as a reagent to remove sulphur in bitumen upgrader operations or for water purification at in situ oil sands projects.

Sandstone, Shale, and Siltstone

In Alberta, sandstone is the most widely used stone material due to its abundance and ease of workability. Sandstone consists primarily of quartz, feldspar, and mafic minerals (i.e., dark-coloured minerals containing iron and magnesium). The minerals vary in grain size, composition, shape, roughness, and degree of dissolution. Sand grains are usually laid down in bands or layers and are cemented with silica and/or calcium carbonate. The quality and type of cement binding the grains naturally affects how the sandstone performs as a building stone.

Current producers of sandstone in Alberta include Thunderstone Quarries Ltd.'s Spray Falls operation near Exshaw and Lafarge Canada, which operates the Yamnuska Quarry in Kananaskis. Lafarge's sandstone has high silica content so the company blends it with the limestone for cement production, along with some silica and aluminum from its shale quarry nearby at Seebe South. While its limestone resource is quarried adjacent to the plant area in Exshaw, sandstone and shale are quarried about 10 kilometres to the northeast, in the Yamnuska and Seebe Quarries, respectively.[14]

Siltstone, comprising silt-sized mineral grains, has typically smaller pore sizes and higher clay content than sandstone. Siltstone may also have numerous laminations and may contain concretions and fossils. The historic Banff Springs Hotel and the restored 1914 Banff Springs swimming pool used siltstone. A major producer of siltstone in Alberta is Kamenka Quarry Ltd.'s Rundle Stone near Canmore.

Decorative Stone

Several smaller quarries in the province produce decorative stone and ballast rock. Fish Creek Stone Products operates two quarries near Rocky Mountain House and Nordegg, supplying a variety of stone products for erosion control, transportation, chemical grade, and decorative architectural applications. The quarry also produces dolostone (dolomite) and limestone. Thunderstone Quarries also mines decorative stone at the Spray Falls operation at Exshaw.

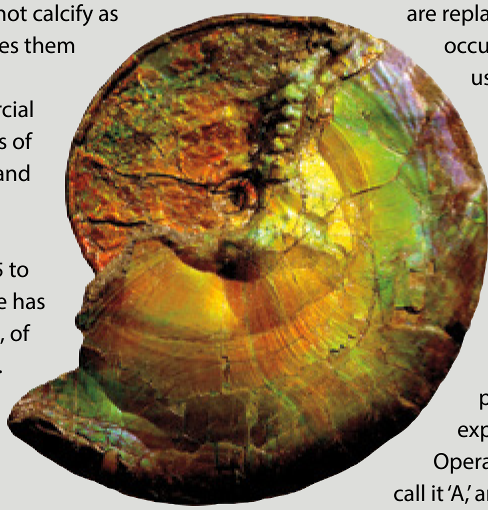
When quarrying stone for building purposes, it is generally preferable to extract the largest blocks possible because bigger blocks allow for greater variety in usage. Larger blocks are more difficult to obtain because of the jointing and bedding plane directions and impurities that could cause the rock to crack in undesired places.[15]

Another major use of quarry material is for ballast and rip-rap. Two such quarries are operated in the Bow Corridor. One is the Graymont Pit, where an operator is taking waste rock from operations. The second is in another Graymont Pit called the Three Fingers Quarry that was mined by predecessors for limestone up to 1970. The mining took place in a slot pattern, leaving three "fingers" of vertical hard rock. Chief Construction Company is mining the fingers and backfilling the longer slots with waste material. A remnant operation from the past is being reworked, and the site will be reclaimed. The quarry produced rip-rap for bank protection and stabilization projects after 2013.

Ammonite Quarrying in Alberta

Ammonites are predatory, squid-like creatures that lived inside coil-shaped shells. First appearing around 240 million years ago, ammonites went extinct with the dinosaurs 65 million years ago. They are among the most abundant fossils found today.[16] Amber deposits at Grassy Lake are one of the most studied in Canada.[17]

Organic and not a mineral, the fossilized shells of ammonite are called ammolite and are mined and collected as gemstones. Polished, they exude iridescent rainbows of colour. The best grade of gem quality ammolite is found along high-energy river systems on the eastern slopes of the Rockies in southern Alberta. Conditions there are unique in the world—near the end of the Cretaceous, ammonites were buried rapidly under intense tectonic pressure. This ensured the shells did not calcify as in other parts of the world, which gives them their distinctive radiance. Korite International has conducted commercial quarrying operations along the banks of the St. Mary River and near Magrath and Lethbridge since 1979. Quarrying consists of open pits usually two hectares in size and approximately 15 to 20 metres deep. Over the years, Korite has excavated approximately 16 hectares, of which about 14 have been reclaimed.



Unlike other quarries and mines in the province, ammonite operations are also regulated by Alberta Culture and Tourism, which regulates archaeological and paleontological fieldwork through the Archaeological Research Permit System and the Palaeontological Research Permit System; under the authority of Alberta's Historical Resources Act.[18] All decisions regarding the management of historic resources are made by Alberta Culture. Officially, if an activity is likely to result in the alteration of, damage to, or destruction of a historic resource, the person or company undertaking the activity may be required to:

- conduct an historic resources impact assessment (HRIA)
- submit a report of the HRIA results
- avoid any historic resources endangered by activity
- mitigate potential impacts by undertaking comprehensive studies[19]

Ammonite shell is a paleontological resource. As it is a resource to be harvested, an exemption from the Heritage Resource Management Branch of Alberta Culture is required to recover it. No permit is needed to collect ammonite in Alberta, but an Ammonite Shell Agreement must be signed.[20]

Reclamation of Ammonite Quarries

Korite calls its land reclamation program "Leave No Trace." Working closely with provincial environmental officials, the company aims to preserve the landscape and engage in habitat improvement to ensure native flora and fauna are protected. Once the original soil, shale, gravel, and sand are replaced in the specific naturally occurring sequence, native grasses are used to re-seed the area to help restore the short grass prairie ecosystem.[21]

Following test drilling in a new area, the reclamation sequence is much the same as for other disturbances. "When we know the [ammonite] concentration in the shale is the same average [as economically producing areas] then we start," explained René Trudel, Korite's Field Operations manager. "We strip the topsoil, call it 'A,' and we put it in one pile; then we strip the next couple of feet, we call it the 'B,' and put that in a different pile. Then we strip the 'C,' which is mostly lake sediment and put that in a different pile. When we get to the gravel it goes in a different pile, too. So then we are down at the black Bearpaw shale. We excavate that slowly with the backhoe."[22]

As the process moves along, the company backfills each trench with the shale material, which is levelled and contoured. "Then we put back the gravel where it was, we take the 'C' and put it back and so on," said Trudel. "We blend (contour) it with the natural ground and when it is perfectly smooth—no low spots where water can accumulate—then re-seed, and fence it with an electric fence for at least two years, otherwise the cows will destroy it. Then the landowner gets it back."

Metallic Minerals in Alberta

Unlike most other regions of the world, Alberta's Environmental Protection and Enhancement Act and the Conservation and Reclamation Regulation consider quarries to include all minerals other than coal and oil sands—thus what would be a gold or iron ore mine anywhere else would be regulated as a quarry in Alberta.[23] Although none is in production that would necessitate land reclamation, several metallic minerals are under exploration and investigation for feasibility in the province.

Iron and Vanadium

Ironstone Resources Ltd. has a 100 per cent working interest in over 190,000 hectares of mineral properties in Alberta in various stages of development. The company is in active development of its poly-metallic iron and vanadium project in Clear Hills, with the eventual aim of commercial production. The project proposed is to be a low-impact, open-pit quarry plan with on-site, value-added production of high quality iron metallics and vanadium pentoxide. The company is currently conducting commercial pilot testing of its Hatch-Ironstone CS iron reduction process and vanadium extraction in advance of commissioning a pre-feasibility study.[24]

Poly-metallic Shale

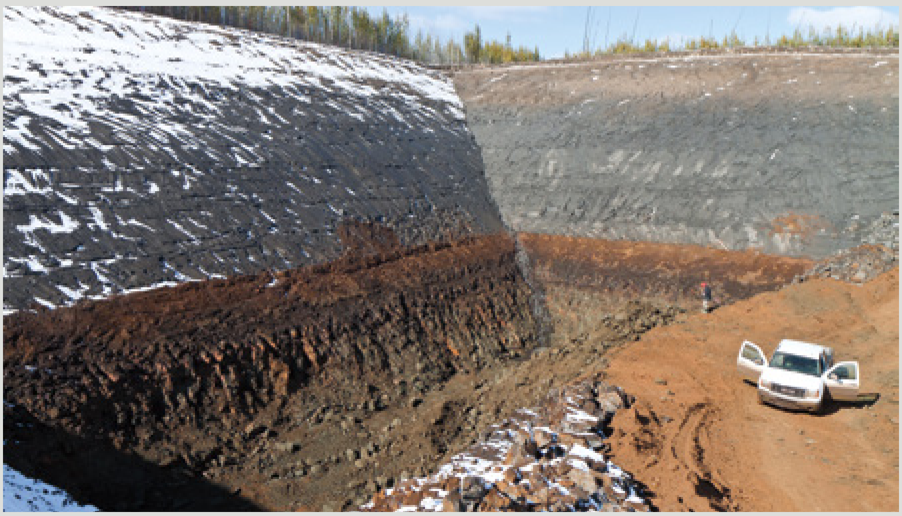
DNI Metals Inc. is exploring metal-enriched black shales over its northeastern Alberta land position to delineate bulk mineable mineral resources as a long-term source of base metals, uranium, specialty metals, and rare earth elements, which are recoverable by heap leaching (using chemical reactions to recover the resource). DNI has advanced one of the poly-metallic zones identified on its property, the Buckton Zone, through a preliminary economic assessment.[25]

Uranium

Declan Resources Inc. is pursuing uranium exploration on their projects in the Athabasca Basin region of Saskatchewan and Alberta. The company says the Athabasca Basin is one of the premiere uranium exploration districts and hosts some of the world's richest uranium deposits, with a well-developed mining infrastructure. Recent discoveries of high-grade uranium in the Athabasca Basin are believed by company management to indicate the prospective merit and continued discovery potential of underexplored areas in the basin.[26]

Heavy Minerals

Heavy minerals have long been known to exist in Alberta's oil sands in minor quantities. They are attracted to bitumen and become concentrated during bitumen extraction processes. The majority of these minerals accumulate in the final stage of that process, the froth treatment plant. One company, Titanium Corporation, reports developing unique technologies to recover heavy minerals, primarily zircon, from this tailings stream.[27] It is unclear whether excavation/removal of tailings to supply a process plant would be considered a quarry.



Ironstone Resources's completed bulk sample pit, Rambling Creek reserve area, Clear Hills, Alberta. *Ironstone Resources Ltd.*

Quarry Lands Reclamation

When Greg McAndrews took the position of provincial government public lands inspector in the late 1970s, he was struck by the lack of reclamation plans in Alberta's quarry industry. He recalled they all had mining plans but frequently did not have specific plans in place for reclaiming individual mined areas.[28] This was in large part because the early quarries did not have environmental impact assessments.[29] This shortcoming was gradually remedied as companies and government worked together with the common aim of developing suitable regulations for quarries and ensuring compliance with them. Developing new techniques was a necessary part of the process, some specific to quarries in the Rockies.

Although most quarries' land disturbances are on a much smaller scale than coal and oil sands mines, requirements under Alberta's Conservation and Reclamation Regulation apply equally to quarries as to all other industrially disturbed lands.[30] When reclaiming quarry sites under the earlier regulations of the 1960s and 1970s, operators faced challenges similar to the province's coal and petroleum companies—added cost burdens and a dearth of reclamation research data being among the most prominent.

Similar to the coal-mining picture, quarry reclamation practices differ between plains and mountains/foothills operations. The limestone resources of Parsons Creek Aggregates and Hammerstone Corporation, near Fort McMurray, lie under fairly flat terrain, as do most of Alberta's plains coal mines. Lehigh's Cadomin operations and those of Lafarge Canada and Graymont are mountain and foothills projects, so they share some of the reclamation considerations faced by mountains/foothills coal miners in the province. The main differences between plains and mountains quarries of course lie in the respective terrains, geological structure, and environmental conditions. Plains quarries are not faced with excavation of entire mountainsides or the harsh winds and minimum topsoil experienced by the foothills and mountain quarry operators.

Coal mines might more rightly be called rock mines as they handle much larger quantities of rock than they do coal. And while the coal is transported from the mine, the rock remains and is used to backfill a pit or placed in an external rock dump. These can be progressively reclaimed. At a quarry, such as the limestone operations in mountain settings, most of the rock excavated is shipped away and reclamation of the final conditions may be decades away.

Coal mines and quarries also differ in that materials such as limestone are much more durable than the comparatively soft bedrock materials encountered above coal seams. Differences in mineralogy also produce different chemical conditions for consideration in reclamation.

Some, such as the above operations in Exshaw, are high visibility sites and have different geotechnical stability issues. These also are generally in operation over longer, extended time frames compared to coal—up to a century.

Regulations and Communication

The Alberta Heritage Savings Trust Fund's Land Reclamation Program funded research and guidelines for quarry operators through the Reclamation Research Technical Advisory Committee (RRTAC). A significant document produced by the committee was a comprehensive 158-page, step-by-step guide for quarry operators, which covered the reclamation process in detail from a project's startup to its closure.[31] The publication, *A User Guide to Pit & Quarry Reclamation in Alberta*, was issued in 1992 and compiled before enactment of regulations under the Environmental Protection and Enhancement Act that year, although it anticipated the requirements of that act.

The document covered important considerations in reclamation planning for six major types of land uses: agriculture, forestry, wildlife habitat, fish habitat, recreation, and residential/industrial use. However, it was never considered a regulatory document. Only one printing took place, but the information was useful in getting things started.

Until that time, most of the evolving government action on land reclamation emphasized energy extraction—oil and gas, coal, and oil sands. Quarries garnered considerably less attention. Greg McAndrews, now retired, recalled working with quarry operators in his early years with Public Lands beginning in 1979.[32] "The older quarries had no requirement for reclamation, it seemed, when you first went to deal with them," he said. "It was just a plan for mining." He said many seemed surprised when he showed up. McAndrews had a large geographical area to cover and recalled the challenges of getting quarry operators to share their plans for reclamation—some had their own, but the plans were not necessarily government pre-approved.

"Basically, when you first came, you probably didn't look at [reclamation] for a while," he said. "But then you started to learn your area, and you finally ended up going out to look and see what they were doing. There was some stuff on file, but not a lot. You start saying, well, where is your operating plan? Where is your reclamation plan? 'Oh, we don't have one,' they would say. 'We have a [mining] plan.' Can we have a copy of it? 'Well, I don't think so.'"

Compounding the problem, some, like Lafarge, had long-term leases—of several decades, even 100 years. "You couldn't go back in and make them put a reclamation plan in until such time as that lease expires, because there was no requirement in the lease," recalled McAndrews. "But, the fortunate thing is that the lease did expire." When that happened, the government would separate the lease into the quarry mineral lease and a plant site lease so as to apply reclamation standards to the quarry site. "The mineral lease covered the quarry area, but it was just for the surface, because we didn't control the rock," said McAndrews. "The rock was all controlled by other [government] departments." These departmental responsibilities changed over the years: Mines and Minerals, Energy Resources Conservation Board (ERCB), Department of Labour, etc. As has been the case since 1963, quarry certification in the province lies with Alberta Environment and Parks (formerly Alberta Environment and Sustainable Resource Development or AESRD).

Bruce Patterson, also with the government at that time, worked alongside McAndrews; Patterson's responsibility was for quarries operating on private lands, but his and McAndrews's objectives naturally matched. They worked together on new long-term reclamation plans specifically applicable to quarries—in consultation with the operators. A major focus of these plans for mountain quarries was aimed at providing habitat for wildlife together with visual impact. "They changed their mining scheme to facilitate reclamation, by coming up with side ramps and different things," recalled Patterson.[33] The concept was dubbed "rock sculpting."

Lafarge had brought the innovative concept from Colorado, and it was formally incorporated into the company's 1994 reclamation and mining plan, currently pending an update approval.[34] It is similar to "escape terrain" used in some mountain coal mine reclamation projects where steep highwall conditions can be proven stable and backfilling is limited. The end aim will be a blending of short vertical walls, benches, scree slopes, wildlife trails, grazing areas, all vegetated as conditions permit. Early problems, many of which still present challenges, discussed in more detail below, were getting vegetation and trees to grow in the harsh wind exposure in the mountain quarry areas—the wind tunnel effect.

While McAndrews thought rock sculpting was the best solution to pursue[35] an alternate method of limestone quarry reclamation being tested in Great Britain was by "landform simulation." In 1988, the UK Department of the Environment commissioned the creation of trial sites on selected faces in two Peak District limestone quarries in terms of their stability, visual appearance, and vegetation establishment, with the intent to make recommendations for its future application. Different than Lafarge's rock sculpting, the project's ultimate objective was to consider whether the landform simulation technique can play a role in the final restoration of limestone quarries so that they resemble natural, unquarried landforms and are visually, ecologically, and structurally acceptable.[36] Basically, it was to employ blasting to eliminate sheer faces and shape the landform to appear natural, topped off by vegetation.

Results of the UK trials were mixed, and they help to demonstrate the challenges involved as well as some of the initial concerns of McAndrews and Patterson in using creative blasting to reclaim Alberta's mountain quarry sites. The experiment revealed several unfavourable consequences, mostly from the impacts of the extensive blasting required. Buttresses tended to be badly damaged with open, face-parallel discontinuities, with overhanging sections and spalling in the lower exposed parts. Prominent fissuring occurred behind some of the headwalls. Headwall crests contained unstable overhanging blocks. There was a significant danger that localized failure, especially rock fall and toppling, could occur as a result of the loose nature of the rock mass, necessitating periodic monitoring and scaling or other remediation. The report emphasized a need for detailed geotechnical input into the design and implementation of restoration blasting. One success was accomplishing a reasonable species diversity on the new landform; but they did not have the harsh wind and freeze-thaw risks of the Rockies to contend with. "Whilst some aspects of the designed landform can be created, it may not be possible to recreate a stable landform with all the required features by this method alone," was the report's main conclusion.

McAndrews recalled that once he established a good rapport with operators he would stop by quarry operations once every year or two to check on reclamation progress. "If things were happening, I would go by every year just for a quick inspection or whatever, but usually every two or three years to keep on an eye on things," he said. Most companies were highly cooperative, he remembered.

The government inspectors had a hammer, just in case: if things were going badly in the wrong direction, the government did have the power to shut down an operation. "The 1973 legislation had [provision for] a surface disturbance control order," explained Patterson. "It could shut down a whole operation or a portion of an operation or an activity, with ministerial approval. Before that, there were no real shutdown authorities." However, McAndrews added, communication was generally very good, and he never had to recommend any shutdowns. "You have to regularly go by and just have a look and see what's happening, and say 'how's your plan?'" he said. "That was the key, keeping in contact with them—communication."

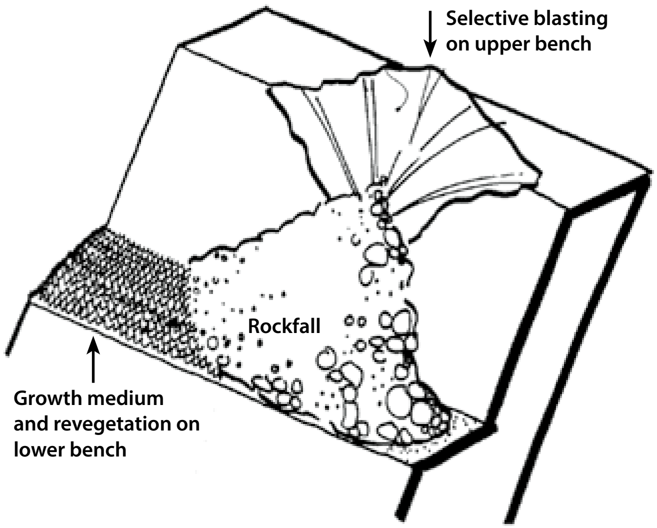
It grew into an efficient two-way street. Regular visits by government inspectors brought operators fresh insights, pending policy updates, and more. "You're going out there with anything that might be new from a government point of view and some of the policy changes that could be coming through," said Patterson. The inspector would ask, "Is it going to be an issue with respect to certification?" The process brought to the operators new regulatory requirements that might be pending or under discussion, so they could provide feedback to government as to how the change might affect their operations. "Rather than getting a document saying here are the changes we want, you can walk through it with them," said Patterson. Sometimes, "You'd test one, go back the next year, and see how it turned out. You worked with them." It was all about cooperation, he said. Once the communication was established, positive feedback and good exchanges of ideas followed.

Overall, McAndrews reckoned regulation of quarry reclamation in Alberta was adequate during his tenure as an inspector from 1977 to his retirement in 2008. "Once they brought the proper regulations in, and they were willing to enforce them, over time it got better and better." It necessarily took a while to evolve, as adopting many of the changes entailed a cost for companies. McAndrews would point out to them, "If you do this now, you don't have to do it at a higher cost later. You'll have to do it at some point. So, if it's built into your system then you can manage it. Most of them bought into that."

Part of the problem in the early years was lack of experimental data. What had been successful and what had not? There was little to go on. Much was by trial and error. "So, basically what they had to do is try different things," recalled McAndrews. For example, "Lafarge set up test plots and put some material on at certain depths, and they tried different grasses, etc. Whether in the long run it would work, who knew? But, they were trying it." Limited rainfall, shallow topsoil, sheep eating newly planted young shrubs—they were up against several challenges in the process.

Rock sculpting has been no exception. Although included in the reclamation plans for each of its quarries, Lafarge has not yet reached a point where the technique can be fully implemented. Production plans stretch past 50 years or so, but some experimentation has been underway. On a sunny but cool morning in May 2015, Quarry Transition Project Manager John Boyt pointed out some niches recently blasted from the rock face in the Exshaw Quarry. Such trials are needed, as creating the ideal scree slopes demands precision localized blasting.

"What you see from the Trans-Canada Highway is a nice slick wall with some benches," he said. "Rock sculpting is actually shooting the bench partly off to make a path for the animals to go up. We have not yet got to that point; we can't start it yet because it has to be done from the top down." Earlier in the company's conference room, he had shown the sequence of production progressing with diagrams out of the company reclamation plan: 50-plus years out.



In rock sculpting, niches are precision-blasted from the upper bench. Together with the resulting rockfall they form a slope providing pathway terrain for wildlife and access to vegetation. *Lafarge Canada Ltd.*

Not all of the existing rock wall faces have benches, however; when they were first mined it was not a regulatory requirement as it is now. "As we mine we have to put in catch-benches along the wall here," explained Boyt. "That is a safety bench so if any rock rabbles from the top it lands on the bench versus falling a couple of hundred metres and posing the risk of hurting someone."

As Boyt mentioned, the process starts from the top. "Then as we progressively go down we leave benches with access from other parts of the quarry. At a certain point we start rock sculpting, placing soils, planting trees, and so on," he explained. "Access is by ramps between the benches." They are just starting to get those first benches established.

The technique has its challenges. The slopes between the benches need to be backfilled at a 2:1 ratio, i.e., two metres of vertical to one metre of horizontal. They do not have adequate soil, so some must be trucked in. Same for much of the organic medium on the catchment benches to grow grass and trees. "We may have to buy it," said Boyt. In addition, "we are on the windward side of the mountain so it's difficult for trees to take hold. But as you go down the mountain it gets easier—the wind has less velocity."

Structural integrity is crucial too, as was shown by the UK trials. "We have done slope stability calculations," said Boyt. "We don't want another Frank slide.* We have a whole section in the plan on rock mechanics—will the wall hold up in the long term? We spent a lot of time and money understanding the different strength characteristics of the rock, chemistry, etc., and all the different mechanical properties of the rock."

One area of Lafarge Canada's operations that has been partially reclaimed is Seebe North; it is only partially reclaimed because the lease still holds shale deposits although it is not currently being quarried (see photo below). Once quarrying is complete sometime in the future, "our end plan for Seebe will be a big lake, about 350 metres across. We will make the lake and at some point decide if we want to stock it," said Boyt. No reclamation certificate can be applied for until the operation is complete. It is entirely on Crown land, where partial certificates are not issued. Boyt said that could be 50 or 60 years down the road, and it may eventually become part of the adjacent Bow Valley Provincial Park, as he pointed to the active cycling path nearby.

(Above) Lafarge Canada's Seebe North shale quarry, partially reclaimed. Seebe North opened in 1910 and has not been an active quarry since 1987. Since this time, the quarry naturally filled with water through surface runoff and groundwater seepage. The 2013 floods in southern Alberta also had an impact on the lake level. *Graham Chandler*

* The Frank Slide was a rockslide that buried part of the mining town of Frank in the Crowsnest Pass on April 29, 1903. Over 82 million tonnes of limestone slid down Turtle Mountain within 100 seconds, obliterating the eastern edge of the town. One of the largest landslides in Canadian history, the primary cause was the mountain's unstable geological structure, exacerbated by heavy precipitation and freeze-thaw cycles, although contributing causes may have included coal mining operations at the toe of the mountain as well as natural and blast-induced seismicity.

The company has selectively reclaimed old quarried areas too, on an ongoing basis. One example is the reclamation of part of its Exshaw limestone operation, shown on page 103.

Lehigh Hanson Canada's operation at Cadomin has been operating for more than 60 years. It has had little impact on the landscape due to its somewhat unique mining and processing. "The quarry was developed back in the mid '50s and resulted in a unique design with carved out limestone storage caverns inside the mountain for stockpiling limestone as well as a primary crusher and associated feed belts located about one kilometre inside the mountain," explained Brent Korobanik, environment manager at Lehigh Cement, an affiliated company. "This design minimizes the optical presence of the quarry as well as minimizes dust resulting from crushing operations."[37]

This unique approach minimizes the footprint of the operation, conserving land and air quality. But the company is preparing for longer-term reclamation. "Reclamation test plots have been completed to test different seed mixes and their ability to survive and propagate on a steep slope and in a valley with very high winds. Reclamation of the current quarry will not take place until far into the future when the access roads and internal systems are no longer in use and potentially a more traditional form of mining (pit) commences. Once the limestone is removed, the mountain will be significantly reduced in size and be more of a pit-like quarry." As that time is far off, no reclamation certificates have been applied for.

Away from the mountains, in the flatter lands to the east, different reclamation schemes are the order of the day. The most recent reclamation plans approved by the Natural Resources Conservation Board (NRCB) for quarries are similar to those discussed in Chapter 5 for coal. A June 2010 environmental impact assessment application by Parsons Creek Aggregates (PCA) for its Parsons Creek Aggregates Limestone Quarry, which included the reclamation plan, was approved by NRCB in March 2014.[38] Subsequently, it received Environmental Protection and Enhancement Act (EPEA) approval* in March 2015.[39] It is the most recently approved limestone quarry in the province. The project is north of Fort McMurray and a joint venture by Graymont Western Canada and Lehigh Hanson Materials Ltd., an affiliate of Lehigh Hanson Canada.

Much like the coal mining reclamation plans of recent decades, reclamation of the Parsons Creek Aggregates Limestone Quarry property includes stockpiling topsoil and overburden, revegetation with native species, and three end-pit lakes. According to the NRCB Decision report, the proposed end land use after quarry reclamation would be determined using the "best available information and in consideration of consultations with stakeholders (public, environmental groups, First Nations, the Regional Municipality of Wood Buffalo, and Alberta Environment and Parks) regarding rehabilitation goals and end land-use options." By planning a mix of woodlands, wetlands, and a quarry pond at the north end of the reclaimed site, PCA reasoned that the reclamation plan would provide for wildlife, and there would be a transition to natural areas from the south end of the site.

Some adaptive management (see Chapter 3, page 41) as resource extraction progresses is also provided for in the plan, as has been increasingly necessary in Alberta land reclamation. PCA emphasized that a sustainable recreational fishery is a primary objective for the end-pit lakes but acknowledged that if the water quality in the end-pit lakes proves detrimental to fish health, plans to establish a fishery in the lakes would be re-evaluated. It would, as an initial option, reconsider the design parameters of the end-pit lakes to attain the original reclamation objective. As a secondary contingency it would replace the end-pit lake feature as a reclamation objective and, depending on the balance of remaining reclamation materials, construct additional upland and wetland areas. The company noted that the end-pit lakes would also provide an enhanced waterfowl habitat. To support this, end-pit lakes would be constructed with irregular lake perimeters and with random placements of remnant oversized rock or overburden along the shoreline.[40] The Parsons Creek Aggregate Quarry is expected to enter production in 2016, after test activities that were slated for 2015.[41]

Hammerstone Corporation, in the same general area, is taking a new tack on end-pit lakes as a reclamation method. It is included in the company's brand new conservation and reclamation plan submitted at the end of March 2015. "I would say it is quite a departure from the typical; we previously had an end-pit lake, which was pretty common and still is," said Chris Wellwood, Environment, Regulatory, and Stakeholder manager. "But [an end-pit lake] is not a desirable end result so we chose to leave that behind and implement a totally new plan."[42] He said that was because there has been poor success in establishing the desired end points. In a lot of cases the larger the end-pit lake is, the more problematic it is. He felt many of the smaller ones have been successful, but when "you get into the larger ones a few kilometres long with unknown water quality entering them there are huge issues and a liability on the company."

Instead of an end-pit lake, Hammerstone is proposing

* EPEA approvals are only issued to quarries that have been subject to an environmental impact assessment; as a result, most of the quarries listed in the table on page 107 do not have EPEA approvals.

a wetland and chain lake system from the outset—as a primary objective. "It is a lot more work up front, but there are quite a few benefits to it," said Wellwood. "We have gone in this direction because number one it is much more appealing to the stakeholders whom we are leaving the land to once we're done. Because it supports the things they are after—traditional land use." Their stakeholders are primarily First Nations, so it supports moose habitat, which is key to them, along with traditional plants that require wetland areas to grow. "And those are diminishing because a lot of traditional lands are becoming end-pit lakes," said Wellwood. "Which are great for fish but not for trees and plants."

Controlling the surface hydrology is the main challenge in re-establishing wetlands—i.e., reconnecting pre-existing surface hydrology. "Anywhere water entered our lease from the east—water flows from east to west in our area, eventually heading to the Athabasca—we reconnected each of those spots coming from the east," explained Wellwood.

> So when we're all said and done, if there was a stream or channelized surface flow it will be reconnected in four different phases so that the Muskeg River will be receiving the same inflows that existed before we were there, rather than capturing it in an end-pit lake. I separated the four phases of our reclamation based on surface hydrology characteristics so that once we have moved out of one phase we can completely reconnect the hydrology in the area we just left and not have the risk of it flooding our current pit. Otherwise you can't do truly progressive reclamation because you have to wait for 20 years to do reclamation the way you need to.

It is really a new idea, he said, and indicative of new directions as quarry reclamation evolves. "There is still a lot of work to be done; I would like to say we are ahead of the game," said Wellwood. "What we have established for our reclamation plan is light years ahead. We have shown what can be done. I think with regard to end-pit lakes alternatives we might be a guinea pig."

It is a new application, and Wellwood feels adapting to new ideas like going for wetlands reestablishment from the start, in lieu of end-pit lakes, is going to take time.

> I definitely wouldn't expect the change in the next five years, but as new applications become due for renewal you might see new things requested by government that have the scientific backing to justify the request. Until there is new research you don't really have a lot to stand on if you're the government and are asking a company to spend a few million dollars on something. As government you need to have research to show this is why we'd like to have it done. And people want to know it will work. It becomes a tipping point where more and more companies will take it on.

Generally in the province, each quarry operation will have its own reclamation plan that may not follow a detailed set of guidelines and criteria. One specific area will deal with differing final landscape concerns, high walls, and long-term safety. Location and public use will be important factors in designing final landscapes.

Looking Ahead

Approaches to reclamation of quarries, as with other land disturbances in Alberta, continue to evolve. As we have seen in this chapter, at least two advances peculiar to quarry reclamation are poised to be instituted and proven: in the mountains, it is rock sculpting, and in the flatter Athabasca region, it is steering away from end-pit lakes and their replacement with more natural wetland complexes. Both are at the experimental stage and, because they are associated with several decades of future production, will demand some long waits before applying for reclamation certificates. Should ongoing reclamation activities prove up the new approaches with positive data and outcomes, they would likely be adopted into regulation.

Oil Sands

We do not inherit the Earth from our ancestors; we borrow it from our children.

Source unknown

During the warmer months, Eric Gérard's office is in effect the boreal forest surrounding the giant Syncrude project, and his job is to study local vegetation. "Research is improving our knowledge of the boreal forest and the key species," said the Québec-born vegetation specialist.[1]

"We are going to start including more and more species [in the forest] that even a few years ago we were not able to establish. What I see in reclamation in the future will be faster establishment of boreal forest and it's going to be more diverse as well. For example, we want to establish the low-bush cranberry. It's only one species, and there are about 2,000 species of plants in the boreal forest. We'd been looking

Strawberry patch in reclaimed area. *Syncrude Canada Ltd., CC 2.0*

at it for years before someone figured out how to break the plant's dormancy." Gérard is confident he and his peers will be able to re-establish other species in nearby forest and wetlands, one species at a time.

"As I walk through the land I look at biodiversity in terms of plants," he said in a June 2014 interview. "Before it was grass, now it's mostly flowers; like, raspberries, strawberries, roses like crazy, and you see insects everywhere. And, we have those mini-wetlands because of the bio-engineering and also because of the roughness that we leave." [2]

Amazed to see the number of frogs, he realized that as a species they were moving into reclaimed land. "Two years ago I walked one of the reclamation squares placed just a few months before, and I saw frogs," he said. "They are laying their eggs in the water. I thought it was impossible that a frog at this time of the year would travel to this freshly reclaimed land to lay their eggs. But then I realized that because we salvage the soil in the winter, we most likely salvaged those frogs with the soil. They are coming back in the spring and now they're fully alive and there are pools of water for them to lay their eggs in." [3]

This was a key development. "It is really sustainable. Every year now we see more and more frogs, and they feed on insects. Birds of prey eat those frogs and the chain is created," he said. "And now, we see a lot of foxes on the land feeding on eggs from different birds. We have some ducks nesting in upland areas. We have grouse that lay their eggs—a fox will eat that. It's not rare for my tree planters to see wildlife around. Having key species and a functioning ecosystem helps re-establish the fauna." [4]

Growth to the 1990s

The application of science and technology to the oil sands dates to the 19th century; mining for bitumen goes back 100 years. Interest in the oil sands has been a joint venture among industry, government, and science since promoters first identified it as a potentially attractive resource. The earliest mining attempts sought ways to exploit the resource, without any thought to reclamation. Given a growing environmental movement in North America since the 1960s, it was inevitable that government would use applied science as the basis for its thinking about reclamation, while industry would use applied science as the basis of its planning.

Serious on-site science of oil sands processing began with Sidney Ells, a federal mining engineer who shipped tonnes of oil sand to Edmonton for a road-paving experiment in 1916. Mining projects began in the 1920s when Thomas Draper established the McMurray Asphaltum and Oil Company, Max Ball began the Abasand project, and Robert Fitzsimmons incorporated a company that later established the Bitumount mine. These activities led to the first attempts to create commercial oil sands mines and upgrading plants.

The son of an oil equipment manufacturer active in Petrolia, Ontario, Thomas Draper first saw the oil sands in 1920, and received a lease in late 1922. The conditions the federal government imposed included that he was to construct an extraction plant within 18 months at a minimum cost of $30,000 and to operate it continuously for at least six months per year.[5] However, in its initial year of operation, 1924, his plant burned to the ground. He rebuilt it over the winter, and the following summer claimed that he was processing oil sands into oil. However, it turned out that he was actually mining the oil sands ore and delivering it for road paving and hot water separation experiments in

Sidney Ells and his crew hauling the first shipment of Fort McMurray oil sands 386 kilometres up the Athabasca River in 1914. *Glenbow Archives NA-711-187*

Edmonton. According to one commentator, "The load had certainly been processed, but not by Draper."[6]

Robert Fitzsimmons first visited the Athabasca oil sands in 1923 and bought out the exploration rights of an existing company. Incorporated in 1925, Fitzsimmons's International Bitumen Company—renamed the Great Canadian Oil Sands Project (GCOS) in the 1950s—was a business disaster for the entrepreneur but represented a breakthrough for the industry. He unsuccessfully attempted to obtain crude oil by drilling, and then constructed a small mine and oil separation plant at Bitumount.* He used a hot water process to separate bitumen from the oil sand, and made his first sale in 1930. Edmonton was the only city of any size in northern Alberta, so that is where he went to sell raw bitumen for setting pavement, but also as fence post dip and roofing tar.[7]

Max Ball's Abasand Oils Ltd. project was located on federal land near Fort McMurray. It began operation in 1936, using a hot water separation process, and intermittently produced small quantities of gasoline and diesel fuel until a fire destroyed the plant in 1941.[8] It was rebuilt in 1942 and taken over by the federal government in 1943 as part of the war effort. The project was abandoned after a second ruinous fire in 1945.[9]

Planning for the first large-scale bitumen mines started in the 1950s, even though conventional oil production was rapidly increasing and Alberta producers had concerns about competition from synthetic oil production. Plant construction did not begin until the mid-1960s. Sun Oil's Great Canadian Oil Sands went onstream in 1967, at a cost of $235 million. Soon after it began producing, the industry and the Alberta government began worrying about reclaiming the mines.

GCOS, which became part of Suncor Inc. in 1979, was the first commercial oil sands operation, but Syncrude became—and remains—the giant among oil sands mines and upgraders. GCOS received initial approval from the Oil and Gas Conservation Board (OGCB) in 1962—the same year the board rejected the Syncrude consortium's first application.[10] Syncrude applied again and the Energy Resources Conservation Board (ERCB—successor to the OGCB) deferred the application, but this time only for a year.[11] During that year, the Alberta government re-evaluated its oil sands policy and increased the production limit to a total of 150,000 barrels per day. In September 1969, the ERCB approved Syncrude's application, conditional on it going into production before July 1976. In 1971, Syncrude received further approval to increase its planned production capacity from 80,000 to 125,000 barrels a day. Syncrude finally went onstream in 1978 after a tumultuous time that saw greatly increased project costs, design changes, expanded capacity, and changed ownership, which eventually included participation by the governments of Alberta, Ontario, and Canada.

From the business side, Sun Oil became increasingly concerned about economic viability in an environment of lower oil prices. If Sun as a multinational corporation worried about the bottom line, the GCOS project led to worries within Canada that foreign interests—Sun Oil was, after all, a large American oil company—would come to dominate this vast resource. In 1972, the province developed a strategy clearly focused on this concern when, in 1972, the Conservation and Utilization Committee (CUC) prepared the *Fort McMurray Athabasca Tar Sands Development Strategy* for the provincial government's executive council (see Chapter 3). "Alberta must stand firm in the conviction that the tar sands make up approximately one third of the known world petroleum reserves," the authors wrote.

> As the demand for energy throughout the world increases, the price per barrel of crude will increase, and the higher the price rises the more economical it will be for the industry to extract, process, and synthesize secondary and tertiary components … [In time] Alberta should be able to utilize the tar sands as a lever in the socio-economic development of the province … In addition to regulating the timing and sequencing, the development of the tar sands will be constrained by insisting on Canadian investment and participation. This should be very definitively spelled out. The province recognizes that the development of the tar sands can only serve the interests of Albertans if Albertans are significant participants in the development. It should be the intent of the province to permit the development of the tar sands only where it has been satisfactorily demonstrated that Albertans and Canadians both will have the opportunity to significantly participate in the development.[12]

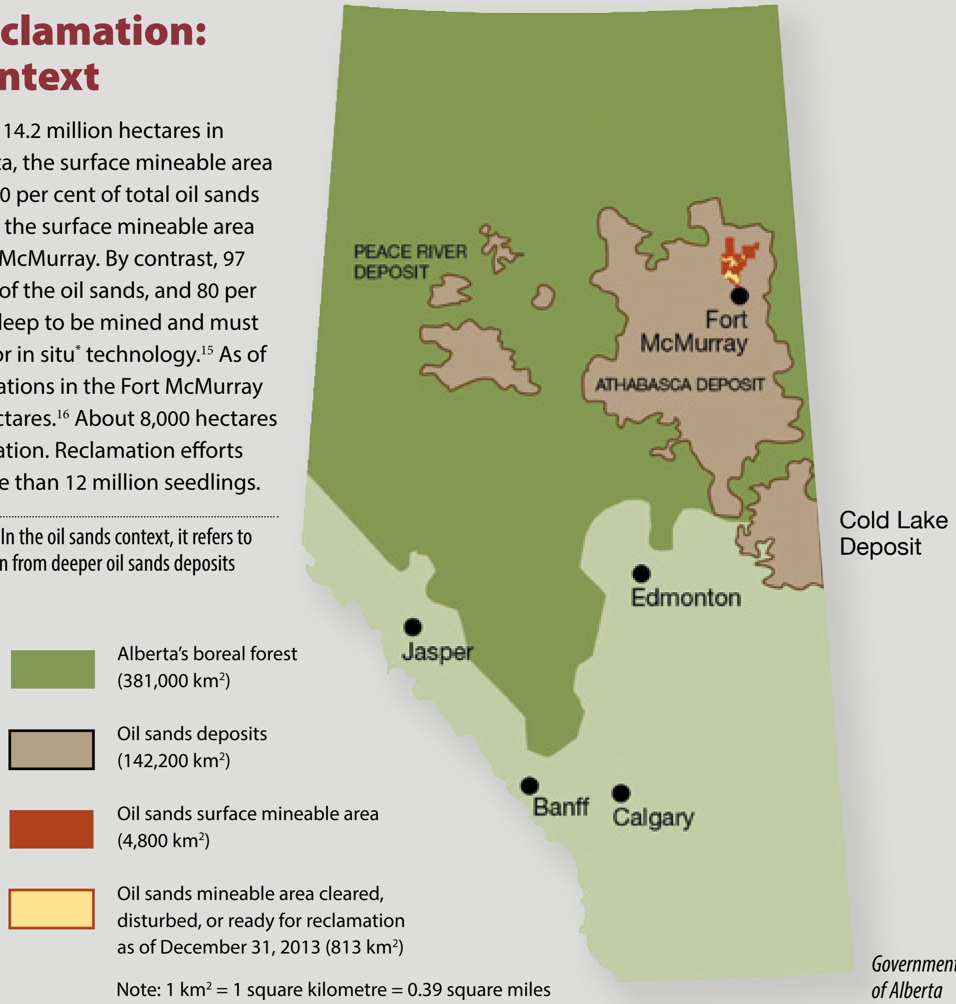
The strategy document also noted land reclamation issues, which it summarized graphically. Assuming eight Syncrude-sized plants, an annual production rate of 1 million barrels per day would mean daily water requirements equal to nearly 10 per cent of the minimum monthly average flow

* In recognition of its significant role in the development of the oil sands, in 1974 Bitumount was designated a provincial historic resource. Many aspects of the mid-20th century oil sands activities are still visible. These include the oil sands mine pits, separation plants, refinery buildings, office, and support and residential structures.

Oil Sands Reclamation: The Context

While the oil sands underlie 14.2 million hectares in northern and eastern Alberta, the surface mineable area is 480,000 hectares.[14] Thus, 20 per cent of total oil sands resources are squeezed into the surface mineable area located to the north of Fort McMurray. By contrast, 97 per cent of the surface area of the oil sands, and 80 per cent of the resource, is too deep to be mined and must be produced using drilling or in situ* technology.[15] As of year-end 2013, mining operations in the Fort McMurray area had affected 89,592 hectares.[16] About 8,000 hectares are in some stage of reclamation. Reclamation efforts have included planting more than 12 million seedlings.

* In situ – the Latin means "in place." In the oil sands context, it refers to technologies used to produce bitumen from deeper oil sands deposits without mining them.



Government of Alberta

of the Athabasca River. In addition, 2.5 hectares of land would be disturbed daily by mining operations. This report presaged a period of increasingly strict government environmental and land reclamation rules.

"Owing to the delay required before tailings ponds can be reclaimed, the denuded area may reach as high as 20,000 acres [8,000 hectares] before a balance between newly disturbed and reclaimed areas could be reached. And the volume of waste being disposed to the tailings areas would be in the order [of 1.5 million cubic metres] daily"—an amount equivalent to mining, each day, a volume of oil sand ore equal in volume to 17 Alberta Legislature buildings.[13]

By the mid-1970s, GCOS had reached some conclusions about effective ways to reclaim its mines. The company understood early on that reclamation would become an issue. GCOS was not only a pioneering oil sands plant; it was a pioneer in the complex forms of reclamation that oil sands mining required. Government and industry knew many of the environmental challenges posed by oil sands mining and undertook major research projects, such as those discussed in Chapters 3 and 4, to find solutions. The sheer size of the Syncrude project raised the stakes; although after its start oil sands development then slowed until new technologies and improved economics emerged in the 1990s.

Nearly 50 years after the opening of the GCOS plant, oil sands extraction has become big business in Canada. Large-scale oil sand mining operations and their associated upgrading facilities are among the largest industrial employers in the country. During periods of higher prices, oil is Canada's most valuable export. The challenges of reclamation are huge, too. Even if mining stopped today, the reclamation work would take decades and cost billions of dollars.

1990s to 2015:
Into the Modern Era

As bitumen mines grew in number, size, and capacity, the Alberta government's regulatory system began working with industry and others to develop standards for the reclamation of both mines and tailings ponds, both of which represented large land disturbances. It became evident that to reclaim these mines was a complex problem that would grow exponentially as the oil sands industry expanded. The interplay of field experimentation, legislation, and innovation led to increasing sophistication and, in recent years, greater collaboration.

In the 1990s, the stars aligned for a transformation in the oil sands mining industry. The oil sands business struggled with return on capital well into the mid-1990s because of high costs relative to low oil prices, said Rick George, who took over as chief executive of Sun Oil's Canadian operations in 1991.[17] Under George, the company did a public financing to become an independent Canadian company—Suncor Inc.—and he put together a team to transform company operations. Dee Parkinson-Marcoux, executive vice-president of oil sands and a mining engineer, took the lead role in developing a system of trucks and shovels to replace the bucketwheel excavators and conveyors. This innovation and that of hydro-transport of mined bituminous sand played an important role in the economic viability of these big mining operations by increasing speed and efficiency.

Led by the Edmonton-based Alberta Chamber of Resources, the government, the petroleum industry, and other stakeholders appointed representatives to review oil sands policy on a variety of technical committees. Eighteen months later, in 1995, the task force issued a report titled *The Oil Sands: A New Energy Vision for Canada*.[18] After the report's release, the federal and provincial governments developed a generic oil sands royalty and tax regime that would apply to all new projects after 1997.[19] One outcome was a large increase in oil sands spending. Suncor began a period of immense growth in mining and in situ operations. Syncrude also announced large expansions.

The 1995 *Energy Vision* report addressed the necessity of successful reclamation and acknowledged its importance in respect to mining operations and tailings ponds.[20] But some regulators, non-government organizations, and First Nations did not believe the government and the oil sands industry were doing enough on the land and tailings reclamation agenda. "The amount of cumulative land disturbance and tailings accumulation relative to reclaimed land was becoming a major concern," said Ralph Dyer, who was an Alberta Environment approval coordinator during this era. "This concern increased with each new oil sands project approved in the late 1990s and in the 21st century."[21]

The Operators

Oil sands mining is dominated by a small number of operators: Syncrude, Suncor, Shell, Canadian Natural Resources, and Imperial Oil; other companies—for example, French oil company Total and Teck Resources—also have proposed projects in the lineup, waiting for better market conditions.

Huge trucks transport oil sands from the mine to separation facilities at the Athabasca Oil Sands project. Clean sand and tailings will eventually fill the pit prior to surface reclamation. *Robert Bott*

The largest oil sands producer, Syncrude, is also the largest oil producer in Canada. A joint venture operated by seven different oil companies with a management team headed by Imperial Oil, it produces more than 350,000 barrels per day from two mining areas—Mildred Lake and Aurora North.[22]

Suncor Energy is Canada's largest energy company. Its oil sands operations include the Millennium Mine and Upgrader, vastly expanded since it began operating as GCOS in 1967, and the North Steepbank Debottleneck and Mine Extension operation, in service since 2007.[23]

In 1981, Shell began construction of the 100,000 barrel per day Scotford refinery near Fort Saskatchewan. The facility, which began operation in 1984, "is the first and only 100 per cent synthetic crude oil refinery," according to former vice president John Broadhurst. Scotford and Shell's Alsands mining and upgrading project, proposed in 1978, were originally designed to complement each other: Alsands would produce synthetic crude oil, and the refinery would process it. However, given the economic circumstances in the early 1980s, "the mine to produce the synthetic bitumen didn't make sense. There was an ample supply of synthetic crude oil from Syncrude and Suncor," and the Scotford refinery contracted to process that supply.[24]

When Shell revisited its Alsands project again, in the mid-1990s, it considered how best to integrate the output into its existing refinery. "We had to figure out how to transport bitumen 590 kilometres to the upgrader [located adjacent to the refinery]," said Broadhurst. And "that drives the process you have to have in place for the upstream. It was a very creative process: you have to look at what assets you have and what assets other people have and then you build out your options to take advantage of that."[25] The Alsands leases formed the basis for the Athabasca Oil Sands project led by Shell, which began production in 2003 and now has mining operations at Muskeg River and Jackpine.

The fourth oil sands mining and upgrading operation is Canadian Natural Resources's Horizon project, which went onstream in 2009. Located on leases initially covering 14.3 billion barrels of bitumen in place, at this writing CNRL's Horizon project produced about 112,000 barrels of synthetic oil per day.

The most recent of the current oil sands mining operations is the Imperial Oil/ExxonMobil Kearl project, which began its first stage of production in 2011. Using unique low-carbon technology and other innovations, Kearl could rival the scale of Syncrude and Suncor if and when it reaches full production as planned in 2020.

Legislation and Policy

Although Alberta's first reclamation legislation was enacted in 1963, formal requirements for land reclamation on public lands in the forested Green Area did not come until 1969. By that time, GCOS had already been operating for two years.[26] In 1973, the new Land Surface Conservation and Reclamation Act made it clear that reclamation would be an integral part of planning and operations for Syncrude and all subsequent oil sands mines.

The Syncrude project's research on land reclamation actually began in the late 1960s and early 1970s. "Reclamation planning was part of the original mine plan and obviously continued to be part of mine plans from that point forward," said former Syncrude Environment Manager Don Thompson. Thompson worked at Syncrude for 32 years, and during his tenure reported to every Syncrude president except the first. After retiring in 2010, he spent four years as president of the Oil Sands Developers Group. According to Thompson, the 1973 legislation represented a fundamental change in Alberta's approach to conservation and reclamation.[27]

Beginning in that year, environmental impact assessments (EIAs) were required for all new major projects. Syncrude submitted its EIA on July 13, 1973. That was the province's first EIA under the new legislation.*

The Lower Athabasca Regional Plan

In response to widespread concern about high levels of land disturbance across Alberta, in 2006 the province began a series of public consultations, with the notion of creating an integrated land-use management plan. Another public consultation process had also revealed widespread concerns about the cumulative effects of oil sands development. Two years later, the province released its Land-Use Framework, given force through the Alberta Land Stewardship Act in 2009. For the oil sands, the most important result of the framework was the Lower Athabasca Regional Plan (LARP) covering a 93,212-square-kilometre section of the province that encompasses oil sands mining projects and most in situ oil sands operations.

Before assessing the biological and cultural diversity of the region, LARP lays out its objectives. To balance the province's economic, environmental, and social goals, it would:

- engage Albertans, including Aboriginal peoples, in land-use planning

* An environmental assessment for the proposed upgrading of Highway 40 in Kananaskis (see Chapter 10) was done before the legislation.

Suncor's oil sand is mined using shovels with buckets that hold 100 tonnes, loading huge 240 to 380 tonne trucks. The mine delivers about 500,000 tonnes of oil sand per day to the ore preparation sites. *Suncor Energy Inc.*

- balance economic development opportunities and social and environmental considerations
- establish desired economic and environmental and social outcomes and objectives for the region
- provide guidance to provincial and local decision-makers regarding land-use management for the region[28]

Regarding oil sands mining, LARP notes that since these projects are sizable and continue for decades, "it is not practical or desirable to wait until activities are complete before commencing reclamation." As a result, Alberta developed a "progressive reclamation strategy" for these operations. While reclamation is taking place in some areas, clearing or mining are taking place in others. Sometimes it is possible to move the materials (topsoil* or subsoil) directly from the newly cleared areas to the reclamation site. Called "direct placement," this single-haul transfer saves money and minimizes degradation of soil. In many instances, especially in early stages of development, mines cannot avoid stockpiling large volumes of topsoil and subsoil. This storage means more land area is out of service, and adds to the cost and duration of reclamation operations.

* In this chapter, the term "topsoil" is used to include surface soils that are a mixture of various horizons (e.g., peat and underlying mineral soil) as well as the more accurate A-horizon-only usage of the term.

The progressive reclamation strategy "includes a suite of initiatives to improve clarity, security, and environmental performance within the oil sands mining sector." Examples include an enhanced certification process, transparent public reporting, and a reclamation financial security program.[29]

Mine operators must provide reclamation security as a guarantee that reclamation work will take place. As of August 31, 2014, the province held more than $1 billion in financial security.[30] The program considers the future oil sands production as part of the asset value of a mine project and uses that value to offset the liabilities; security is provided in letters of credit for the remaining liability amount. The Drayton Valley-based Pembina Institute suggested in 2010 that actual cost of reclaiming the disturbed land could be in the order of $10 to $15 billion—say, $220,000 to $320,000 per hectare.[31]

Reclamation became an increasingly complex and sophisticated business. "Oil sands project reclamation is described by a number of constraints and opportunities, resulting from regulation of the industry, the pre- and post-mining landscape, and the state of research and knowledge of reclamation techniques," said a team of experts in a 2011 technical study of the oil sands.[32]

Reclamation and Science in the Oil Sands

During the period between disturbance and reclamation, mining of oil sands has significant impacts on hydrology, topography, wildlife habitat, and native vegetation. The mining begins with the upstream diversion of waterways, clearing trees from the site, and sending the commercial-sized trees to forestry operations—a business the province regulates as strictly as oil sands development; government foresters and biologists work alongside forest industry representatives to develop harvest plans for the forest areas. Where present, peatlands are dewatered. Topsoils and subsoils are then salvaged and either placed on reclamation sites or stockpiled.

Then comes the removal of overburden—clay, rock, and even lean oil sands ore—and the creation of major storage facilities for overburden and waters affected by the mining and extraction processes, and the excavation of vast mines to produce oil sands ore.

After the mining is done, sand, overburden, and treated tailings are placed into the mine pit. External above-ground tailings ponds plus (recently) areas for drying tailings and a place to put them once they dry are also necessary. Then a working landscape forms—one that allows for surface water movement, drainage, and minimal erosion. Once the general shape of the landform is ready, crews cover its surface with stored subsoil and topsoil to prescribed depths.

Reporting Disturbance and Reclamation Status

In 2009, Alberta Environment introduced new definitions to better track the degree of land disturbance and reclamation progress. The chart illustrates the status of land disturbed by oil sands mining, with reference to the new definitions.

Certified Reclaimed (104 hectares at year-end 2013) means the area has met stringent reclamation requirements. When a piece of land receives this final certification, the land may be returned to the Crown. To date, only Syncrude's Gateway Hill has received this certification.[35]

Permanent Reclaimed (5,447 hectares at year-end 2013) means landform design, soil placement, and revegetation are complete (for both land and aquatic ecosystems). To receive this designation, companies must use local plant species to target the return of local boreal forest ecosystems. The company tests the soils and monitors tree and shrub growth for 15 years or more. Once it has achieved the required ecological trends, the company can apply for reclamation certification.

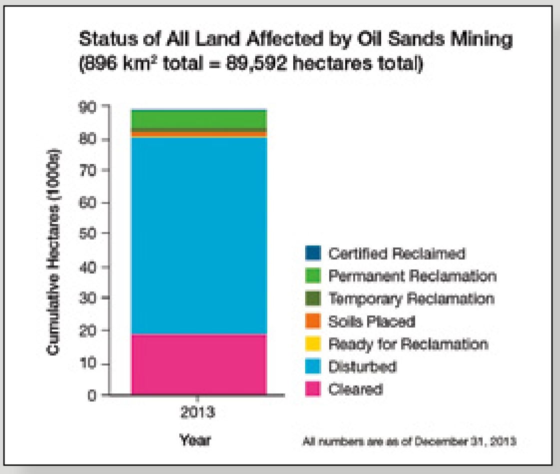
Temporary Reclaimed (1,244 hectares at year-end 2013) means some areas have been reclaimed and revegetated to grasses for the purposes of stabilization and erosion control. Still under company control, these areas may see future disturbance.

Soils Placed (1,543 hectares at year-end 2013) means soils have been placed as directed by each facility's reclamation and soil placement plans, as approved by regulators.

Ready for Reclamation (181 hectares at year-end 2013) refers to areas no longer required for mine or plant purposes, and therefore available for reclamation. However, the company has not yet begun reclamation activities.

Disturbed (61,832 hectares at year-end 2013) means the land is still part of a project's active operations.

Cleared (19,265 hectares at year-end 2013) means the land has been cleared of vegetation, but the soil is relatively undisturbed. In forested areas, the trees have been harvested and some of the smaller wood may be conserved for use in reclamation.



Disturbed and Reclaimed Lands[36] *Government of Alberta*

The operator is then responsible for planting native forbs, shrubs, and trees. The topsoils contain nutrients, seeds, and roots. Under the right conditions these begin to grow, recreating land much like the original forest. Frequently, however, to recreate the original habitat the operator needs to layer peat, fertilizers, or other constituents into the soil.

Oil sand processing also produces by-product coke and sulphur. While there are active markets for sulphur products, and coke can be used as a fuel or in steel-making,[33] unsold volumes require storage and eventual disposal.

Reclamation will also apply to the extraction and upgrading plants themselves. These huge sites will someday require decommissioning, remediation, and reclamation.

Once reclamation is complete the operator is responsible for monitoring. This involves testing the soil's chemical and physical properties and monitoring vegetation growth. Reclamation certificates are only issued after a suitable period of monitoring—possibly 15 years or more for boreal landscapes of the oil sands mining region.[34]

During the evolution of these practices, how best to handle soils and revegetation were topics of many discussions, according to agrologist Terry Macyk. "A key topic of debate was the efficacy of tailings sand as a growth substrate," he said. "Some argued that tailings sand was hostile material and that plants established in a replaced peat cap would not root into them. Time showed that all vegetation types and in particular trees did develop root systems that extended into the tailings sand layer and were comparable to those of trees in undisturbed soils in the surrounding forest."[37]

Practices and Processes

"Reclamation, as it is applied in the Athabasca oil sands region, involves returning the post-mining landscape to a condition that is capable of meeting the needs of local land users," a 2010 handbook stated.[38] The altered landscape must be placed on a long-term trajectory that will result in resilient, self-sustaining, and dominantly native plant associations similar to those existing in pre-disturbance conditions.

For practical purposes, processed sand from oil sands mines is infertile—virtually barren of nitrogen, phosphorus, and potassium, which are the three major nutrients for plants. Scientists found that soil reaction was highly alkaline due to treating the oil sands with caustic soda in the extraction process. The overburden clay and muskeg were higher in available nutrients and, mixed with sand, could provide a suitable seedbed by reducing alkalinity and improving water percolation and moisture retention. Until mixed with clay, peat, and fertilizers, the tailings sand would not support the mix of boreal vegetation that existed before mining began.[39] Early efforts to reclaim these areas, which began in the 1970s, could fail totally during rainless summers in the "droughty" climate of northeastern Alberta.[40]

Don Klym was in charge of reclamation at the GCOS-Suncor oil sand project from 1973 to 1986. From 1986 to 1992, he headed up the environmental group at Suncor, and his duties broadened beyond reclamation. Then his responsibilities expanded to include the entire regulatory area until he retired in 2003.[41]

When GCOS began operations in 1967, the topsoils that covered the mine site were called "muskeg soil—peat in various stages of decomposition. It was organic soil primarily, but it also was composed of other material including overburden, which is primarily clay and silt," Klym said. The way site preparation was done at the time, the soil was not retrievable for later reclamation. It was not until a decade later that the company decided to start stockpiling soils and became more selective in storing these materials so that they would later be retrievable and accessible.[42]

By the late 1970s, it was becoming increasingly clear that mine reclamation would soon become an imperative. In response, Klym's group conducted an inventory of all the organic materials in the mining area and made a map of their locations. Once these maps were ready, "the planning engineer—the person in charge of dealing with the overburden—had something to go on," he said. "We wanted to find direct placement opportunities as well as stockpile locations and to assure long-term soil needs for final reclamation."[43]

Initially, the objective was erosion control, and early experiments used agronomic grasses and legumes because they grow quickly and limit erosion. The ground cover was later replaced with barley playing an important role as a "nurse crop," which prevented erosion. "It is an annual plant, so it did not establish itself permanently. Instead, it played a temporary role as native plants established themselves." This became more important after the 1973 reclamation legislation came into effect and operators began looking at self-sustaining vegetation.[44]

"Our focus changed from introducing agronomic species as vegetation type to ecosystems, and that was a major turning point. In the latter 1990s, we began looking at soil capability for forest ecosystems," said ecologist Noreen Easterbrook, who also worked for Suncor. Into the next decade and currently, the industry worked on soil development for upland forests and wetlands, with subsequent revegetation to a variety of eco-sites. "In addition, we have advanced reclamation research and practices by expanding the perspective on the landscape more wholly and at the watershed level."[45]

Through trial and error, Klym said, "we found that if you're careful enough in terms of your soil stripping and if you strip your soil in such a way that you're not mixing it with other underlying materials, it's a wonderful storehouse of seed and root fragments and propagules*."[46]

In 1979, Suncor received its first Development and Reclamation Approval from the Alberta government. Because GCOS had begun before Alberta proclaimed the 1969 Public Lands Act amendment and the 1973 Land Surface Conservation and Reclamation Act, Suncor was in a unique situation with a unique set of land reclamation conditions.[47]

Surface soils on the Suncor lease were primarily organic with fen peat being most prevalent. Organic soils averaged about two metres in thickness. "Overburden handling and tailings disposal create the major land disturbances," Klym told a 1982 conference. "Upon site clearing and drainage, the muskeg soil is removed separately and stockpiled for reclamation use or deposited within overburden waste dumps."[48]

In his 1982 presentation, Klym noted that the sand would impound the liquid tailings by a dyking technique. Thus, the two substrates that must be contended with are the tailings sand and overburden spoil, and because these materials are used in construction of dyke and dump embankments most revegetation efforts up to that time had been on steep slopes of dykes and dumps.[49]

When Syncrude went onstream in 1978, the mine was the largest in the world.[56] It was the first oil sands project that needed to meet the criteria established under the 1973 Land Surface Conservation and Reclamation Act.

Robert Fessenden, who joined Syncrude in 1978, said that in the early years the idea was to return the whole mined area plus the tailings area back to natural forest environment. "The technology that was being used had essentially been brought in from agricultural experience and consisted of simply grasses and legumes." Fessenden has a forestry degree and a Ph.D. in soil microbiology; he worked for Syncrude's Edmonton-based environmental group from the start of operations in 1978 until 1982. He explained that Syncrude wanted to ensure that it had in place the technology to meet the reclamation standards of the day. The other kind of area that needed reclamation he called "construction disturbance"—for example, reclaiming water courses diverted to make way for operations.[57]

In the early days, the topsoil—what Syncrude's Don Thompson called "reclamation gold"—would get scooped up and mixed in with subsoils, destroying much of its value. Now it is carefully stripped from mined sites, stockpiled until needed, and eventually replaced on the surface of the back-filled mined areas during reclamation.[58] At one time, the idea was backfill the mine, plant the trees, and you're done," Thompson said.[59] "Today, it's to create self-sustaining watersheds and the diversity of habitat so it's not just a monoculture of spruce trees."[60] Getting there was the hard part.

With a background in silviculture, Earl Anderson worked on reclamation in 1974 as a summer student with Don Klym at GCOS. He joined Syncrude in 1977 and helped develop its reclamation practices. During that summer with GCOS, "our methodology was to fertilize at high rates and seed grass and legume at high rates," he said. They used muskeg peat to cover tailings sand and provided the fertility with chemical fertilizer and seeded grass and legumes to control erosion. The purpose of the legumes was to provide a longer-term source of fertility. Legumes fix nitrogen from the air and add it to the soil. "The plan was to fertilize until you didn't need to fertilize anymore. In that day and age, nobody wanted to think too far ahead."[61]

Reclamation practitioners, specialists, and staff at that time would establish a "grass blanket" to control erosion. The land was originally boreal forest, and a boreal forest requires trees. "The trees really were an afterthought, but of long-term consequence. Trees didn't do well competing with grasses on steep sand slopes."[62]

The reason it was so important to keep those slopes from eroding was that they were "holding back tailings ponds and you couldn't afford to have a breach of your pond and have those millions of gallons of tailings flow down the Athabasca River. I'm thinking here of both GCOS and Syncrude. If those dams had burst, that's where the tailings would have ended up," Anderson said. Early reclamation focused on maintaining the structural integrity of tailings ponds. "Reclamation was still in an infant state. If you look at other mines in Alberta or Saskatchewan, they were either un-reclaimed or reclaimed in an equally primitive manner."[63]

Anderson said the first objective in those early days was structural integrity, but the second was to make things look green. "If it was green you could take a picture of it, and it looked like you were doing the job you were supposed to be doing which was making it look like it wasn't an ugly mess. If you were growing barley, you knelt down in the barley and you had someone take your picture and you looked like you were standing shoulder deep in barley." Then both science and attitudes began to change. The focus changed to creating a reliable ecosystem in the area. After all, muskeg over tailings sand really didn't hold much water.[64]

* Propagules are any materials that assist in propagating an organism to the next stage of its life cycle.

Tar Island

The original concept of Great Canadian Oil Sands Ltd. was to take tailings from oil sands production—an emulsion of clay, bitumen, and other chemicals—and spill them over the escarpment into the Athabasca River where a small collector dam at Tar Island would hold them. The company initially expected that this system would hold back the solids and release clean water into the river. Unfortunately, the system did not work according to plan. Instead of cleaning the water for reuse in oil sands operations, the small dyke was releasing the materials as an untreatable colloidal suspension into the river.[50]

GCOS initially planned to deposit liquid tailings into the snye area impounded with a small overburden dyke. However, the company underestimated the liquid tailings volumes produced from the extraction process, Don Klym said. "So they decided, it's close to the plant and we have part of a containment there as the escarpment of the Athabasca River and we'll build a larger dyke out of the sand component of the tailings stream. In time, when there's enough of a mine pit, we'll start dumping everything into the mine pit, which would go westward."[51]

In short, the wisdom at that time was to create the first tailings pond by building two dykes to Tar Island, creating an "impoundment." That was "the state of the technology, regulatory regime, and environmentalism in the early 1960s. But over the years, the dyke was built up to a safe level, with stringent design, construction, and monitoring requirements."[52]

Although building a tailings pond immediately adjacent to the river would not get regulatory approval today, Klym was adamant that it was not an environmental disaster. "We built quite an extensive collection system for internal drainage which was required for geotechnical stability," he said.

> We had pipes coming in from the internal part of the dyke and everything got collected at the base and recycled back to the pond. As the pond was no longer required for tailings storage the reclamation process began using a new technology whereby the tailings water component was separated from the fines component and recycled to the extraction process. The pond was totally in-filled with the fines and sand to a trafficable surface ready for surface reclamation. Today it is well on its way to being a natural landform. Albeit, a new landform in the environment and on the river.[53]

A 2010 technical report on this reclamation project also described the pond as a relic from another time. GCOS successor Suncor Energy now terms the operation "Pond 1." When it went into operation "it was not certain that reclamation was possible," according to the authors. "The initial reclamation goals were significantly different than they are today, and environmental regulations were in their infancy. The pond is now being closed in a highly regulated environment and with a substantial knowledge base of reclamation techniques, well defined reclamation goals and clear end land use targets."[54]

The aim of this reclamation, they said, is to create a safe terrestrial landscape; to reclaim the landscape with soils that meet regulatory approval; to revegetate with vegetation that supports wildlife and traditional land use; and to create a small wetland that provides aquatic habitat without affecting the area's geotechnical stability.[55] On the surface, these may seem like simple goals. In practice, they were large indeed.

These photos show Suncor's Tailings Pond 1 in 2002 (left) and in 2010. Pond 1 was in operation from 1967 to 1997. As production increased, dykes were built to create a wider and deeper basin until eventually the pond was lifted about 100 metres above the Athabasca River. By 2010, reclamation of the pond created a stable surface solid enough to support vegetation. *Suncor Energy Inc.*

Anderson said reclamation became an important operation at Syncrude after the project began operations in 1978. The company used clays and muskeg over the sand, and then tried to till the muskeg into the clay. “For the next 10 or 15 years, we continued looking at ways of employing mineral material—fine-textured or more coarse-textured loams to sandy loams and sandy clay loams, and in various depths. We always wanted to get muskeg material mixed into mineral material.”[65]

Then, according to Anderson, Syncrude took a big jump. The native plants the company had been using for reclamation had grown in muskeg—“a very wet, poorly drained environment where they had evolved for ten thousand years. If you try to use them on an arid slope, probably those aren’t the propagules you want.” Since the landscape at Syncrude’s Mildred Lake property was half muskeg and half upland, it took the company a long time to get over the thinking that muskeg alone would make its prime reclamation material.[66]

All through the 1980s and into the 1990s, Syncrude looked at the upland areas as the source of its mineral material and the muskeg as a source of its organic material, Anderson said. “We did very little in terms of saving the LFH layer* of the upland forest soil—the layer of biologically active material.”[67] Depending on the type of eco-site, this layer can vary in thickness from two centimetres up to 30 centimetres. Reclamation researcher Dean MacKenzie found that “the less productive, nutrient-poor, dry eco-sites like a Jack pine stand wouldn’t have as thick of an LFH as aspen stands.”[68]

Anderson said it involved quite a shift in thought to begin taking off and storing thin layers of soil. Prior to that time, the company focused on using big machines removing thick layers of soil and minerals, the thicker the better. “We needed both mineral material and organic material.” The organic material came from muskeg, from deep muskeg pockets; the mineral material from the upland areas, “and in as deep a layer as you could take.”[69]

Stripping LFH topsoil did not become a standard industry practice until after the oil sands hearings of 2005, former Alberta Environment regulator Ralph Dyer said. “The Government of Alberta signalled this potential soil requirement in its submission to the hearing panels and followed it up with conditions in subsequent approvals.”[70]

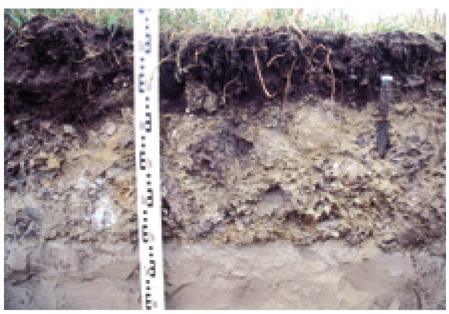
By the 1990s, Syncrude and Suncor had established the basic procedures still used for land reclamation in oil sands mining. This involved the placement of secondary material over tailings sand, followed by mixtures of peat of increasing thicknesses (up to two metres) over the minerals covering the tailings sand. The idea was to determine “how much of what is necessary to grow trees”[71] in the reclaimed areas, according to a 2008 expert report. Reforestation requirements, along with the need to re-establish ecosystem biodiversity, led to Alberta’s most recent reclamation policy —one developed specifically for the region of northeast Alberta that hosts the mineable oil sands deposits.

* Leaf litter (L), fermentation (F), and humus (H).

Secondary soil material over tailings sand, June 1995. *Terry Macyk*

Peat mix over secondary soil material layer over tailings sand, June 1995. *Terry Macyk*

Peat mix over tailings sand, June 1995. *Terry Macyk*



Peat mix tilled into secondary soil material layer over tailings sand, September 2001. *Terry Macyk*

The Challenge of Fine Tailings

Tailings ponds—a necessity for water-based extraction processes—are engineered dam and dyke systems. They are a combination of settling basin and storage container for the mixture of water, sand, clay, and residual oil left over after oil sands processing. As oil sands production has grown, so have the ponds, which now cover 17,600 hectares in the mining area.[72] Tailings management has risen from being almost a side issue when the first commercial oil sands plant began operations in 1967 to one under increasingly rigorous regulation and control.

Another critical challenge for oil sands mining operations is how to handle the tailings—a mixture of sand, silt, clay, water, and residual bitumen—left after bitumen has been extracted from the oil sand. Currently, this by-product is contained in large settling basins. The problem: there is no quick way to get the fine tailings to settle and dry out into a substance solid enough to support the equipment needed to get reclamation soil onto the surface. The longer-term goal, of course, is to reclaim the soil to the stage where it can support vegetation, trees, and wetlands.[73]

Tailings ponds serve two fundamental purposes. First, they allow the mineral solids resulting from the extraction process (i.e., sand, silt, and clay) to settle to produce clarified water suitable for recycling into the extraction process; on average, at least 85 per cent of the water used becomes available for recycling. Second, the ponds store the settled mixture of sand, silt, and clay.

The fines (tiny clay particles) associated with the tailings settle only over an extremely long time frame and build up in the pond. Even after many years they will still have the consistency of yogurt. Because fine tailings have come into contact with bitumen during the extraction process, the remaining water contains concentrations of natural chemicals that are toxic to fish.[74]

The problems related to tailings reclamation are technical and offer the biggest challenge, Noreen Easterbrook said. "Different companies have come up with their own versions of handling the tailings in terms of solidifying and neutralizing toxins. Tailings become the underlying material in the reclamation landscape."[75]

In his 2012 biography, Rick George described both the problems and the successes Suncor faced in dealing with tailings pond reclamation. "The first pond the company chose to reclaim covered about 220 hectares (Pond 1)," he said. No new tailings had been added to the pond since 1980. The company believed the older tailings would settle out quickly, but it took many more years than expected. "In 2010, when the tailings surface was finally considered sturdy enough, we covered it with 50 centimetres of soil, added large snags and rock piles to encourage predators, and then seeded it with native grasses and oats before adding 630,000 native shrubs and trees. The area was watered and fertilized, and the vegetation growth will be monitored for many years to ensure that it develops into a self-sustaining ecosystem."[76]

"The transitional cycle from tailings pond to mixed-wood forest and small wetland took more than 40 years," George said. He described that cycle as much too long but said the cycle would continue to be shortened.[77]

"You've got to start somewhere," George said. "The path forward is for us to have continual, rapid reclamation. Eventually, you will get to the point where you can mine without any significant tailing ponds."[78]

The industry is working with government, regional and Aboriginal communities, and academic research centres to develop technologies that will speed up the transformation of tailings into reclaimed land so that the land can receive a reclamation certificate and be returned to the province. "In the meantime," the government said in a 2015 web page, "strict regulations and a broad and intensive monitoring program are in place to mitigate potential impacts."[79]

"Storing the tailings and associated water in ponds has raised a serious policy issue, according to Robert Fessenden. "When the oil sands first got going, the government's policy was total water containment on site," he said. Over time, that policy led to incredible accumulations. A lot of that water does get re-used in the process, so there's a lot of recycling that goes on, but a lot of that stuff really can't be recycled. It's got too much of the colloidal fines in it, and they take forever to settle out. Over time we're going to have to find a way to treat some of that water to the point where [we can] reintroduce it into the natural environment in an acceptable way. Otherwise, I don't know physically how you're going to contain all of that material below grade forever."[80]

New Tailings Technologies

Under the 2009 ERCB directive 074 and the 2015 Tailings Management Framework, the government mandated the end of tailings ponds.* Companies were now required to reduce tailings and provide target dates to close the ponds. Also, operators were under pressure to create technologies that would enable them to process fluid tailings as they produced them.[81] The goal is to eliminate growth in fluid tailings.[82] New ideas were not long in coming.

Syncrude had used a system known as consolidated tailings (CT)—mixing its coarse tailings with fluid fines and gypsum. Since the company now needed to eliminate tailings ponds altogether, it began to develop centrifuges to remove the water from the solids.[83]

The new centrifuge technology would take three steps to transform the tailings into a reclamation material. The company would remove tailings-saturated water from the pond. It would then add a water treatment material—"a bit like flocculants used in water treatment plants"—to cause the fine tailings to congeal. The company would then use centrifuges to spin out the fluid. The $1.9 billion plant would feature 18 parallel centrifuges. About nine metres long and two metres high, the centrifuges look like long, steel tubes, spinning at approximately 1,700 revolutions per minute.[84]

In operation, the centrifuge plant would produce a clay-based tailings cake that would be held in storage for use in reclamation. After 12 to 18 months, "that material will become strong enough for use as a reclamation material. It first needs to go through one freeze cycle. Probably all 18 centrifuges will not be operational at once. Some may need to be kept in reserve for maintenance in the centrifuge plant. Also, we need to be able to manage the amount of tailings cake being produced."[85]

As Syncrude's centrifuge program illustrates, the most important problem with tailings is to remove water from them for land reclamation. Shell is also developing centrifuge technology, though using much larger devices.[86] In the interim, until the company has developed its centrifugal system, Shell uses a technology that carries the Atmospheric Fines Drying (AFD) name to accelerate the pace of tailings reclamation.

According to Shell VP John Abbott, the original test of AFD involved pumping mature fine tailings from the tailings pond into a large barge, which transferred them to a 30-hectare drying area. The mature fine tailings were then mixed with flocculants and the concoction spread on a sloped surface. This allowed the sun and gravity to extract the water from the tailings. The released water was reused for bitumen extraction, and the deposits of particles further

* The Alberta Energy Regulator suspended the directive in 2015 pending implementation of a new Tailing Management Framework developed as part of the Lower Athabasca Regional Plan.

(Above) Syncrude's $1.9 billion centrifuge plant, currently under construction, will spin water out of tailings to allow for accelerated land reclamation. Centrifugation is part of Syncrude's suite of technologies designed to manage tailings. *Syncrude Canada Ltd.*

dried to make sure they were strong enough to use in reclamation. The treated slurry has delivered 250,000 tonnes of soil useable for land reclamation.[87]

By combining it with non-segregated tailings, the Shell system can create a fine tailings mixture that contains 40 to 45 per cent solids and has the consistency of motor oil. Then other solids are added to the emulsion to create slurry.

Canadian Natural Resources does much the same, but they have an added piece, said Alan Fair, original director of Canada's Oil Sands Innovation Alliance (COSIA) Tailings Environmental Priority Area. "They treat all of their tailings with CO_2. The carbon dioxide changes the pH of the slurry, making it more basic so the fine clays drop out. They precipitate out more easily in a basic environment than in a neutral or acidic environment."[88]

"All de-watering technologies to some degree rely on gravity," according to Fair, "and they also rely on some form of polymer." These chemicals bind to clay particles, with each polymer becoming a complex molecule connected to many clay particles. Once a molecule has taken on its load of clay, it will settle more quickly. That, he said is the first step. From that point on there are only a few ways to separate solids from the water. "You can use thermal energy—heat it up and boil it off—or mechanical energy," which is what centrifuges do.[89]

"You can also use evaporation, like what naturally occurs, and that is what thin-lift drying does. In that particular technology you add the polymer or the flocculent and then spread the resulting slurry in thin layers. By doing that you create a large surface area that's exposed to the atmosphere," he said. "In the winter months there's little evaporation. It's a seasonal effort to dry them with evaporative forces."[90]

Suncor's most important contribution in this field is its Tailings Reduction Operations (TRO), another patented technology. TRO has enabled the company to cancel plans for five additional tailings ponds at existing operations. And in the years ahead, the company expects it to play a role in reducing tailings ponds at its present mine site from eight to two, and reduce the land area covered by ponds by 80 per cent.

Canadian Natural Resources, Shell, and Imperial Oil also use thickener technology for treating fluid fine tails, but each has a different approach.[91]

The technologies used at the Imperial's Kearl project are so new that the project will require entirely new reclamation technologies. Imperial has not yet established exactly how it will be done. "There are two key words about this reclamation proposal," said Imperial Oil's Stuart Nadeau. "First, it's progressive—we want to get in and begin the environmental work earlier. Second, it's adaptive, which means this plan will change as new technologies and learnings emerge, and as societal expectation about the desired end point of reclamation continues to shift."[92]

Differing Views of Success

The Alberta government withholds regulatory approval of projects until it has received and reviewed the closure plans that engineers and scientists prepare to describe reclamation proposed for the post-mining period. The cost and complexity of good land reclamation therefore offer powerful incentives for oil sands operators to do it right—to prevent unnecessary land disturbance when plant design begins, and to reclaim properly after disturbance. However, in recent years some industry critics have argued that the process is flawed.

In 2012, three scientists submitted a technical paper to the *Proceedings of the National Academy of Sciences*. They argued: "Alberta has no wetland policy requiring compensation for wetland loss in the boreal region." In addition, since the "volume of tailings and upgrading by-products exceeds the size of mine pits," when the mines have been reclaimed the area's landscapes will include hills instead of the level topography that dominated the region before mining began. "Thus, wetlands will be restricted to the depressions between hills and surrounding end-pit lakes." This would lead to a third concern: reclaimed landscapes would need to include channels that drain quickly. When these channels encountered wetlands that slowed the flow of water, the result could be "soil saturation, gully formation, and landform collapse." Finally, they argued, closing a mine would mean leaving ponds or lakes for tailings management. Since those lakes would be encircled by wetlands, the extensive evaporation surrounding them would reduce their ability to function. There is not a great deal of precipitation in the Fort McMurray area. In other words, these complex factors would limit each project's ability to recreate wetland area during reclamation.[93]

Perhaps the National Academy of Sciences paper took too literally an interpretation of Alberta's Environmental Protection and Enhancement Act. Oil sands operators need to return disturbed land to capabilities similar to those that existed before development, but not to completely recreate those original conditions. "Reclamation in the act's sense means reclaiming land capability in such a way that it will support a given land use [based on] the physical, chemical and biological characteristics of the land, including landscape (i.e., topography, hydrology, hydrogeology), soils and vegetation," another academic observed. "Individual land capabilities and land uses may change, but overall land capability and land use will be equivalent to pre-disturbance conditions."[94]

Every step in the oil sands story is open to public scrutiny, and the sector has long been subject to public comment by such environmental critics as the Pembina Institute. In a 2008 report, Pembina concluded, "the current policies and practices governing oil sands mine reclamation reveal an alarming range of challenges, uncertainties, and risks that deserve immediate attention and broader public discussion."[95]

In 2009, an organization named the Shareholder Association for Research and Education undertook a study of the risk to investors that tailings posed, and reached the following conclusion: "The information we collected suggests that companies are facing considerable risks associated with reclamation, in particular of fine tailings, process water, and wetlands. Limited progress has been achieved to date, and uncertainty remains regarding the future success of selected technologies and reclamation methods. Companies do not disclose the costs of specific reclamation technologies (in particular to treat their fine tailings), or of alternative methods that may need to be implemented if selected technologies prove inadequate." Thus, they concluded, the information available did not permit us to assess whether oil sands companies were deferring enough money to cover future reclamation liabilities.[96]

Robert Fessenden watched the oil sands progress from posts in industry, government, and academe. He did not play a role in the creation of the regulatory system, and in his view provincial regulation could have been better. He suggested the province should have taken a "full project approach" to land reclamation. Fessenden saw the reclamation of mines as an opportunity to create a better landscape. "The guys who like bogs at the University of Alberta took me to task for saying that. Maybe the politics weren't right at the time."[97]

Similar to the full project approach advocated by Fessenden, a team of technical experts argued in 2011 that reclamation should cover broader interests. It could focus on achieving equivalent capability, but it could also look for ways to optimize the value of the reclaimed area by considering "watershed, timber, wildlife habitat, recreation potential or other resources; and taking into account stakeholder preferences." Other considerations might include restoring forest productivity, developing the "aesthetic qualities of the landscape," or reclaiming the land for traditional land uses—a category that could include "spiritual and cultural uses," as well as hunting, trapping, fishing, and berry-picking.[98] These uses are all allowed for in the reclamation legislation and the End Land Use Committee report.[99] However, the options are constrained by the requirement for creating a locally common productive boreal forest ecosystem in the approvals.[100] The government, in consultation with stakeholders and Aboriginal people, has the final say and must balance the various expectations.

Conclusion

In terms of capital investment, the oil sands collectively represent the largest energy project on the planet—but also the largest reclamation effort. The oil sands will provide energy as long as they can economically produce hydrocarbons for transportation, heat, industrial operations, and petrochemical manufacture. As long as mining the oil sands represents a major Canadian industry, land reclamation around Fort McMurray will be a vital environmental and economic activity. The many voices echoed in this chapter suggest that reclamation techniques and policies have improved and will continue to do so, and that reclamation techniques developed for the oil sands will benefit industrial operators in the other boreal forests.

The industry, environmental specialists, government regulation, and key stakeholders have made oil sands reclamation a reality in places. The scale of oil sands operations creates the land reclamation challenges. It is behind the need for large amounts of brainpower, money, equipment, and effort to meet the province's regulatory requirements and public expectations. "Through regional planning, as well as other initiatives," the Lower Athabasca Regional Plan (LARP) said, "Alberta is shifting to a more effective and efficient management system that considers the cumulative effects of all activities and improves integration across the economic, environmental and social pillars. The system must adapt to place-based challenges and opportunities as well as allow decision-makers to see the bigger picture."[101]

PART THREE

CONVENTIONAL AND IN SITU PETROLEUM

Pump jacks in Alberta.
Shutterstock

Wellsites

It is this relationship of regulators, industry, and researchers that is fundamental to us evolving in the areas that we need to.
Anne Naeth

In 2010, Terry Osko and Maggie Glasgow released a study aimed at trying to understand why wellsite disturbances were slow in returning to natural forest. They noted that the density of trees on recovering wellsites could vary from very few to tens of thousands of trees per hectare, regardless of time since abandonment.[1] *To understand this problem, they studied 16 sites in four age groups—sites abandoned at five-year intervals from 1970 to 1995.*

"Since the ages of the sites varied, construction practices among the historic sites would also have varied somewhat," they said. They conducted their study on upland sites constructed during winter within deciduous-leading forest and

Five-year-old planted spruce among naturally occurring aspen suckers of the same age on a low-disturbance wellsite. *Terry Osko* *abandoned within one month of drilling. The sites covered about 100 metres by 100 metres and had been cleared of forest vegetation. The timber had not been salvaged, but burned. To level the sites, the operators had stripped away the upper soil layers. Given the reclamation criteria of the day, this soil may not have been replaced in the two older age classes. Such surface features as berms and sump pits remained in place after abandonment, and the sites had been seeded to non-native mixes of grasses and legumes rather than left for natural revegetation.*[2]

The inability of these sites to sustain natural vegetation was attributed primarily to the practice of removing the forest floor. This destroyed or disturbed plant propagules and reduced the organic material available to support tree growth. It also led to soil mixing and compaction—factors that resulted in "poorer conditions for root growth and water uptake."[3] *Also, of course, seeding the disturbance with non-native species made it more difficult for native tree seedlings to establish and grow.*

The researchers also examined the effects of a low-disturbance wellsite construction practice that incorporates "woody debris in combination with ice and snow" to level the site rather than stripping soil. Naturally colonizing trees did better on low-disturbance sites than on stripped-soil sites, primarily due to the proliferation of aspen suckers from roots left intact within the soil.[4] *This kind of collaborative research aims to help Mother Nature reduce industry's footprint on the land.*

Oil and gas wellsites and access roads, past and present, constitute a total land disturbance at least an order of magnitude greater than the widely publicized oil sands mining operations, yet the impacts are widely dispersed and pose quite different reclamation challenges. Science and technology, regulation, industry practices, and specialized contractors have made great strides in meeting these challenges since the first legislation in 1963. Back then, the first priority was to return the productivity of agricultural land. Initially, this involved removing debris and recontouring to prevent erosion and enable tillage. Then came a focus on conserving topsoil and later, the use of native seed on grasslands and the decontamination of contaminated sites. More recently, attention has been paid to reforestation of sites on public lands in the foothills and boreal regions. At any given time there are more than 120,000 inactive and uncertified abandoned wells in Alberta, out of a total of about 445,000 wells drilled since the early 20th century, including 55,000—mostly long, horizontal wells—for in situ bitumen production in northern oil sands regions.[5] This high level of activity and the ups and downs of the oil and gas market meant that land disturbances rocketed past reclamation efforts. Government and industry, with input from landowners and municipalities, have attempted to manage the vast reclamation task effectively and economically.

An Historical Perspective

In the middle of the 20th century, hydrocarbons began to develop into the mainstay of Alberta's economy. This began with the discovery and development of light oil at Leduc in 1947. Advances in technology helped the oil and gas industry expand rapidly but meant that land disturbance outpaced reclamation efforts. The province took steps to ensure that reclamation continued and evolved and that it did not take place at the public's expense.

Prior to Imperial Oil's transformative discovery of oil at Leduc in 1947, about 2,000[6] wells had been drilled in Alberta; on average, those wells reached a depth of about 1,000 metres.[7] Drilling and other forms of industrial development proceeded briskly, however, after Leduc #1. In 1947, agriculture contributed 16 times more to the provincial economy than oil and gas.[8] By contrast, in 2014 petroleum contributed almost nine times more than agriculture, which had cash receipts of $13 billion compared to oil and gas revenues of $110 billion.[9]

The nodding-horse oil pump has become a symbol of Alberta's oil industry and prosperity. These pump jacks, and the associated storage and transportation facilities, are a feature of rural life. "Christmas trees" of valves mark locations where gas wells reside. Power poles carry electricity to the wellsite, where controls may be housed in a waterproof shed. Typically, the pump jack would be sitting on a concrete pad on agricultural land.

The access to these operations connects them to public roads and highways. In the forested area of the province,

Arnold Janz does wellsite assessment with staff from ABMI and AITF, 2013.
Arnold Janz

clearings for wellsites, power lines, pipelines, access roads, and seismic cutlines are ubiquitous and responsible for opening up vast swaths of previously inaccessible lands to hunters, fishermen, all-terrain vehicles, snowmobiles, and the recreational public in general. The impact of the oil and gas industry on the forested area's vegetation, streams, lakes, wildlife, and fisheries has been immeasurable.[10]

More than 100,000 such wells have been depleted since Alberta's oil boom began in 1947, and production of conventional oil is declining throughout Alberta's oilfields as older wells become exhausted. The Leduc #1 discovery well—fully depleted in 1974, and now associated with a petroleum museum—illustrates what will eventually happen to all the wells drilled in Alberta since the industry got its start.[11]

There are no specific regulatory requirements that stipulate when reclamation and certification should begin. As a result the gap between the number of abandoned wells and the number certified continues to widen.[12]

The Chairman's Certificate

Both the Surface Reclamation Act and the Land Surface Conservation and Reclamation Act contained provisions for the issuance of a special class of reclamation certificate that became known as the Chairman's Certificate (see photo on page 50). The legislation provided that a certificate could be issued without an inquiry if the landowner consented to the termination of the surface lease in a form satisfactory to the chairman (see provisions below). Although not specified in the legislation, it was assumed that a landowner would not provide signoff unless the land was in a condition that allowed productive use. Hundreds of these certificates were issued, however it became apparent that many companies did not understand, or forgot, the second clause in the legislation that required a subsequent inquiry and issuance of a final certificate. This was likely in part due to the loss of the reminders provided by the annual rental payments.

Surface Reclamation Act s. 15

(1) when the Council is of the opinion that the surface of the land in respect of which the inquiry was held is in satisfactory condition, the Council shall issue a reclamation certificate

Surface Reclamation Act s. 16

(1) where evidence is supplied that is sufficient in the opinion of the Chairman to indicate that the owner or occupant, as the case may be, has consented to the surrender or termination of the surface lease or right of entry order, the Chairman may, before an inquiry is held by the Council, issue a reclamation certificate

(2) where a reclamation certificate is issued pursuant to subsection (1), the Council shall hold an inquiry with respect to the condition of the land referred to in the certificate and, at or following the inquiry, may issue an order under section 9

When the provision was not incorporated into the Environmental Protection and Enhancement Act in 1993, Land Reclamation Division staff decided to clean up the records related to the Chairman's Certificates. They sent out between 100 and 150 letters to companies informing them that they had only Chairman's Certificates, not final reclamation certificates for sites, and gave them a deadline for obtaining the final certificate.[13] Many companies were surprised to learn they did not have final certificates—common reasons were that they had lost records or had purchased a batch of sites and simply assumed that the word "certificate" in records indicated final certification.

The effort was successful in terms of getting final certification for the majority of the sites. Those that did not comply continued to be listed as uncertified and form part of the backlog of uncertified sites.

Derrick in southeastern Alberta, circa 1912. *CPR Archives A.37360*

Advances in Technology

In the early years, hardware used in the field consisted of wooden derricks and wooden tanks. Today's oil and gas industry has shifted to portable steel rigs and sophisticated tools and systems.[14] One part of the story is of the development of machines that provided ever-greater power and portability.

Improved down-hole drilling motors and the invention of other necessary supporting equipment, materials, and technologies—particularly down-hole telemetry equipment, which enabled rigs to drill straight on target—led to an explosion of new exploration and development applications. Producers and the drilling and service firms that support them found many new uses for directional drilling, especially when used for horizontal wells. Horizontal drilling also improved systems of underground fracturing ("fracking") of the reservoir and made shale gas and tight oil production possible at the beginning of the 21st century.

As horizontal drilling became more commonplace, the petroleum industry began combining it with innovations in both drilling and well completion technologies and ideas. Enhanced by geo-steering equipment, measurement-while-drilling tools, coil tubing, down-hole motors, and new bit designs, producers could now drill multiple horizontal wells from a single drilling pad, and those wells could be many kilometres in length.[15]

A related development is the use of multi-well sumps—that is, a sump pit used for a number of different wells. This reduces the footprint but makes attribution of reclamation obligations harder, and it increases the period before they are likely to be reclaimed.[16]

The accuracy of seismic surveys has also improved dramatically since the crude graphs that helped locate Leduc and other major discoveries in the 1940s and 1950s.[17] Innovations such as three-dimensional (3D) seismic today can pinpoint the underground location of potential oil and gas reservoirs. This reduces one type of land disturbance, for drilling unproductive "dry holes," but increases the number of seismic cutlines criss-crossing the landscape. This impact has been partially offset by use of much narrower, less intrusive cutlines. In forested areas of Alberta, the standard cutline today is a trail of mulched brush, less than three metres wide, compared to previous bulldozed corridors six to eight metres wide.[18]

Evolving Regulation

Alberta law provides energy companies with the right to surface access on private lands to drill for oil and gas. This enables companies to construct access roads and clear lands for wellsites. Typically, the company and the landowner sign a surface lease whereby the company agrees to pay rent for access. In other cases where companies and landowners fail to agree, surface access is governed by a Right of Entry Order issued by the province's Surface Rights Board.[19] On public lands, surface rights are acquired through a permitting and licensing process administered by the Crown. That system developed along with reclamation practices for the oil and gas sector since the mid-20th century. Unlike large projects that submit reclamation plans before development as part of the environmental impact assessment, most oil and gas wells and associated facilities have been licensed without prior government-approved reclamation plans. Today, the companies must abide by relevant regulations and environmental criteria, for both public and private lands.

Through the 1950s, oilfield practice was simply intended to keep a site clean and safe. Ross Pituka, who began work as a government field inspector in the 1960s, said that when an oil company cleared a drilling site in those days, "it was just cleared. Later on it became a question of, 'Why don't we have them strip the wellsites and then save that topsoil so that there'd be enough to put back on without having any kind of a problem?' That turned out very successful."[20]

In the 1960s, the provincial government—heeding complaints from farmers and ranchers—began focusing on having the growing petroleum industry reclaim its exploration and production sites to a state where they were compatible with agriculture and other uses. Initially, this meant restoring contours and preventing erosion. In 1963, the Surface Reclamation Act established a Surface Reclamation Council, a body of provincial and local officials to inspect and certify reclamation of lands disturbed by the construction of the wellsite and associated infrastructure such as connecting pipelines and access roads.[21] A 1969 amendment to the Public Lands Act allowed the government to issue reclamation orders and certificates for public lands not covered by the Surface Reclamation Act.[22]

In the early days, all reclamation certificates issued for private land had two signatures. One was a provincial government person, and one represented the municipality. The local members were appointed by the municipality to assist the provincial government and provide the local municipality's perspective. "They proved to be, in my case, very useful and beneficial," former field inspector Bruce Patterson said. "You weren't outnumbered [when dealing with a landowner or oil company]; there was somebody that had your back, so to speak."[23]

> They knew the management practices in the area. They knew the farmers in most cases, and they were a major source of information. It was an education working with them, because going from site to site to site they could fill you in on what's happening in different areas, what some of the soil issues were. In my case, I had experienced local members. They could give me a bit of the history of issues so you knew what to expect. You knew that certain things had to be covered in your inspection and the discussions before you made a decision.[24]

As mentioned, companies needed reclamation certificates to end their leases and therefore surface lease payments. By the early 1970s, they had to deal with rising landowner expectations and increased public environmental awareness, media scrutiny, and government requirements. The companies "were responding a lot better to what was happening," Patterson said. The oil and gas industry began to improve practices for sumps, trenches, and soil handling. "I'm going to give industry credit for taking a good look at these things and making adjustments. Some companies did and some didn't; some were more proactive, and others dragged their feet."[25]

As the 1970s progressed, the petroleum industry began working with government to leave their operations "green and stable"—that is, vegetation established on land adequately contoured to prevent erosion. "The debris was hauled away. It was levelled out, that kind of thing. It was mostly debris contouring and dealing with any water channels or anything like that so that they weren't creating those kinds of problems." That approach began to change after 1971 when soil salvage was included in requirements for coal mines at Grande Cache and Canmore.[26]

Key government initiatives included the 1973 Land Surface Conservation and Reclamation Act and the creation of a Land Reclamation Division within the province's Department of the Environment.[27] The legislation set standards for conditioning, maintaining, and reclaiming the surface of the land, but the provisions regarding wellsites did not cover remediation, approvals, environmental impact assessments, or financial security. Only major projects such as mines were subject to prior assessments.

In the following decade, as the science of reclamation evolved, the importance of soil handling and vegetation emerged. The province released reclamation guidelines in 1977[28] and minimum reclamation standards in 1980, updating them two years later.[29] During the 1980s, the government also developed the concept of equivalent land capability. "The ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land." This idea acknowledges that, "individual land uses will not necessarily be identical."[30]

Previously, including under the 1973 legislation, the emphasis had been on vegetation productivity as a measure of reclamation success, particularly in agricultural lands. As time went by, it became apparent that this was not an appropriate measure as it could be affected by natural factors such as drought or excess precipitation. It could also be affected by human intervention such as fertilization, herbicides, and cultivation that would result in a delay in regulatory decisions until the next crop year. When forested land was added to the scope of the program, it became obvious that time to confirm productivity would cause significant

Perspectives on Reclamation Practice

There are many reasons why people become passionate about reclamation. Take Arnold Janz, for example. "I was born in southern Alberta on an irrigation farm – sugar beets," he said. "In southern Alberta you have a lot of wind, [and] during the spring windstorms you'd see soil blowing across the landscape. My father told me when I was seven or eight years old and the neighbour's land was coming through the air across our home: 'Arnold, I'm never going to let that happen on our farm.' That piqued my interest about why you would want to conserve soil. When it came time to go to university and there was an opportunity to get into soil science, I jumped at the chance."[34]

In the late 1980s, he took a job as soil specialist for the Alberta government's Land Conservation and Reclamation Council. "That gave me the opportunity to meet [the province's] reclamation inspectors. There were about 20 of them across Alberta, working on private land, inspecting wellsites that could be certified. They would call me out if they saw issues or if they wanted confirmation of their assessments."[35]

Site inspection illustrated some of the internal conflicts that developed around petroleum development. Oil and gas operators would want to get reclamation certificates so they would no longer have to pay rent to farmers for the use of their land. "That's why the whole certification system was put in place, so companies' obligations would cease and liability would transfer to the Crown," he said. Cancelling the surface lease for a site requires reclamation and a reclamation certificate, so companies would have liability for a certain number of years, after which [liability] would pass to the Crown.[36]

"That's why there are 60,000-plus [currently about 66,000] reclamation certificates for wellsites, but few issued for other activities that do not have surface leases. Certification involves private landownership and it's focused in areas where people can be quite vocal and passionate about the lands that they're managing for themselves," added Chris Powter. "Some farmers were reluctant to get reclamation certification, because they wanted to extend annual rents from their leases to the industry, while others were perfectly happy to have their leases certified as reclaimed."[37]

There were many inspectors, and they operated in different ways. So in the early 1990s, Janz proposed to Alberta Environment's reclamation council that it establish criteria that would standardize the rules. That was because companies kept asking, "How can you say that that site is not ready for a certificate? What are you basing it on? Do you have a set of criteria that you can share with us?" Janz suggested that the department develop "criteria or a standard, and that's what I did in 1990–91. That formed the basis of what we currently have as the wellsite criteria." The outcome was the creation of a 13-point set of land reclamation criteria.[38] Alberta revised these guidelines four times, most recently in 2010.[39]

"When I initially got into this, we did not have the tools, the electronic tools and all the sampling techniques to identify contamination" that are available today, Janz said. "We were primarily looking at the surface, making observations. I had a soil auger and a shovel and I used those extensively, especially my shovel." In that way, " I was able to identify a lot of contaminated sites that eventually cost companies millions of dollars to reclaim."[40]

Before view of flare pit. *OWA*

Reclaimed view of former flare pit. *OWA* delays. Beginning in 1983, the focus began to shift to capability, the ability of the landscape and soils to support the intended use. Vegetation could still be a factor in evaluating the success of reclamation, but it would not be the only determinant. (The performance of vegetation could also be an indicator of other issues such as soil contamination.)

Ties between Field Inspectors and the Farm

The relationships between the Alberta government's reclamation inspectors and landowners had an important impact on land reclamation work in the field. Former inspector Bob Onciul began his reclamation work for Alberta Agriculture in 1967 and then with Alberta Environment after the department was created in 1971. In that period—the early 1970s—a field inspector's mandate was to hold inquiries and either issue reclamation certificates or "advise [the companies] to do more work" to get one. At that time, the reclamation mandate on agricultural property was, by today's standards, primitive: get debris off the wellsite, remove rocks, and make sure there was growth. "There was no such thing as equivalent [land] capability" back then. Operators had to remove obstacles to farming.[31]

Farmers faced numerous issues related to oil and gas operations. They were "hooking buried metal with their equipment," Onciul said. Buried trees in wooded lands were causing cave-ins. Some land was unproductive because of salts or petroleum products spills. It was difficult for older sites to meet the earliest provincial criteria because of practices that had been going on to that point in time.[32]

One of Onciul's colleagues at Alberta Environment was Ross Pituka, who described similar situations. Field inspectors would "try to get the location looking back more or less like it was," Pituka said. He acknowledged that the outcome would not be perfect: "If they had any side hill or something like that, they wouldn't be able to build that side hill back to the plane that they want. So what we'd allow them to do was to flatten it out [by modifying the soil with a tractor or other heavy equipment] to where there wouldn't be any problem." Then "we would have it seeded, making sure something would grow." When the owner said he was satisfied, "we would let it go at that."[33]

Wellsite Remediation and Reclamation

Both remediation and reclamation became increasingly important as the petroleum industry grew in size and complexity and as older sites needed to be reclaimed. Innovation in reclamation science and practice paralleled growth in conventional petroleum activity. In the recently developed practices of producing shale gas and tight oil by fracturing from horizontal wells, the same reclamation practices apply. With the development of in situ production from the oil sands, reclamation of an intensive complex set of oil and gas facilities and operations becomes more complex and will also need to be addressed eventually.

Before discussing the matters of remediation and reclamation, it is worth reviewing the difference between the two words. In 1973, the word "remediation" was not in general use in Alberta. "Everything we did was under the broad rubric of 'reclamation,'" said former Alberta Environment official Ralph Dyer. "Consideration of remediation (decontamination) only began in the early 1980s." Amendments in 1983 added contamination to the definition of "surface disturbance" in the legislation.

The final cleanup of a wellsite begins with "abandonment" (the technical decommissioning of the well). Remediation, if necessary, comes next, followed by reclamation activities such as contouring, topsoil replacement, and establishment of vegetation.

If at time of exploration a well is "dry" (that is, no commercial volumes of oil or gas) it needs to be abandoned and the site reclaimed. If both oil and gas are found, the oil will likely be depleted first, since pressure from the gas cap is used to drive oil to the surface. When the oil is depleted, most of the wells in the field are shut in, abandoned, and reclaimed. The remaining wells are used to produce the gas cap (in general, operators need fewer wells to produce natural gas, which flows more easily to the surface than oil). When the gas cap is gone, the operator abandons and reclaims the remaining wells. Producing wells may be in operation for 25 years or more. Often, wellsites may become quite contaminated over time with salt water and hydrocarbons.

Since the 1980s, regulators and environment officials have expressed concern about the growing numbers of

Wellsite lease, Alberta, 2005. *Wikimedia, CC 3*

inactive wells (those that have not produced for a year or more) and abandoned wells that have not been reclaimed or have not received reclamation certificates. By 2014, when the Alberta Energy Regulator announced its latest program to address the problem, there were 80,000 inactive wells.[41]

Abandonments

The oil industry refers to the process of returning old wellsites to their preindustrial condition as "abandonment." Licensees abandon wells when they no longer need them for production and development, or because their mineral leases have expired. By law, the licensee is responsible for abandonment. Oil and gas authorities, i.e., the Alberta Energy Regulator and previous bodies such as the Energy Resources Conservation Board (ERCB), regulate the process.

The first step in the process of abandonment is to get everyone with an interest in a particular well to agree that it should be abandoned and determine how the job should be tackled.[42] Those involved include the oil and gas licensee (often one company operating a lease or leases for several partners) and the owner of the mineral rights (usually the province). The landowner (e.g., a farmer) or occupant (e.g., a forest company or grazing lease holder) must also be notified. The licensee needs to test the well to ensure that it will not pose any risk to the environment or the public once abandoned. If problems arise during the tests, the licensee has to modify the well to bring it up to standard. Each partner has rights to be respected, and each needs to be satisfied when abandonment is complete. It is important that abandonment happens promptly, according to Barry Robinson, who was an environmental consultant for 15 years before becoming a lawyer for Calgary-based Ecojustice. This organization often intervenes in matters related to well regulation. "The longer wells sit, the fuzzier the records get," Robinson said. "And the longer wells sit, the more likely that if there's underground contamination—and quite often there is—it moves off site."[43]

Producing wells can lead to soil contamination, which generally consists of hydrocarbon or saltwater spills or leaks. Most oil spills do not migrate very far and are easy to remediate if caught early because they biodegrade or can be treated chemically. In some cases, lighter hydrocarbons like benzene filter into groundwater.[44] Saltwater spills are particularly problematic. Extremely salty water, up to 100 times more saline than seawater, emerges from some deposits along with oil or gas. "Chlorides from saltwater don't bond with soil, and so, if spilled, move freely through sediments along with runoff and groundwater," a 2011 article noted. "A buildup of chlorides can ruin an entire aquifer, making it undrinkable for humans, as well as useless for irrigation and livestock. Sodium molecules bond tightly to soil particles and cause clay dispersion (or 'soil dehydration'); the only way to reclaim such soil is to replace the entire affected area."[45]

Saltwater spills and oil spills were common in the 1960s and 1970s. "The ERCB actually allowed companies to release a certain amount of salt water every month if they were producing more than they had the capacity in their tanks to store," said Alberta Environment's Arnold Janz, who had also served as a field inspector. The industry was "allowed to release it onto … farmland, and I imagine this happened up in forested areas, too. They were releasing salt water every month."[46]

Satisfying Reclamation Expectations

The final look of a reclaimed site should reflect the wishes of the landowner and the intended use of the land. When a

An abandoned wellsite in the boreal forest near Conklin. Until recently, reforestation was not a requirement for reclamation of oil and gas sites on Crown land. *Robert Bott*

well ceases to be productive, a contractor for the petroleum company typically reclaims the site. The company's environmental advisor requires uncommon skill. "He or she must be part agronomist, part landscape architect, and part diplomat."[47] Having lived alongside the oil industry for a lifetime, in many cases, western Canadian farmers are tough and shrewd negotiators.[48]

The operator needs to meet exacting standards when reclaiming wellsites and this involves several distinct procedures. Over many years equipment and machinery compact subsoil, so that soil has to be loosened mechanically. The operator then re-contours the surface to make it blend in with the surrounding topography, which also requires reestablishing the original natural drainage courses to avoid erosion. The next step is to replace the topsoil—enriched, perhaps, with straw, manure, and peat—and finally establishing vegetation.[49] Precise criteria are spelled out for landscape, soil quality, and vegetation under the 2010 *Reclamation Criteria for Wellsites and Associated Facilities*.[50] For example, the crop-growing capability of a reclaimed site must be equivalent to that which existed before disturbance began.

The operator of a well and associated access road applies for a reclamation certificate after addressing contamination and surface reclamation issues. It is important to note that wellsite certificates do not cover the connecting pipeline, even the part under the wellsite. The pipeline requires a separate certificate.[51]

The application must include a determination of the potential for contamination, and where applicable an analysis of contamination and details about how contaminants were remediated, and assessments of soil replacement (quantity and quality) and revegetation. The Alberta Energy Regulator (AER) will not issue the certificate until all conditions are met.[52] The AER certifies the reclamation based on information in the company's submission, which must be "signed off" by the relevant registered professionals such as engineers, biologists, agrologists, foresters, or chemists. The certificate can be cancelled and additional work ordered if deficiencies are identified through follow-up audits or complaints from landowners. This is a significant departure from the previous regime that existed since the 1960s in which government inspectors would visit the site and conduct a detailed field inspection before approving certification.[53] Introduced in 2003 (earlier for some public lands), the audit-based system meant that private-sector professionals replaced reclamation inspectors as the evaluators of reclamation success.[54]

If requested by the landowner, in some cases the operator will leave access roads and pads in place as an acceptable reclamation option. This, of course, can have repercussions for both present and future landowners as, once the decision is made to leave these in place, there is no requirement for the company to remove them in the future.[55]

Legacy Seismic

In the first stage of oil and gas exploration, surveyors conduct seismic surveys by detonating explosions* along lines constructed through the countryside. The corridor in the photo was built through a boreal forest in the late 1980s or 1990s and is only now being reclaimed. The continuing presence of these lines has had a negative impact on woodland caribou because they serve as "highways" (or "access corridors"), making it easier for packs of wolves to hunt these endangered creatures. The soil mounds in the photograph are part of a contemporary reclamation effort.[56]

Alberta's boreal forest is "a wolf-moose system," according to Susan Patey-LeDrew, a senior environment advisor at Cenovus Corporation, who is now involved with reclamation work in the Cold Lake Weapons Range. "Wolf and moose would hang out in the more productive forest areas such as river valleys and mixed-woods. Caribou would hang out in the less productive bog and fen areas," she said. "But the old way of doing seismic was creating mini-highways and moose habitat maybe six to eight metres wide. But for some reason those seismic lines are not growing back, specifically on those wet sites. "It's a stagnant system. You don't have trees coming back, or natural revegetation.[57]

Foresters have offered a number of hypotheses to explain why so many heritage seismic lines have not grown back. Limited regeneration is caused by the lack of a viable seed bed (a heavy moss layer), level and compressed surfaces that retain spring snowmelt, a high water table in general, and shade. Whatever the reason, to start re-growing trees requires a "kick-start" to give the seedlings a higher success rate. "Often when you plant seedlings in wet areas you get a high percentage of trees that die off. But we're trying other techniques to get the trees to grow faster."[58]

* The concussions for seismic surveys can also be produced by "vibroseis" trucks or, in water, air guns.

In a process called "linear deactivation," Cenovus reclaimed seismic disturbances by enabling natural growth to return. *Cenovus Corporation*

Reducing the Footprint

Soil management is now a major component of wellsite reclamation. Soil science practices have become sophisticated, as have related developments in revegetation, hydrology, and land contouring. In agricultural areas, the emphasis is on crop productivity, in non-agricultural areas the establishment of native vegetation.[60]

As the amount of disturbance grew and regulations became stricter, companies began to specialize in land reclamation. "We're getting really good at putting it back to equivalent land capability," said Paul Blenkhorn, a vice-president with one of those companies. The work his firm does is not about reducing the number of wellsites created. Rather, companies want "to create that wellsite, maximize use of that resource, and then put it back to equivalent land capability. That's the measure of success. Whether it's in the oil sands or it's as simple as a wellsite on an agricultural field." In those cases they go out, they produce the oil or natural gas, and after reclamation "it's a wheat field again. It's back to equivalent land capability."[61]

The contemporary non-conventional oil and gas sector—production of tight oil and shale gas through fracking—sometimes involves underground horizontal wells several kilometres in length. This activity leads to a lot of land disturbance at the well pads, since many wells can be drilled from a single pad, and therefore a large requirement for reclamation. "It's a bit counter-intuitive," said Blenkhorn. "You have fewer surface disturbances, but each one is larger. A pad site has multiple wells on one pad. The pad is bigger, the roads to get there are bigger, the services are bigger, but there are fewer pads because [the wells] branch out like a spider web from a single location."[62]

By contrast, although conventional shallow gas drilling programs involve more drilling sites, each site creates less land disturbance. They also have a long lifespan (reducing the need for additional future sites) because the companies that develop those sites "do a sophisticated job of calculating net payback value, and put them in locations where they'll get a lot of bang for their capital," Blenkhorn said.[63]

According to current government policy, the operator "shall reclaim all disturbed land surfaces within two growing seasons. Interim reclamation, including site and debris cleanup, slope stabilization, recontouring with subsoil, and spreading of topsoil shall be done progressively and concurrently with operations. This includes all disturbances associated with the site (log decks, campsites, borrow areas, remote sumps, access roads, etc.). This also applies to prepared and/or built-not-drilled sites."[64]

In some cases, different operators drilled from overlapping wellsites. In others, wellsites overlapped other activities such as access roads and pipelines. In cases where more than one operator creates a disturbance on the land, each of the operators needs to get a reclamation certificate. An operator may apply for an exemption from certification providing the other operator agrees to be responsible for reclaiming the overlapping portion of the site.[65] It has also become common for different industries to have overlapping reclamation responsibilities. This adds additional complexity to an already complex reclamation process.

The reclamation of land disturbed by conventional oil and gas operations established many of the regulations and methods also used for in situ bitumen production operations and fracking to produce tight oil and shale gas.

The Orphan Well Issue

Orphans are wells that belonged to companies that became insolvent before their owners could meet their obligations to fully abandon and reclaim them. From 1998 to 2014, the provincial orphan well program spent $73 million on abandonment and $113 million on reclamation of wellsites.

The question of how to reclaim these wells arose in the late 1980s. Hans Maciej—vice-president of the Canadian Petroleum Association, then the largest oil industry association in Canada[66]—took the position that the petroleum industry should be responsible for reclaiming them. After all, that sector had benefitted from oil and gas production.[67]

At that time some companies were developing schemes to create shell companies into which they could put their unprofitable assets, according to Maciej. He worried that a "lowest common denominator" approach would prevail, and he got support for his concern from the large oil companies his industry association represented.[68]

In 1994, the government passed Bill 5, establishing the Orphan Well Program "to abandon oil and gas wells which have no remaining viable owner." It was financed by the oil and gas industry and administered through the regulator (known as the Alberta Energy and Utilities Board or EUB from 1995 to 2007). Companies paid for the program through a licensing fee on new wells and a levy based on their number of inactive wells.

In 1997, the EUB attempted to force abandonment on the industry with the launch of the Long Term Inactive Well program. This program gave companies five years to abandon, sell, put a deposit (a kind of financial retainer) on, or reactivate wells that had been inactive for 10 or more years. Constrained by low oil prices at the time, industry pushed against the new rules. "Their response was that [these requirements were] too financially onerous. It was a liability management question, not an environmental question," a magazine article observed.[69]

The inactive well program was an environmental failure because companies placed deposits rather than actually abandoning and reclaiming inactive wells.[70] Facing pressure from industry, the regulator rescinded the program and replaced it with an expansion of two pre-existing regulatory mechanisms: the Licensee Liability Rating program (LLR) and the Orphan Well Program.[71] In 2000, the Energy Statutes Amendment Act extended the program to pipelines, upstream oil and gas facilities, and surface reclamation.[72]

In 2002, the government established the Orphan Well Association (OWA) as a separate organization, financially independent of the regulator, to manage the abandonment of orphan wells, pipelines, and facilities, and reclaim associated sites.[73] The association is a uniquely Albertan entity called a Delegated Administration Organization, established whenever the government regulates the collection of funds for a specific activity and remits the funds to a separate not-for-profit organization to manage the funds.[74]

In 2013, the ERCB upped the industry's liability costs to minimize financial risk to the OWA and "to protect Albertans from the costs to abandon and reclaim upstream oil and gas facilities from defunct licensees." Under the revised regulations, the board required 248 licensees to post financial security of $297 million over a three-year period. The ERCB (which shortly thereafter became the Alberta Energy Regulator or AER) compared a licensee's assets with its liabilities, and it required companies to provide security if their liabilities exceeded their assets. If a company failed to pay the required security, the board could order the operator to suspend or abandon its facility.[75] These realities notwithstanding, at this writing some vocal landowners believe that Maciej's worry about the lowest common denominator is becoming reality.[76]

Energy price shocks contribute to the inventory of orphan wells. Given the volatile nature of petroleum pricing, they arrive in batches. In January 1986, for example, oil prices plummeted by about $13 per barrel in a single month, averaging $14.43 per barrel for that year.[77] A dozen years later, a respected business magazine trumpeted that, "the price of oil has fallen by half in the past two years, to just over $10 a barrel. It may fall further."[78]

In 2014, the Orphan Well Association reported that a key reason behind another surge in orphan wells was that, "the price of [natural] gas has been low too long."[79] The gas price collapse began in 2006 and climaxed two years later, during the Great Recession. "A huge increase in the amount of wells that operators have walked away from due to regulatory changes and a hike in bankruptcies means Alberta producers will soon be doubling their payments towards a fund that reclaims those wells," wrote the *Daily Oil Bulletin*. The industry publication quoted OWA manager Pat Payne, who said the number of orphan wells had gone up fourfold

Before and after photos of reclaimed orphan wellsite. *OWA* in the previous six months, and that producer associations had agreed to double their 2014 levy to $30 million.[80]

In 2015, the number of orphan wells quadrupled, from 162 to 702. At the current rate of OWA reclamation it will take 20 years to address just this year's supply. The number of abandoned wells was almost equal to the number reclaimed in the 21 years since the Energy Regulator set up systems for orphaned site reclamation. In the 10-month period ending April 2015, the Orphan Well Association inherited 100 or more wells each from four companies.[81]

Yet there are probably more orphans to come. The oil price collapse that began in 2014, after nearly 10 years at historically high levels, would likely lead to a new round of orphan wells; but not for a while, according to David Wolf, OWA chair and president of a small oil producer. "It takes a while for a company to go bankrupt," he said, because a number of players have roles in the process. Company executives and boards have to make decisions at the executive level; banks and other lenders need to be involved. [82]

As constituted today, the OWA board includes members representing the AER, industry associations (the Canadian Association of Petroleum Producers and the Explorers and Producers Association of Canada), Alberta Environment and Parks, and the Alberta Department of Energy. To prevent the proliferation of orphan wells, the AER ordered companies to submit regular statements of their financial health.[83] The regulator uses a monthly calculus of financial health to identify in advance companies that may be at risk of being unable to meet their environmental responsibilities.[84] When deemed liabilities exceed deemed assets, the licensee must put up cash or a letter of credit as security. This ensures that the licensee has the ability to reclaim sites at the end of project life.[85]

In Situ Reclamation

About 80 per cent of the bitumen recoverable from Alberta's oil sands will require in situ methods, which include steam-assisted gravity drainage (SAGD), cyclic steam stimulation (CSS, which is primarily used at Imperial Oil's Cold Lake project), and Cold Heavy Oil Production with Sand (CHOPS). As in the case of oil sands mining, the province specified that reclaimed lands would help achieve "desired economic, environmental and social outcomes based on the region's evolving needs. As oil sands resources are recovered and the lands reclaimed over time, opportunities will arise to reconnect lands to help achieve regional objectives relating to biodiversity, recreation, and forestry."[86]

Steam-assisted gravity drainage and other approaches to in situ oil sand production are relatively new, but growing. As mentioned earlier, by the year 2013, 55,000 wells had already been developed for in situ production. "It stretches from Bonnyville to Fort McMurray and then west to Peace River Country," said the Alberta Energy Regulator's Kevin Ball. People think of in situ development as "footprint reduction," in comparison to oil sands, "but I would say they're not looking at the entire scope of the projects. An individual in situ project starts with 3D seismic across the landscape to identify the resource." Interpretation of those seismic lines leads to exploration leases, "and then you drill shallow core holes to identify where the resource is, how thick it is, maybe its water attributes."[87] 3D seismic is a particularly intensive technology that results in more seismic lines being laid down in an area than with conventional seismic surveys.

After deciding to put a typical in situ thermal project in play, the operator constructs a central facility for steam generation, water treatment, and oil processing. But the project also has "big, seven-hectare, multi-well pads," Ball said. "You have all of the pipelines, above-ground pipelines carrying steam and carrying product back to the central processing facility, and each of those multi-well pads has a borrow pit associated with it." The borrow pits provide clay, for example, for use in construction. One proposed project had 60 multi-well pads and 67 associated borrow pits. "It really adds up to a footprint."[88] More important than the surface disturbance associated with in situ development, it has a large cumulative and incremental impact on the forest land base.[89]

In situ development involves horizontal or directional drilling and steam generation and injection, and it is different from conventional oil and gas activity in another way. Before beginning operations, large-scale in situ operators (producing more than 2,000 cubic metres per day) need to prepare an environmental impact assessment and secure approval under the Environmental Protection and Enhancement Act.[90]

That approval has other things associated with it. "Wherever there's going to be a disturbance more than one hectare in size, they need to do some pre-site work. They need to identify the soils, to help the companies properly conserve that material," said Ball. The company needs to establish large stockpiles of topsoil and subsoil for reclamation and have closure plans in place, as well as conservation and reclamation plans. Two additional differences between these "approved" sites (known by the regulatory term "oil production sites") and the smaller sites are that the audit-based certification process does not apply—onsite inquiries are still held by a reclamation inspector before a reclamation certificate is issued—and the site has no post-certification reclamation liability.

"There's a lot of planning to do, but we're still in the infancy of these developments. We haven't seen a lot of sites go to closure and final reclamation," according to Ball. "How can you reclaim well pads back to peat or a wetland? Conventional oil and gas we've got a pretty good handle on. We've had a lot of years of practice and we've got very strong rules, reclamation criteria around what are our expectations. But in situ, we still need to do some work on."[91]

The notion of replacing wetlands is an example of changing reclamation priorities. Historically, the thinking was that leaving the pad as an "upland" site (dry ground above the water table) was a good idea, while today the emphasis is on reclaiming wetlands. "The technology has to change, the assessment of success has to change, and unintended consequences have to be addressed. Where do you locate the pad? Where do you put the road material that is removed to keep the surface at or below water level?"[92]

The unique characteristics of developing, operating, and reclaiming in situ oil sands extraction sites led to a collaboration by the member companies of Canada's Oil Sands Innovation Alliance (COSIA) and government representatives, academic researchers, and consultants. A Best Practices Fall Tour of in situ facilities in 2013 was followed by a workshop to develop a report entitled *In-Situ Oil Sands Extraction Reclamation and Restoration Practices and Opportunities Compilation.* It included these observations:[93]

> Reclamation of in-situ facilities poses several unique challenges in comparison to conventional oil and gas and oil sands mining. In-situ results in a high density of relatively small scale (in comparison to mining) disturbances concentrated in an area which severely fragments a forest. Disturbances range widely in intensity, spatial and temporal scale and occur over many different forest types and ecosystems and there are considerable chances that a reclaimed facility will be redisturbed. Furthermore, construction of in-situ facilities occurs on a variety of forest types and ecosystems which can have variable levels of resiliency. Dry and nutrient poor ecosystems are inherently less resilient than wet and nutrient rich ecosystems. Similarly, due to the complex interactions of hydrology in fens and low productivity and growth in bogs, resiliency of these ecosystems may also be low. The interactions between different types of disturbances and ecosystems with different resiliencies are not well understood and historical and current practices may need to be altered to meet reclamation and restoration goals…
>
> Current and past reclamation of in-situ facilities has focused primarily on exploration facilities (i.e., seismic lines, oil sands exploration (OSE) wellsites and associated access roads,) which generally have a lower intensity of disturbance (e.g., minimal soil disturbance) and are active for only a short period of time. Individually, they have a small footprint; however, at a landscape scale they consist of many interconnected linear disturbances resulting in a much greater area of disturbance compared to production facilities and fragmentation of forested areas. Minimal reclamation has currently been completed on production or commercial facilities (i.e., well pads and associated access roads, plant sites, borrow pits and pipelines); however, they will be the focus of future reclamation. Production facilities have high disturbance intensity, persist for years or decades and can have a relatively large individual footprint as well as collective footprint.[94]

Several over-arching themes were evident during the workshop. The themes apply to the majority of the practice areas. The themes were summarized by the workshop moderator, Chris Powter of the Oil Sands Research and Information Network, and are provided below.

> - Current regulatory rules (whether real or perceived) are hindering adoption of practices that would improve environmental outcomes. An example is restrictions against moving salvaged soil to a new location to facilitate direct placement (even though the newest EPEA approval encourages direct placement).
> - Some of the terms we use when discussing enhancing environmental performance are restricting open dialogue because of the baggage associated with them. For example, terms like criteria, guidelines and Best Management Practices invoke specific connotations for some participants even if they are merely intended to convey their common language interpretation. We need to find some mechanism to overcome this hurdle so we can talk freely about change.
> - There is a need to establish and clearly articulate the goal(s) for environmental performance. This is the first step, before any technical discussions are held. Once the goal is determined the technical options available

to achieve the goal will often be narrowed; this makes discussions and decisions easier, but it also reduces flexibility. We also need to recognize that goals have changed over time, and that today's goals will very likely be different from the goals when today's new footprint is to be reclaimed. This means we need a clearly articulated policy for how industry is to adapt to changes in goals—are changes applied retroactively or only to new footprint or … Note that in the discussions goal was sometimes used interchangeably with land use and outcome.

- There is a need to establish and clearly articulate the scale at which goals are expected to be achieved. Goals, and the plans to achieve them, will be very different if the scale is a pad vs. an entire in-situ operation vs. a sub-region (e.g., South Athabasca Oil Sands Regional Strategic Assessment and Sub-regional Plan) vs. a region (e.g., Lower Athabasca Regional Plan). The latter two scales will require cooperation and coordination among operators and regulators.
- Training, awareness, and communication are critical for implementing sound environmental management practices. Standardized training should be provided for equipment operators, their supervisors and any other individual that works in the construction and reclamation/restoration of in-situ facilities. This is particularly true when looking to adopt new practices.
- Staff, contractors, and regulators all need to be willing to adopt new practices, methods, and tools to achieve more complex environmental outcomes such as ecological function and biodiversity. Old ways of thinking and doing, no matter how successful in the past, may not achieve new goals. People who cannot change may need to be shifted to other duties.
- Frequent staff turnover in industry and government means that there is an increasing need to document actions, decisions, and rationale for these long-lived sites (the mining community calls these site biographies). Too often a new staff member will make (or require in the case of a regulator) changes to plans without being aware of the rationale for the current plan (or even the plan itself). Change in itself is not bad; uninformed change is.
- Good ecological practices that will meet the new goals will have costs (e.g., money, time, extra land). The balance between outcomes and costs should be described and the trade-off should be explicitly acknowledged by all parties.
- We do not necessarily have to run out and create new practices. There is lots of opportunity to synthesize and publish/communicate existing knowledge. We need to be open to the idea that the knowledge can come from other industries (forestry being the one most referenced), or other parts of our industry (e.g., conventional wells, mining). The guide books should provide ecosite specific direction for each practice and should not provide prescriptions but instead help field personnel make decisions.
- We are likely going to need different solutions for legacy footprint than for new footprint. While the legacy footprint may be problematic because it was created with old practices, we are able to implement solutions now and see immediate environmental improvements. New site development footprint will not be reclaimed for many years so the benefit of new practices will not be evident for a long time.[95]

Oil and Gas Plant Sites

Crude oil and natural gas seldom come out of the ground in pure forms. The petroleum is typically mixed with contaminants such as water, carbon dioxide, and hydrogen sulphide (H_2S) that must be removed from the flow and safely disposed. The liquid and gaseous hydrocarbons also need to be separated into marketable commodities. There are thousands of oil batteries (facilities for crude oil) and hundreds of gas plants in Alberta; most are still in operation, and relatively few have been fully reclaimed. Decontamination has been the primary concern after facility abandonment. Establishing equivalent land capability or alternate industrial use of the disturbed land after remediation is likely to be a growing issue as more facilities are eventually abandoned.

Most attention in the past has focused on the large plants that process "sour gas"* to produce elemental sulphur as a marketable by-product.[96] Only a few of these plants have been totally abandoned. Companies developed reclamation plans in consultation with municipal and provincial authorities. Sites were subdivided into parcels for reclamation purposes since some areas would require much less time and treatment than others. Decontaminating and reclaiming the soil under the sulphur storage areas posed unique challenges and led to innovative approaches.

A decision was made early in the regulation phase of the Land Surface Conservation and Reclamation Act in the 1970s not to enact a specific Industrial Sites Regulation. Instead, the government required developers of major industrial projects to produce reclamation plans in advance of construction and to get approval from the province's Department of Environment. The Conservation and Reclamation Regulation's definition of plant site is broad, covering the construction, operation, or reclamation of a plant, and it covered an operation's buildings, structures, process equipment, pipelines, and vessels; the list of plants is provided in the Schedule of Activities in the Environmental Protection and Enhancement Act.[97]

Sour Gas Plants and Reclamation

A colourless gas with the characteristic foul odour of rotten eggs, hydrogen sulphide (H_2S) is heavier than air and extremely poisonous. Its presence in petroleum makes the oil or natural gas "sour." Producers need to "sweeten" production by removing H_2S to make the natural gas safe and marketable. Historically, large quantities of H_2S were burned in flares at plants and wellsites, although this practice is now strictly regulated and relatively uncommon. Recently more companies have been injecting the H_2S and carbon dioxide ("acid gas") into underground formations. However, most of the produced H_2S has been converted to elemental sulphur and stored at large, sophisticated processing plants.

To a large extent, the business of extracting sulphur from sour gas was a war necessity. Although the business goes back 100 years, during World War II sulphur was so important for manufacturing war material and as an input to the rapidly developing petrochemical industry that the practice grew and developed—first, in southwestern Arkansas; later, at sites elsewhere in the United States, from California to New Jersey.[98] The sulphur industry subsequently developed in Alberta because some gas wells had extremely high sulphur content in the form of H_2S.

Shell Oil constructed a small sulphur recovery plant in Alberta in 1952, but—with production of only 9,150 tonnes per year—it was tiny by later standards. Three years later, British American Oil—later Gulf Canada—announced plans to construct a plant at Pincher Creek that would produce about 24,000 tonnes per year. Also in 1955, Shell made its nearby Waterton sour gas discovery. Soon to become another giant facility, Shell's Waterton complex would eventually have the largest sulphur plant in the province, though today it is only sixth in terms of sulphur reserves. About the same time, operators installed small sulphur recovery plants in Turner Valley and at the Redwater field—then a long, 60-kilometre drive over mostly rough gravel roads northeast of Edmonton.[99]

Today Alberta's 27 major sour gas plants convert the hydrogen sulphide into high-purity elemental sulphur, a by-product used to produce fertilizer, sulphuric acid, and many other commercial chemicals. The province produced 4.1 million tonnes of sulphur in 2014—2.1 million tonnes

* Any natural gas containing detectable quantities of H_2S is technically "sour" (and this is important for health and safety purposes) but the usual definition in the natural gas industry is gas containing more than 1 per cent H_2S.

Sour gas facility near Balzac. *Alberta Energy Regulator*

recovered from natural gas, and 2.0 million tonnes from oil sands bitumen—and held an inventory of 11.2 million tonnes.[100]

The gas plants pipe the sour gas through successive catalyst beds, which progressively remove sulphur and other impurities from the gas.[101] The sulphur is produced as a liquid, which may be pumped to outside blocks, where it solidifies; to storage tanks for direct shipping in liquid form; or to slating, granulating, or prilling plants.[102] In the mid-1970s and again 20 years later, declining sulphur exports led to the development of sulphur stockpiles in the form of huge blocks at locations across Alberta.

During the 1970s, however, producers began to store the sulphur in ways that had both commercial and environmental advantages. For example, in the late 1970s, Gulf Canada began using a technology imported from Poland to turn sulphur from its Nevis gas plant into "prills," a pelletized form of the chemical element. Prills are a neater, simpler form for handling this product. Another advantage is that dealing with prills means less dust than, for example, preparing sulphur for trucking by using heavy equipment to break up sulphur blocks. Sulphur dust caused acidifcation of soil on lands adjacent to the storage blocks.[103]

In Alberta, these blocks contained 21 million tonnes of solidified sulphur in 1981 but were reduced to less than 3 million tonnes in the early 1990s as world demand surpassed world production. Since 1993, greater production than sales of sulphur have led to the resumption of sulphur blocking in Alberta. At present, sulphur is stored in blocks in 20 sites in western Canada, most of them in Alberta.[104] Sulphur is also produced at upgraders processing oil sands bitumen.

Decommissioned in the 1980s, Gulf Canada's Pincher Creek plant demonstrated the inadequacies of the reclamation policy of the day. The antiquated technology of the plant (the first constructed in Alberta) and the decline of its natural gas reserves were behind the company's decision to decommission. By that time, the plant was operating at only 10 per cent of capacity. Because the plant was the first major sour gas facility in Canada to be shut down, "there were no precedents, no rules, no guidelines," wrote the company's Brian Plesuk. "An additional political twist" came in 1982, "when the area's representative to the provincial legislative assembly (Fred Bradley) was named to head the Department of the Environment."[105] The site was eventually reclaimed sufficiently for other industrial use. Choice Resources, operator of a gas compressor on the property, said in 2006 it had found little or no contamination on the site.[106]

Like the Pincher Creek plant, the gas plant built by

Texas Gulf Sulphur near Okotoks removed sulphur hydrates from the gas stream through a process known as amine scrubbing. The chemical used in the early days was monoethanolamine (MEA), a product that led to site contamination. Various companies operated the Okotoks facility until 1989 when Canadian Occidental Petroleum Limited (CanOxy, renamed Nexen in 2000) bought both the sour gas plant and the producing field. The company's intent was to tie the gas produced into their existing modern (1985) processing plant at Mazeppa, a 26-kilometre drive to the southwest. This would enable the company to shut down the 1959-vintage Okotoks plant. However, one of the consequences of shutting down the plant was that the company was responsible for decommissioning the old facility. The Okotoks plant closed its doors in 1991. The following year, decommissioning planning began, starting with a suite of environmental assessments.[107]

On the plant property was a waste disposal area that included holding ponds, a flare stack, landfills, and a "boneyard" for solid waste. There was a sulphur storage and shipping area, a condensate storage and shipping area, and an injection well for other kinds of wastes.[108]

"Plant liquid wastes were disposed in the burn pits and holding ponds," according to a technical paper that described reclamation of the site. "These include process liquids (water and hydrocarbons), steam condensate, process floor drain wastes and domestic sewage. Surface water was contained in one of the two ponds, as was produced formation water prior to 1971." In the early years these wastes had been released into the Sheep River. In 1971, the operator constructed an injection well so liquid wastes could be injected into underground reservoirs. In addition, the company designated landfill "cells" for disposing such solid wastes as piping, asbestos, chemical drums, construction materials, rags, and filters. Other solid materials had gone to a storage site.[109]

To prepare for reclamation, the reclamation team conducted an environmental survey of the site. This involved extensive soil sampling, soil vapour studies (to check for solvent/hydrocarbon soil contamination), asbestos analyses at the site, and studies of soil salinity. Other studies looked for trace metals, and the company constructed 21 groundwater wells for water sampling.[110] A geophysical survey of the basepad, loading areas, and nearby agricultural areas suggested sulphur drainage into the soil. The next steps would involve conducting the reclamation and remediation work required to receive a reclamation certificate for the plant and its associated facilities.

Nexen applied for reclamation amendments to its approval for the entire site in 2004. The first, more than 100 pages in length, covered the "Northwest Corner and Lower Terrace of the Former Okotoks Gas Plant."[111] When Nexen applied for approval to close down the Balzac plant eight years later,* its application for the more recent plant was more than twice that length.[112] To an extent, this reflected stricter plant reclamation requirements.

Under the latest guidelines, applications must provide descriptions of their plans in these areas:

- identify and describe end land use, with reference to the land's capability ratings
- describe the proposed reclamation of landform, drainage, and watercourses
- explain proposed "engineered" approaches to such watercourses as streams, lakes, and wetlands, and assess the suggested approach
- provide a plan—one that is compatible with the proposed end land use—for replacing reclaimed soil
- plan for revegetating the site
- discuss stakeholder involvement—who will be involved, when and how[113]

Sulphur Basepads

Prepared by reclamation specialists S. A. Leggett of Jim Lore and Associates Ltd., and S. L. England of Mobil Oil Canada, two important papers in 1989, coincident with the closure at Okotoks, described basepad land reclamation. As the authors explained, plants constructed in the 1950s and 1960s created sulphur blocks by pouring molten sulphur on a basepad. To a large degree there had been minimal effort to prepare the soil before pouring began.

As they summed matters up in their second paper, "recovery techniques range from extensive use of landfills for disposal of sulphur-contaminated material to attempts to neutralize and reclaim the material on site. The problems and costs of site reclamation vary depending on site location, conditions, and basepad recovery techniques. While the location and condition of the sites are fixed variables, choices of recovery techniques can influence the success of reclamation programs."[114]

The first stage of reclamation was to recover commercial sulphur in the basepads. These pads contained at least 30 per cent sulphur, yet early operators had been trucking them to a landfill. One approach to recovering this material was to remelt basepad material to recover as much pure sulphur from the basepad as possible. To attain marketing

* Similar in design to the Okotoks plant, the Balzac Plant is about 60 kilometres away, north of Calgary.

specifications, operators blended relatively pure sulphur in a melter with contaminated materials from the soil. The pure sulphur tended to attract sulphur from the basepad waste. The waste from this process was "sulphur-crete," a hard substance comprised of relatively small amounts of sulphur and contaminated soil. It went to landfills.[115]

At the time, perhaps 10 per cent of the total sulphur inventory in Alberta existed in basepads, which totalled some 100 hectares in area.[116] Increasing sulphur sales combined with "declining hydrocarbon reserves in older sour oil and gas fields" meant that the need for reclamation of sulphur blocks began to increase. The authors wrote that "sulphur oxidation and, in turn, acidification will occur if the soil is left untreated."[117]

To conclude their report, the authors made five general observations. One was that sulphur levels on each site vary quite a lot. Without sampling on a small-scale grid, it is difficult to accurately determine sulphur levels. Sites required repeated liming and seeding operations to treat bare spots.[118] Another related to the importance of site preparation landscaping to improve drainage, and rock-picking. "It is important that acidic materials not be buried during landscaping," they wrote, and "leave sulphur-contaminated soil on the surface, where limestone can be easily mixed with it."[119]

Reclaimed areas were most likely to re-acidify—thus, not supporting plant growth—around their perimeters. This would happen because sulphur had been continually deposited on the soil surface through block operations and spills. Bare spots were also common in locations where, during basepad recovery operations, there had been piles of sulphur-contaminated material, remelt pits, or equipment.[120]

In addition, the methods used for seeding and the types of seeds used, they found, were critical for success. Broadcasting seed was not a good approach; rather, the team should use a seed drill. Because of the relatively small size of the sites and the even smaller size of the bare spots, eight-foot-wide (2.4-metre) farm equipment was used. "This allows treatment and seeding of the bare areas without disturbing the rest of the site that is supporting growth."[121]

As the reclamation program progressed, sour gas producers shifted their focus. Once they had made initial site assessments and applied limestone often enough, operators would change their management strategy. Instead of reacting to higher pH levels in soil, they would manage the problem. Those responsible for sulphur pad management would focus on the "long-term development and maintenance of adequate soil structure needed for agricultural production".

Conclusion

The eventual reclamation of conventional oil and gas fields in Alberta may present fewer problems for industry, government, and landowners than in the past. One reason is that the industry, reflecting changing social values, is more environmentally aware. Industry and government are also more aware of the financial liabilities. Another is that regulations are more stringent and reflect advancing conservation and reclamation science. The actual practitioners of reclamation, many now working for highly specialized consulting firms and contractors, are increasingly skilled and knowledgeable about landforms, soils, hydrology, and vegetation. However, the sheer volume of reclamation sites in the oil and gas industry means that the workload will continue to grow.

Developing, operating, and reclaiming in situ oil sands extraction sites poses several unique challenges in comparison to conventional oil and gas and oil sands mining. In situ results in a high density of relatively small scale (in comparison to mining) disturbances that severely fragment the forest landscape. Disturbances range widely in intensity and spatial and temporal scale, and they occur over many different forest types and ecosystems that can have variable levels of resiliency. Furthermore, there is considerable likelihood that reclaimed sites will be redisturbed by subsequent industrial or recreational activities.

There is a need to establish and clearly articulate the goals for environmental performance including the scale at which goals are expected to be achieved. Goals, and the plans to achieve them, will be very different if the scale is a pad vs. an entire in situ operation. Adopting new practices will require standardized training for equipment operators, their supervisors, and any other individual that works in the construction and reclamation of in situ facilities.

Staff, contractors, and regulators all need to be willing to adopt new practices, methods, and tools to achieve more complex environmental outcomes. Frequent staff turnover in industry and government means that there will be an increasing need to document actions, decisions, and rationale for these long-lived sites.

Pipelines

There are no shortcuts—you just can't—because the environment doesn't have shortcuts, landowners don't have shortcuts, stewardship doesn't have shortcuts. It's metre by metre in just about every discipline we work with.

Karen Etherington

Turner Valley #2 was a 33-kilometre pipeline constructed in 1925 by Canadian Western Natural Gas to transport gas from Turner Valley to another pipeline carrying gas to Calgary. The subsequent owner, ATCO Pipelines, initiated abandonment and reclamation of the 250-millimetre (10-inch) diameter pipeline in 2005. This posed "numerous challenges," a 2010 conference was told.*[1]

History of the pipeline was limited. The shallow depth of cover due to the shallow original trench depth, as well as erosion over the years, was a risk along many segments. Floods in southern Alberta over the years created numerous washouts at creeks and left the pipeline exposed at some of the watercourse crossings encountered by the pipeline. Land use changed over the years, large trees grew in around the pipeline in a number of areas, and the pipeline right-of-way was located in close proximity to large estate homes.

The company developed specific plans based on a risk assessment for each quarter-section (160 acres or 64 hectares) crossed by the line. About 11 kilometres of pipe segments had to be removed entirely because of intended land use or shallow depth of earth cover or because they might become conduits for water flows. Most of the other 22 kilometres of pipe sections were cut, capped, and left in the ground. Where the pipeline went under roads or railways, it was cut on either side and filled with grout or cement. Heavy equipment pulled out sections of pipe under streams and in some wooded areas. The work occurred in 170 days spread over three years and included 90 cuts and caps, 12 road or railway crossings, and four removals of pipe under creeks.

Conservation and reclamation techniques on native prairie included salvaging large pieces of sod and replacing them as soon as possible after pipe removal. The authors said the sod replacement, which could only be done under certain moisture conditions, was "extremely successful." In wooded areas, hand cutting and light equipment minimized disturbance. Where possible, pipe segments were cut and pulled from one or both sides of a stand of trees. Landowner requests and conditions such as stream flows affected the planning and timing. "The mitigation measures and careful implementation of these measures resulted in the successful abandonment of the TV #2 pipeline with minimal adverse effect on the environment or land use," the presentation concluded.

The company did not apply for a reclamation certificate for TV #2 because portions of the pipe were left in the ground. Curtis Clark of ATCO said this would be the case for most abandonments, except in urban areas where property owners wanted complete removal of pipe to allow for future development.[2] *While this may be good stewardship or prudent risk management, Chris Powter, former Alberta Environment employee, noted that removal of the pipe is not a legislated requirement for certification.*[3]

* Nominal Pipe Size (NPS) is a North American standard, not an exact measurement, although it is roughly equivalent to diameter in inches. The International Standards Organization has adopted rounded-off equivalents expressed in millimetres. This chapter uses the NPS and ISO standards to express pipe size.

Crews building early natural gas pipelines in southern Alberta in the 1920s. *ATCO*

Industrial Pipelines Today*

Since the 1970s, land conservation and reclamation have received increasing amounts of care and attention during the planning, construction, and operation of pipelines. What happens after abandonment is still evolving. As the story of Turner Valley #2 illustrates, today's nearly 450,000 kilometres of industrial pipelines in Alberta could be in service for a very long time. Most of the pipe laid in Alberta since 1950 is still in the ground, and much of it could stay there permanently unless government and industry change their policies and practices.

In 2003, Environment Minister Lorne Taylor said there were about 14,000 abandoned pipelines in Alberta that were not yet reclaimed, reclaimed but not submitted for certification, or submitted and awaiting certification.[4] From 2004 to 2015, the government issued reclamation certificates for fewer than 2 per cent of that number—69 pipelines on public land and 68 on private land.[5]

The options for decommissioning and abandonment of pipelines are:

- cutting and capping the pipe in place, after cleaning and filling it with air, water, or inert gas
- using mitigation such as filling the pipe with cement or grout
- removing the pipe

While in service, sacrificial anodes protect pipelines from corrosion. A DC electric current runs through the anodes and suppresses galvanic oxidation of the pipe. Once this cathodic protection is removed during decommissioning and abandonment, the pipe will start to rust away. For pipelines up to 300 millimetres (12 inches) in diameter, corrosion and eventual collapse underground may not cause serious issues on the surface.[6] There is ongoing debate about the potential for subsidence following corrosion of larger pipelines, which can be up to 1,200 millimetres (48 inches) in diameter, and therefore whether they should be removed or abandoned in place.[7] Most of these pipelines are still in use today.

Industry studies estimate the cost of abandonment and reclamation could be 30 to 50 per cent as much as the cost of constructing a similar pipeline. People used to think that the scrap value of steel pipe would help pay for reclamation, but the coatings used on many pipelines make them unsuitable for recycling and in some cases too toxic for regular landfills. Removing pipe from the ground actually adds to reclamation costs.[8]

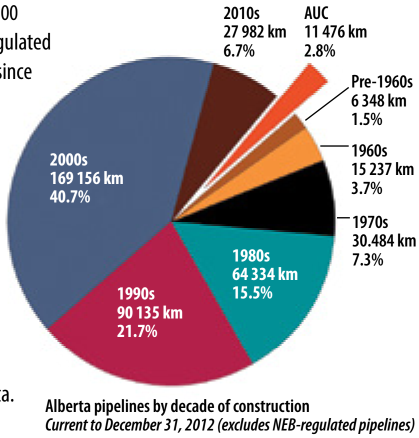
Abandonment and reclamation are receiving more attention from industry and regulators. During most of the industry's evolution, however, the main land issues have been conservation and reclamation during construction and operation.

As of March 31, 2014, the Alberta Energy Regulator replaced Alberta Environment as the regulatory authority for most aspects of pipeline reclamation. The Alberta Utilities Commission (AUC) regulates rural gas distribution pipelines.[10] The National Energy Board regulates an additional 30,700 kilometres of pipeline in Alberta, including interprovincial and international pipelines and, since 2008, the major natural gas transmission system.[11]

Of the provincially regulated industrial pipelines, about 60 per cent carry natural gas, 15 per cent oil effluent (mixed oil, gas, and water production from an oil well; these lines are also known as multiphase), 6 per cent oilfield water, 5 per cent crude oil, 5 per cent sour gas (natural gas with hydrogen sulphide concentrations greater than 1 per cent), and 9 per cent other substances. About 17 per cent of the provincially regulated pipelines are listed as discontinued (35,000 kilometres) or abandoned (37,000 kilometres).[12]

Most pipelines in the province are small, with an outside diameter of 150 millimetres (6 inches) or smaller, and carry production from individual wells to nearby processing facilities. Large-diameter transmission lines 500 millimetres (20 inches) or more in outside diameter make up just 2 per cent of the total AER-regulated inventory, or 8,267 kilometres. About 86 per cent of Alberta's provincially regulated industrial pipelines are constructed of steel, with most of the remaining lines made of polymer or fibre composite

* In 2003, amendments to the list of specified land activities split "pipeline" into two categories: industrial pipelines which are part of the upstream oil and gas audit certification program, and municipal pipelines (sewer and water) which continue to be subject to the inquiry-based certification system.



Two-thirds of Alberta's 415,000 kilometres of provincially regulated energy pipelines were built since 1990. (AUC pipelines are gas distribution lines regulated by the Alberta Utilities Commission, and they have been built in various decades since the 1960s.) This chart, based on data to the end of 2012, does not include 30,700 kilometres of federally regulated pipelines in Alberta. *Alberta Energy Regulator*[9]

materials—a portion that continues to increase as these materials are corrosion resistant and are being used more often in corrosive production situations.[13] Many of the larger transmission pipelines in Alberta are federally regulated; these are all made of steel.

Pipelines run under every type of landscape in Alberta from boreal wetlands to arid badlands, through towns, cities, forests, and prairies, and under waterbodies. Above-ground pipelines carry steam and bitumen in some oil sands operations. Most pipes are buried at least 60 centimetres below the surface, usually 90 centimetres or more; before modern standards* and regulations began to emerge in the 1950s,[14] the practice was simply to bury pipe below the maximum depth penetrated by a farmer's plough. A typical right-of-way for a pipeline 150 millimetres (6 inches) in diameter would be 15 metres wide, with pipe located 5 metres from one side and 10 metres from the other; this offset allows for work space and soil storage during construction and maintenance.[15] Larger pipelines require deeper and larger excavations, more extensive grading, and large equipment to install; rights-of-way for these larger pipelines may exceed 30 metres in width. Older pipelines were placed in trenches beneath waterbodies; horizontal directional drilling is a commonly used trenchless method today to pull pipe under waterbodies without disturbing the banks and causing siltation of fish-bearing waters.

Operators acquire rights-of-way through dispositions on public lands and negotiated agreements on private land. The pipeline operator initially pays a negotiated amount, based on appraisals, and additional amounts for damages during construction and maintenance; payment of annual rentals—as is the case for wellsites—is not common. The parties can appeal to the Surface Rights Board if they cannot agree on terms. The Alberta Energy Regulator and its predecessors have provided dispute resolution for matters such as routing, while the Surface Rights Board typically addresses disputes about compensation. The landowner can request removal of the pipe upon abandonment.[16] Pipeline operators pay municipal taxes where applicable and also compensate rights holders on Crown land such as forest companies and grazing lease holders.[17]

Smaller-diameter pipelines up to 150 centimetres (6 inches) can be "ploughed in" with minimal surface disturbance. This method has been used since the 1960s for gathering systems carrying oil and gas from producing wells to a central location and for distribution lines delivering natural gas in rural areas. It works best in sandy soils; in other soils, the mixing of different horizons may be a concern, and in either case, ploughing-in operations must not be done when soils are wet, to avoid surface traction problems. Plough-in projects are exempt from Alberta's conservation and reclamation approval process,[19] but they still must comply with regulations.[20] A ploughed-in pipeline that is less than 150 millimetres in diameter is exempt from the requirement to obtain a reclamation certificate (but the operator remains liable for reclamation problems).[21]

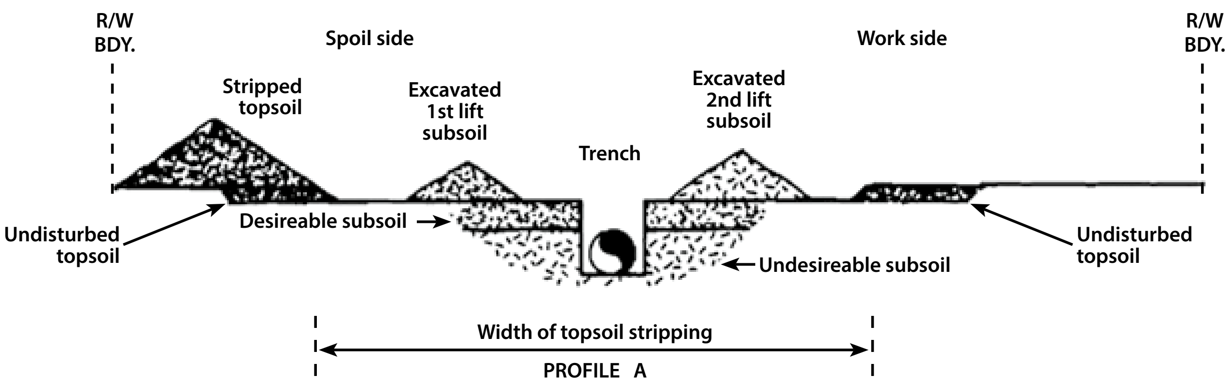
In the late 1980s, there were different perspectives on the extent to which industry undertook environmental planning and soil conservation—at a 1988 conference Dennis Bratton of Alberta Environment said they did more for larger pipelines than wellsites but that still more was required[23]; on the other hand, Dean Mutrie, TERA Environmental Consultants, and Donald Wishart, Interprovincial Pipe Line Company, reported that "topsoil conservation

The plough-in method creates relatively minimal surface disturbance.
This crew is installing a four-inch (100 millimetre) gas line in southern Alberta.
Triple W Gas Co-op Ltd.[18]

* Since 1994, the Canadian Standards Association standard for oil and gas pipeline systems, CSA Z662, has provided guidance to industry and government on the safe design, construction, and maintenance of pipelines. The standard resulted from four decades of pipeline standards development in Canada. Professional engineers base their design specifications on the standard's requirements.

The above photo shows large-diameter pipeline construction south of Longview in September 2002. Darker-coloured topsoil is stockpiled separately from the lighter-coloured subsoil. *Robert Bott*

Three-lift soil salvage segregates the subsoil horizons so that they can be replaced in the trench in the original order. This avoids mixing soils in the root area with undesirable subsoils such as those containing high salt levels. Placing both subsoil piles on the spoil side is also an option. (Drawing is not to scale) *Alberta Environment*[22]



Overview of the Life of a Pipeline Project[25]

- Initial assessment of pipeline route in consultation with landowners and/or government departments; this may also involve Aboriginal groups. Routing begins with the shortest and most economical route between the end points, and then is modified as necessary. For example, geotechnical considerations may influence the location of major river crossings. Urban and industrial developments may also require deviations.
- The landowner or government agency is contacted by the company to obtain consent for the proposed pipeline location.
- On private land, once the pipeline route is established, the landowner and company negotiate a right-of-way agreement, and the company registers a caveat on each land title.
- The company obtains government approvals, compensation is paid, and pipeline construction begins.
- If problems arise during or after pipeline construction, several agencies such as AER, Alberta Environment and Parks, and the Farmer's Advocate may assist landowners in dealing with the operator.
- Generally, one crop year after installation of a pipeline, the company and the landowner or occupant settle any damage claims.
- The company retains the right for re-entry to inspect or repair the pipeline, and the company is responsible for surface damage it causes on or off the right-of-way.
- Once the company stops using an industrial pipeline, it can apply to the AER for abandonment. The company may then apply for a reclamation certificate; after certification the energy company's caveat is removed from the landowner title.
- If the landowner requires the removal of an industrial pipeline, he or she can apply to the AER (removal can also be a provision of the original right-of-way agreement). The AER determines, depending on the information provided, if the pipeline is creating an adverse effect for the landowner. If so, the company may be required to remove or relocate the line.

has become standard practice on pipeline construction in western Canada over the last 30 years."[24] Today, depending on the characteristics of topsoil and subsoil horizons, there may be up to three lifts of soil horizons that are salvaged and replaced. Three lifts might be used, for example, in areas where solonetzic (sodic) soil materials occur at depths beneath the topsoil and a clean subsoil layer. Typically, such soils occur east of Edmonton, both to the north and south. The first known instance of a three-lift operation was done for the Vegreville water pipeline around 1980. The soils consultant who recommended that procedure was Larry Brocke.

Evolution

Canadian Western Natural Gas (now part of ATCO Pipelines) constructed the first long-distance pipeline in Alberta in 1912 to bring natural gas 275 kilometres from Bow Island to Lethbridge and Calgary. By that time those cities already had local distribution systems for coal gas, and they simply switched over to natural gas. Medicine Hat had a local distribution system for natural gas since 1903. In the 1920s, additional gas pipelines were built from Viking to Edmonton and from Turner Valley to Calgary, and an oil pipeline linked the Turner Valley field to a refinery in Calgary.

Federal and (after 1930) provincial mines and minerals officials regulated pipelines until 1949 when authority shifted to the Petroleum and Natural Gas Conservation Board, which had been established in 1938. Pipeline routing issues were resolved by the Board of Public Utility Commissioners.[26]

The modern pipeline era began in the decade after World War II. The Leduc oil discovery in 1947, subsequent oil finds in central Alberta, and discovery of large natural gas reserves at Jumping Pound and Pincher Creek began a search for access to markets within and beyond Alberta. Crude oil was shipped initially by truck and rail until pipelines were built to provide more efficient and economical delivery. Natural gas required pipelines.

In 1950, the Interprovincial Pipeline was completed from Edmonton to Superior, Wisconsin, where lake tankers then carried crude oil to Sarnia, Ontario, until the pipeline was extended to the refinery complex there in 1953. The TransMountain Pipeline from Edmonton to Vancouver

Coal-fired steam trenching machines were used in constructing the Bow Island pipeline in 1912. *Glenbow Archives NA-2446-20*

Below is a more modern trenching machine, the type used in Alberta since the 1940s, in the Alberta Heavy Construction Heritage Society collection at Devon. *Robert Bott*

was also completed in 1953.[27] A growing network of gathering and transmission pipelines carried oil to terminals in Edmonton and Hardisty and to Edmonton refineries. The Pembina Pipeline connected oilfields near Drayton Valley to Edmonton in 1954.

The provincial government created the Alberta Gas Trunk Line (AGTL) in 1954. The pipeline system, which began service in 1957, provided gas transmission from processing plants and gathering systems to local distribution systems within Alberta and to interprovincial and international pipelines. TransCanada PipeLines, connecting Alberta to eastern Canada in 1957, was AGTL's first interprovincial export customer. The federal government established the National Energy Board in 1959 to regulate interprovincial and international pipelines and energy trade. In 1961, the Pacific Gas Transmission pipeline (now called Gas Transmission Northwest) connected Alberta gas to customers in the US Pacific Northwest and California.[28]

Conservation and Reclamation

In 1963, when Alberta enacted the Surface Reclamation Act, there were 7,725 kilometres of oil pipelines and 16,825 kilometres of gas pipelines in the province.[29] In the surveyed lands—settled areas of the province—the act gave government inspectors authority to issue reclamation orders to address pipelines' land conditioning, noxious weed growth, hazards to livestock or farming operations, and matters such as installation and repair of fences, gates, cattle guards, and culverts. There were no environmental approvals required, nor guidelines or criteria; provincial and municipal inspectors used their judgement. Similar authority was extended to public lands managers in the rest of the province in 1969. Oversight of surveyed lands shifted to the newly created Department of Environment in 1971 and was reinforced by the Land Surface Conservation and Reclamation Act (LSCRA) in 1973 and its accompanying regulation in 1974.[30]

During this era, inspectors, landowners, and public lands managers began encountering issues such as erosion and inadequate revegetation on pipeline rights-of-way. One common issue was settling of fill in the trench over the pipe, which created a channel for water flows. Compaction and loss of topsoil also inhibited reclamation success.[31] In some areas of the province, the mixing of soils during single-lift excavation sometimes resulted in poor growth of crops and grasses in the affected strip.[32]

"It was very much a learning experience on everyone's part," said Ralph Dyer, a former Alberta Environment official who also worked for Public Lands in the early 1970s.[33]

> Despite the fact that it was early in the growth of environmental awareness in the province, you had a lot of people in industry that were really trying to do the right thing and minimize the environmental impact of their activities—especially the larger companies like Alberta Gas Trunk Line, Dome Petroleum, Shell, Canadian Western Natural Gas, or Interprovincial Pipe Line.* Some companies in those days spent a considerable amount of effort to minimize the environmental impact of their pipeline construction activities.

Sometimes, he noted, regulators had different perspectives: Public Lands officials wanted to minimize disturbance of grazing and forestry lands, while Alberta Environment want to maximize topsoil conservation. As was often the case, such disparate views led to research and demonstration trials to get at the "right" answer.[34] (Current government emphasis on public lands and native prairie is to minimize stripping and use native seed mixes.)[35]

"It was quite an active and engaging debate that occurred around the larger pipeline projects of the day," Dyer said. "Alberta Environment would sponsor annual industry-government field reconnaissance events to bring the parties together to debate the various practices. It was very much a unique 'intellectual' period in Alberta's reclamation history."

Alberta Environment's Land Conservation Guidelines in 1974 included provisions such as retention of natural shelterbelts on sloping lands and uncleared setbacks from ravines and waterbodies. Information required for water crossings included water flows and levels, below-water

* AGTL was renamed NOVA, An Alberta Corporation in 1980 and merged with TransCanada in 1998. Canadian Western Natural Gas became ATCO Pipelines in 1999. Dome Petroleum was acquired in 1988 by Amoco Canada, which was acquired by BP Canada in 1998. Interprovincial Pipe Line became Enbridge Inc. in 1998.

topography, and design features of the proposed installations. The guidelines aimed to protect watersheds from erosion, protect the natural habitat for waterfowl and wildlife, and preserve the higher-capability recreational lands.[36] Security Deposit Regulations, also enacted in 1974, required sufficient funds to ensure reclamation.[37]

While the LSCRA also required environmental impact assessments for major projects, including pipelines, the overwhelming majority of applications were addressed under the direction of the Land Conservation Regulations. Only two went through the formal EIA process: the Raymond Ammonia plant and pipeline in 1974 and the Fort McMurray–Edmonton Oil Pipeline in 1975.[38]

"It was a bit of a public misperception at the time that if an EIA was not called for a particular major pipeline that appropriate environmental oversight was not being provided," Dyer said.

> Not so. Most of the environmental assessment and protection planning for major pipelines in the province was being done pursuant to the regulations. These pipeline projects were subject to a regulatory review process that included a number of government departments. Alberta Environment's policy approach at the time was based on the assumption that the environmental "learnings" derived from regulatory oversight of major pipelines would spill over to the vast majority of the so-called unregulated smaller pipelines.[39]

The assessments included conservation and reclamation plans, termed environmental protection plans. Proposed crossings of streams and rivers received particular scrutiny. The approvals could include conditions to address such concerns as runoff and erosion control, soil handling, groundwater monitoring, and revegetation.[40] Soil handing conditions on agriculture lands formed a major part of the approval document. During this process, the Energy Resources Conservation Board would evaluate the public interest and hold a public hearing if necessary.

In the initial period of pipeline regulation, soil survey requirements were a source of much contention between Alberta Environment and the industry and even among department staff, Dyer said. "Gradually, the industry began to see the wisdom of doing these soil surveys. Much of the initial credit for this change in perception must be given to some of the soil scientists of the time such as Al Twardy, Len Leskiw, Len Knapik, and Larry Brocke."

As companies and consultants conducted soil surveys and evaluated construction practices and routing options, they began to identify issues that inhibited reclamation success on rights-of-way. An amendment to the LSCRA in 1983 made topsoil conservation a requirement. Following consultation with industry, Alberta Environment commissioned an 82-page *Manual on Soil Conservation and Pipeline Construction*[41] in 1985 and the *Environmental Handbook for Pipeline Construction*[42] in 1988. The manual and handbook addressed key issues such as topsoil loss, compaction, and soil mixing. In the following years, industry-government bodies such as the Alberta Pipeline Environmental Steering Committee and the Canadian Pipeline Environmental Steering Committee continued to refine methods for conservation and reclamation, including additional guidelines and manuals.[43]

Based on his experience in the 1970s, Larry Brocke became an advocate for multiple lifts so that different soil horizons were not mixed when put back in the trench. This was particularly important when one horizon contained salts that were toxic to plants. Former inspector Bruce Patterson explained how it worked in practice:

> A guy would go down the pipeline with the grader or the dozer, peel down to a colour change, and then he'd just come back and peel down to the second colour change. So, you've got topsoil and subsoil, and they knew that it would be a lot easier to re-establish vegetation, especially if you've got a thin veneer of topsoil and you've got major root mass in your subsoil.[44]

Brocke then joined Alberta Environment in the 1980s and evaluated applications as head of the Development and Reclamation Review Committee. "The approval requirement was designed for major projects," Brocke said. "You weren't going to get involved in every little four-inch pipeline coming off a wellsite."[45] This was the reason behind the "index number" for pipelines: length in kilometres multiplied by diameter in millimetres. Pipelines with an index number of less than 2690 were Class 2 pipelines exempt from the requirement for prior approval, although they were still subject to reclamation and certification requirements.[46] The classification excluded most small-diameter pipelines and a few relatively short large-diameter lines. For example, a two-inch (50-millimetre) pipeline could be up to 50 kilometres long and exempt, while a 40-inch (1,000-millimetre) line would only be exempt if were less than 2.5 kilometres long. Alberta Environment produced *Information Requirements for Regulated Pipelines* in 1981 to help standardize the review of environmental approval applications.[47]

By the 1980s, companies began to develop specialized equipment to salvage frozen topsoil[48] and to salvage just the immediate area over the trench.[49] Improvements in ploughed-in pipelining increased the diameter of gathering and distribution lines that could be installed with minimal disturbance. "The whole notion of saying, 'we just have to take off-the-shelf equipment and just use it,' has gone by the wayside," said former Alberta Environment official Chris Powter. "You see a lot more use of specialized equipment to address specifically the issue of conservation and reclamation so you get the best outcome possible." He said companies such as NOVA Gas Transmission (formerly Alberta Gas Trunk Line, now part of TransCanada PipeLines) were leaders in technical innovation. The "sophisticated" companies "would come up with their own ideas and bring them forward to the regulator, as opposed to waiting to be told what to do, and would in fact conduct and fund their own research, looking at better ways of doing things."

Al Fedkenheuer, a former NOVA soil specialist, recalled the frozen-soil handling innovation.

> NOVA had a topsoil stripping machine that was brought in and was a machine typically used for stripping [pavement]—think it was asphalt—so that we could use it on frozen soil. If you just used the ripper on the back of a Cat, it just comes up in great big lumps. So, we tried the idea of the topsoil stripper at some cost, again, to the company that's for sure and used that as a way to construct pipelines, particularly in frozen soil conditions.[50]

In the 1980s, NOVA also supported the master's and doctoral research of soil scientist Anne Naeth, who is now professor of Land Reclamation and Restoration Ecology and associate dean of Research and Graduate Studies at the University of Alberta. "Everybody loved the fact that they

Winter construction can help to reduce soil disturbance and compaction, but specialized equipment had to be developed for operations such as topsoil stripping. *AER*

Iron Wolf breaking up frozen topsoil. *TransCanada PipeLines*

had a grad student running around doing stuff," Naeth recalled in a 2013 interview.[51] Among other things, her work spurred NOVA to take a leading role in the use of native species for revegetation of rights-of-way on rangeland and forested areas. "For example, crested wheatgrass in the southern part of the province was brought in as an agricultural crop and it was wonderful," Naeth said.

> It had good forage value, did really good in droughts, it did everything that one would expect. But because it was competitive, there were a lot of areas where you'd have this beautiful native range land and the pipeline right-of-way would be planted with crested wheatgrass. So the crested wheatgrass does really well, but then it starts moving off the right-of-way and it doesn't take long for that to happen. If all you want to be doing is using that land for forage for cattle, that's fine. But if you want to retain the natural diversity for habitat, for wildlife, just for aesthetic purposes—if biodiversity is your goal—then you're not going to get that with crested wheatgrass because it will dominate the area. And so you're going to lose a lot of the natural diversity and a lot of the natural habitat.

One of the measures adopted by NOVA to prevent invasive species was steam-cleaning vehicles and equipment before sending them out onto the right-of-way. "They had encountered the costs associated with eradication [of invasive plants] on other lines," said Bruce Patterson, "and they knew prevention was the lesser cost option."[52]

Companies also found ways to reduce impacts on agricultural land and farm operations, such as scheduling pipeline operations to begin after harvests were completed. "In some cases they fall-stripped a right-of-way before freeze-up and then did the installation later," Patterson said. "Soil replacement took place in the spring after the ground had settled."[53]

Beginning in 1988, Ian Scott and Dean Mutrie taught a course called Pipeline Environmental Inspection at the Petroleum Industry Training Service (PITS, later renamed ENFORM). "That course became a standard for training environmental inspectors" for industry and government, said Mutrie, vice-president for major projects at TERA Environmental Consultants in Calgary. The course continued until 2010 when ENFORM dropped its environmental courses to focus on safety. Mutrie, who gave similar courses in the United States for the Federal Energy Regulatory Commission, said teaching allowed him to compare Alberta with other jurisdictions. For a long time, he said, "we were cutting edge" although others have since caught up.[54]

As environmental standards and related research advanced in the late 1980s and early 1990s, conflicts sometimes arose between objectives, Mutrie noted. On native grass in southern Alberta, for example, Public Lands officials wanted "minimal disturbance" with small crews and light equipment, but workplace safety regulations dictated clearing a flat and level work area. "It's kind of unfortunate that safety considerations, in essence, preclude your ability to do minimal grading on a pipeline now," he said. "You have to grade a work surface and so, once you do that, you have to salvage topsoil."

Karl Gilmore, also a planning consultant with TERA, added that a persistent problem for the industry has been fill settling in the trench over the pipe and creating a ditch or depression in the right-of-way. Mitigation that might work in one circumstance does not work in others. "This issue has been going on for a long time," Gilmore said. "It drives the landowners nuts. That's when you really are losing topsoil." (Others, including Don McCabe from the Alberta Energy Regulator, also noted this problem.)[55] One potential solution was to ensure enough subsoil and topsoil was "feathered" over the trench line to compensate for any settlement over the trench, said Ralph Dyer. "This had its own inherent problem of causing subsoil to be brought to the surface by farm implements. This was usually caused by too much subsoil being piled over the trench."[56]

Environmental Protection and Enhancement Act

In 1993, the Environmental Protection and Enhancement Act affirmed "equivalent land capability" as the objective of conservation and reclamation.[57] In that year, Alberta's provincially regulated pipeline network had grown to almost 175,000 kilometres—12,000 kilometres of crude oil pipelines, 100,000 kilometres of sweet gas pipelines, 6,000 kilometres of sour gas pipelines, 12,000 kilometres of water pipelines, 30,000 kilometres of multiphase pipelines, and 15,000 kilometres of other pipelines.[58]

In 1994, Alberta Environmental Protection issued *Environmental Protection Guidelines for Pipelines*.[59] These were followed by draft reclamation criteria in 2001.[60] In 2002, pipelines were included in the Orphan Well Program for remediation and reclamation of sites that lacked a legally responsible and financially viable owner (participation replaced the former security deposit requirement).

The 1994 guidelines promoted and encouraged:

- the return of a disturbed site to a land capability equivalent to the pre-disturbance land capability
- acceptance of pre-development soil, landscape, and vegetation conditions as the standard for post-development conditions
- identification of potential environmental concerns through pre-construction site assessments and pre-planning
- protection of the environmental characteristics of the project site to minimize post-construction remedial requirements
- awareness of the value of soil, the sensitivity of soil to disturbance, and the difficulty of reclaiming degraded soils
- awareness of the importance of protecting native vegetation through minimizing disturbance and rapid re-establishing vegetation that is compatible with the adjacent land
- monitoring and on-site supervision by personnel responsible for environmental quality control of all activities to ensure a complete record of conservation, degradation, mitigation, and reclamation events
- site assessments following reclamation that provide a complete evaluation of soil, landscape, and vegetation conditions and comparison to pre-development conditions, prior to application for a reclamation certificate
- monitoring during the operating life of the facility to ensure that integrity of the environment on and adjacent to the site is maintained

Karen Etherington, an environmental planner with NOVA and TransCanada since 1987, described how she "got to see a lot of development with different techniques and tools, and the underlining theme in all of those cases was what I saw as a real partnership between government, the regulatory agencies, and the pipeline industry."[61]

> We all had the same needs to get to the same end goal, and we were able to work on them together … we had that flexibility and there was that trust to actually do it—test out these techniques and so some of the things I got to see evolve during my time: things like the biostabilization at streambanks. That was one of the new things we were doing in the 1990s … there was the pipeline reclamation criteria and the wellsite reclamation criteria that were huge leaps forward in this jurisdiction that we didn't see anywhere else. There was ongoing discussion of three lift and that particular soil handling protocol. One of the more minor ones, but very critical in the pipeline project, was shut-down criteria. At what point are activities going to cause so much damage that you actually can't reclaim that surface? One of the other big ones was the pipeline abandonment initiative that was launched in the mid-'90s when

> both the provincial and the federal regulatory agencies were struggling with how to deal with pipeline abandonment, before it becomes an issue. The provincial representatives, the federal representatives, and then CEPA and CAPP* launched this whole initiative, which I got to be a part of. Then there were the multi-stakeholder tables like the Alberta Pipeline Environmental Steering Committee and the Canadian Pipeline Environmental Steering Committee, which were really strong and powerful at a time when both government and industries sent senior seasoned folks to the table; then as things progressed and it got to be a point where neither groups were sending their senior folks to the table, they were more or less holding the spot—but the decision makers and those with influence on policy weren't available to sit on the committee table, so the committees essentially went by the by. They weren't effective anymore and there was a bit of a change; it seemed to become more of a company by company relationship with government as opposed to an association or a broader sector-level relationship.

Etherington also worked in other jurisdictions, and she said, "there was probably the most emphasis on reclamation in Alberta than anywhere else we worked." As a result, she said, Alberta developed more specialty contractors and reclamation specialists within companies: "soil scientists who are also very familiar with pipeline construction, what the equipment can and can't do—that's quite a unique skill set that we found—and then having the qualified environmental inspectors overseeing the handling, and that's right from the initial soil stripping to replacement of the soil and having the right people overseeing that and then into reclamation."

Albert Lees, a former head of NOVA's reclamation program (now a consultant with Stantec), was a pioneer in using appropriate vegetation on rights-of-ways. Etherington said that Lees insisted on vegetation surveys prior to construction and selection of appropriate seed mixes. The company developed a strong relationship with Kirby Lowen, then with Prairie Seeds, to provide the mixes. "We worked hand-in-hand in terms of developing these seed mixes, trying different coatings and fertilizers," Etherington said.

> When we were doing a lot of reclamation up in the Green Area—where we did a lot of aerial seeding, testing different weights of coating to get the seed to fall right—it was a quite the exercise … There were some areas where we got into some very specialized seed that we would put down. A lot of it was to do with landowners and special requests, dealing with certified seed growers.[62]

Other innovations since the 1990s have included specialized reclamation techniques for erosion prevention and for environments such as muskeg. Etherington said one key to success was involvement of agrologists, biologists, and soil scientists in the early planning stages of projects. However, one continuing problem on public lands has been post-construction use of rights-of-ways by industrial and recreational vehicles that affect soil, vegetation, and wildlife. This problem was particularly acute on public lands because it was difficult to assign liability to the appropriate party. How liable should the original pipeline company be if they had done a good job in reclaiming the disturbed surface, but subsequent activities redisturbed all the good effort?

After the former NOVA system (now part of TransCanada) became federally regulated in 2008, its operations fell under the National Energy Board and provisions of the Canadian Environmental Assessment Act. Having worked in both jurisdictions, Etherington said the Alberta framework placed more focus on conservation and reclamation. The plans were the same "but yet the conservation and reclamation theme was not top of mind in the federal process."

> But what the federal process brought in that wasn't in the provincial process was a formal structure for post-construction monitoring. Under the federal process you had to measure the success, or measure the effectiveness of your mitigation measures—your environmental protection measures—every year for usually at least five years and file a report with the NEB that was publically available. So, that brought a whole new transparency into the system. Now you ended up with an Alberta framework that was probably very well suited to receive those kinds of reports and take them into the process and feed them into ongoing improvement. The federal process had the legislative requirement to get the reports, but the actual analysis and pulling learnings out of those reports—they weren't quite there yet.

* CEPA and CAPP: Canadian Energy Pipeline Association and Canadian Association of Petroleum Producers.

Municipal Pipelines

In addition to the vast array of energy-related pipelines, Alberta has extensive networks of municipal and regional water and sewage pipelines that are also subject to land conservation and reclamation regulations.[63]

Prior to 2003, all pipelines were regulated the same way. However, with the introduction of the upstream oil and gas audit program, oil and gas pipelines (industrial pipelines) were treated separately from water and sewer lines (municipal pipelines) so that only the former would be subject to the audit system.

Ralph Dyer, former pipeline approval coordinator in the Land Reclamation Division of Alberta Environment, said that during the 1980s, a number of water and sewer line projects came to the attention of Alberta Environment due to the establishment of regional water commissions.[64] There was a grant program in place at the time to assist local governments in upgrading their clean water and sewer systems to the standards of the day; the program was administered by Alberta Municipal Affairs, and Alberta Transportation provided oversight on the contract bidding program and the construction of the facilities.

Alberta Environment approached Municipal Affairs with the idea of treating these projects similar to the way oil and gas projects were regulated because they created a surface disturbance equal to or often greater than equivalent sized oil and gas pipelines, and in the case of sewer lines, could be much larger in diameter and buried deeper.[65] Also, because these water and sewer systems were publicly funded, it was felt that the government should "walk the talk" and lead the way on pipeline land conservation and reclamation. Although, there was some initial reluctance, Alberta Municipal Affairs agreed to comply.

Environmental protection for municipal pipelines is regulated by Alberta Environment and Parks. Conservation and reclamation requirements for municipal pipelines are the same as for industrial pipelines. These requirements are set out in Alberta Environment and Sustainable Resource Development (AESRD) 2012 guidance documents.[66]

The installation of an 88-kilometre water pipeline from Boyle to Wandering River in 2012 illustrated design and construction incorporating modern conservation and reclamation practices and regulations. Horizontal directional drilling (HDD) greatly reduced the environmental impacts and exempted the project from the requirement to obtain an approval under EPEA, according to a trade magazine article.[67] (Former Alberta Environment official Chris Powter said the exemption would stem from "a liberal, but environmentally rational, interpretation of the provision for ploughed-in pipelines"[68] contained in the Activities Designation Regulation.[69])

The article said that HDD reduced the water pipeline's land disturbance by approximately 90 per cent and "minimized topsoil salvage, subsoil excavation, admixing of soils, re-vegetation, erosion, and crop damage, while preserving the natural habitat for wildlife. In cultivated areas it minimized crop damage and reclamation required by private land owners."[70]

Challenges

"It doesn't seem to matter how long the pipeline is, you plan it metre by metre," Etherington said. "There are no shortcuts—you just can't—because the environment doesn't have shortcuts, landowners don't have shortcuts, stewardship doesn't have shortcuts. It's metre by metre in just about every discipline we work with …

> I think the technology is going to continue to evolve. It has to because we are getting more and more concerned about the footprint of energy infrastructure. I think we are going to continue to see more involvement of Aboriginal groups in conservation and reclamation, and I think we are going to see the legislation evolve. I think that will be in response to the expectations of the public to regulatory agencies to regulate. As you get more and more companies operating on the landscape, I think that the whole layer of trust between the public and the companies, it will vary, but what will help comfort the public is seeing the regulators regulate … New policies, regulations, compliance, and enforcement … I think those expectations will continue to rise.

From 2007 to 2009, the National Energy Board conducted the Land Matters Consultation Initiative to address many of the issues cited by Etherington, including interactions among landowners, companies, and regulators. The consultation also dealt with the physical and financial implications of pipeline abandonment.[71] "Many landowners requested that pipelines be removed upon abandonment," the

NEB said in its report on the consultation. "Industry representatives focused on developing an objective, risk-based set of criteria to establish appropriate abandonment methodologies." As a result, the NEB established the Land Matters Group including industry and public participants. The board said that the purpose of the group is to "bring together knowledge and expertise of members of the public and industry" to:

- build awareness and interest in land matters, and encourage a fuller exchange of information between affected individuals and groups
- promote and facilitate in-depth discussion and recommendations on land matters
- inform regulatory development, priority setting, and program delivery decisions made by the board[72]

The unique characteristics of the many different types of landscapes crossed by pipelines pose challenges for conservation and reclamation, said Arnold Janz, a soil specialist with Alberta Environment since 1986.[73] "Knowing your landscape, knowing the sensitivity of your landscape, is really important, and we have not done a good job of that. Our rangelands—we haven't recognized the sensitivity. Our farmlands, there's diversity of sensitivity. Cultivated soils with shallow topsoil, they're very easily damaged …

> Our soils up in the Grande Prairie area have a high clay content, and the topsoil and subsoil have very similar colours, so quite often Cat operators are told, "strip off the topsoil," and they can't tell which is which, so they go too deep … There's a pipeline up there that crosses the Peace River; it's permanently damaged. This pipeline corridor is 80 metres wide because there's a whole bunch of large-diameter pipelines in there, and it's 15 kilometres long—significant damage. So that's the kind of thing. You have to know your land, your landscape and the sensitivity and the properties of it …

The next innovation could be greater use of horizontal directional drilling (HDD) on land as well as its current use for water crossings, said Don McCabe, a biologist now working on pipeline approvals for the Alberta Energy Regulator. "The ultimate is the idea of HDD. You set up a small disturbance, you install a pipeline with virtually no surface disturbance except for those entry and exit points." However, other experts pointed out that during construction the drilling would involve additional disturbance around the entry points and for pipe assembly area—an illustration of the tradeoffs involved. Disposal of drilling muds is another issue.[74] McCabe cited work done by Doug Kulba, a former pipeline inspector, at the government-industry Evergreen Centre established in 2009 in Grande Prairie.[75] Kulba has been using trenchless drilling technology to demonstrate minimal impact of pipeline and culvert construction in a forest landscape.

McCabe began his career doing field work for Imperial Oil in the Cold Lake area, joined Alberta Environment as an inspector in 1992, moved into approvals in 2000, and transferred to AER in 2013. He said there was a lot of progress, government-industry collaboration, and research on pipeline conservation and reclamation in the 1980s and early 1990s, but this slowed because of government cutbacks in the 1990s followed by the rapid expansion of oil and gas activity in the province. As a result, he said, the assessment of conservation and reclamation in Alberta became "complaint based" and there has not been enough scientific research to demonstrate whether the desired results are being achieved.

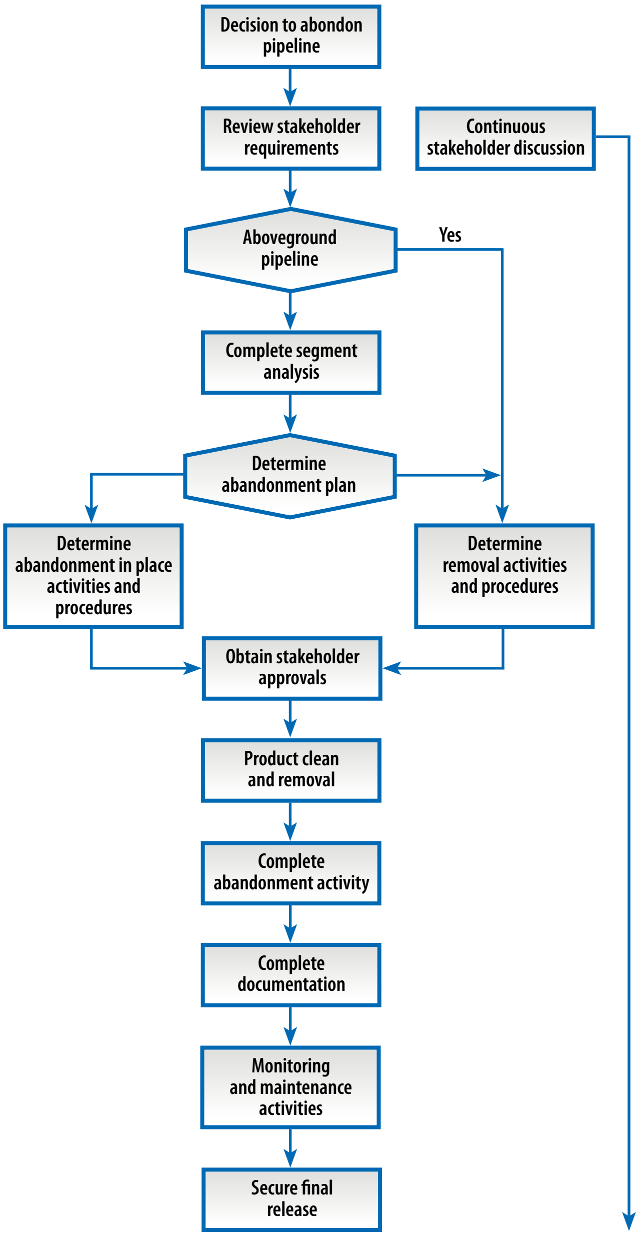
McCabe expects renewed focus on environment impacts following adoption of Alberta's Land Use Framework in 2009 and creation of agencies such as the Alberta Environmental Monitoring, Evaluation, and Reporting Agency (AEMERA). AEMERA is the provincial organization established in 2013 to monitor, evaluate, and report on key air, water, land and biodiversity indicators to better inform decision-making by policy makers, regulators, planners, researchers, communities, industries, and the public. AEMERA's mandate is "to provide open and transparent access to scientific data and information on the condition of Alberta's environment, including specific indicators as well as cumulative effects, both provincially and in specific locations."[76]

Decommissioning and Abandonment

With pipelines as large as 1,350 millimetres (54 inches) in diameter currently being proposed in Alberta, one of the big questions facing government and industry will be the ultimate fate of all the pipe and rights-of-way. After the original 1912 Bow Island pipeline was abandoned, before modern regulations, Dean Mutrie said that farmers just started pulling the cast iron pipe out of the ground and using it for drain pipes and irrigation; it had only been buried 30 to 45 centimetres underground.

Dean MacKenzie, a soil scientist and manager of research at consulting firm Navus Environmental, said that the industry has invested a lot in "best practices" to avoid many of the problems for more recent pipelines. "I think the biggest problem is you've got so many pipelines in the ground from the old days that people don't even know where pipe still is today."[77]

Federal and provincial regulations today are "so onerous that very few companies will proceed with abandonment because there is no reward for them," said Karl Gilmore. "They have to spend all this money to abandon it, but they still have the responsibility and liability. So what have they done? Nothing. They haven't accomplished anything and they've spent a fortune. So they don't."



The National Energy Board commissioned a study of pipeline abandonment by consulting firm Det Norske Veritas, published in 2010. The study produced this flow chart of the steps involved.

"Like the oil and gas industry in general, we may not realize the full impact until these facilities are abandoned," said Ralph Dyer.

Industry and government organizations have been studying the issues of pipeline abandonment and reclamation since the mid-1980s. A 2010 report for the National Energy Board showed there were still outstanding issues such as standards for pipe cleaning, rates of corrosion and subsidence, and effects on surface water and groundwater.[78] Regarding the risk of abandoned pipe eventually collapsing and causing ground subsidence, the report cited a 2007 study by the Canadian Energy Pipeline Association that found pipeline structural integrity would be retained for "decades, if not centuries." However, it added, "considerable work is needed to validate subsidence risks resulting from corrosion."

"If you think about abandonment and actually removing pipe, it's almost as big a construction job as building pipe and there's no money for that," said Mutrie. "It's one of the pipeline industry's thorny issues."[79] An additional factor companies must consider is that removing a section of pipe that meets the 2690 index test will result in the need for a pipeline approval and reclamation security; all of which adds considerable cost and time.[80]

Alberta's Record in Perspective

After his work with Syncrude and NOVA, Al Fedkenheuer continued his involvement in reclamation as a supplier of native plant stock from his Calgary nursery. He summed up his reflections on the evolution in Alberta compared to other jurisdictions:[81]

> I have a couple of things that I believe have had major impacts, not just on pipelining or mining here in Alberta but in Canada and also in the United States, and it continues in the US as they become exposed to what is normal (environmentally) in Alberta pipelining. Certainly some of the regulations assisted in moving these approaches forward, and I believe you have identified these already.
>
> I believe I can speak about the "broadness" of the impact as I have been active not only in the reclamation arena in Alberta specifically and Canada more generally, but I was active for a number of years on the executive of the American Society for Mineland Reclamation as well as regularly attending and presenting at their, and other, meetings in Canada and the United States.

The advent, idea, requirement, and value of stripping, salvaging, storing, and replacing topsoil separate from the underlying B and C horizons on pipelines was a major step forward environmentally and was supported by at least some of us within the pipeline companies, for many situations. This activity was unheard of in the United States and other parts of Canada in its early days (still is in some US jurisdictions for sure). Most pipelining was simply trench the soil all as one lift mixing topsoil and subsoil no matter if topsoil salvage could be beneficial as it is in a number of cases.

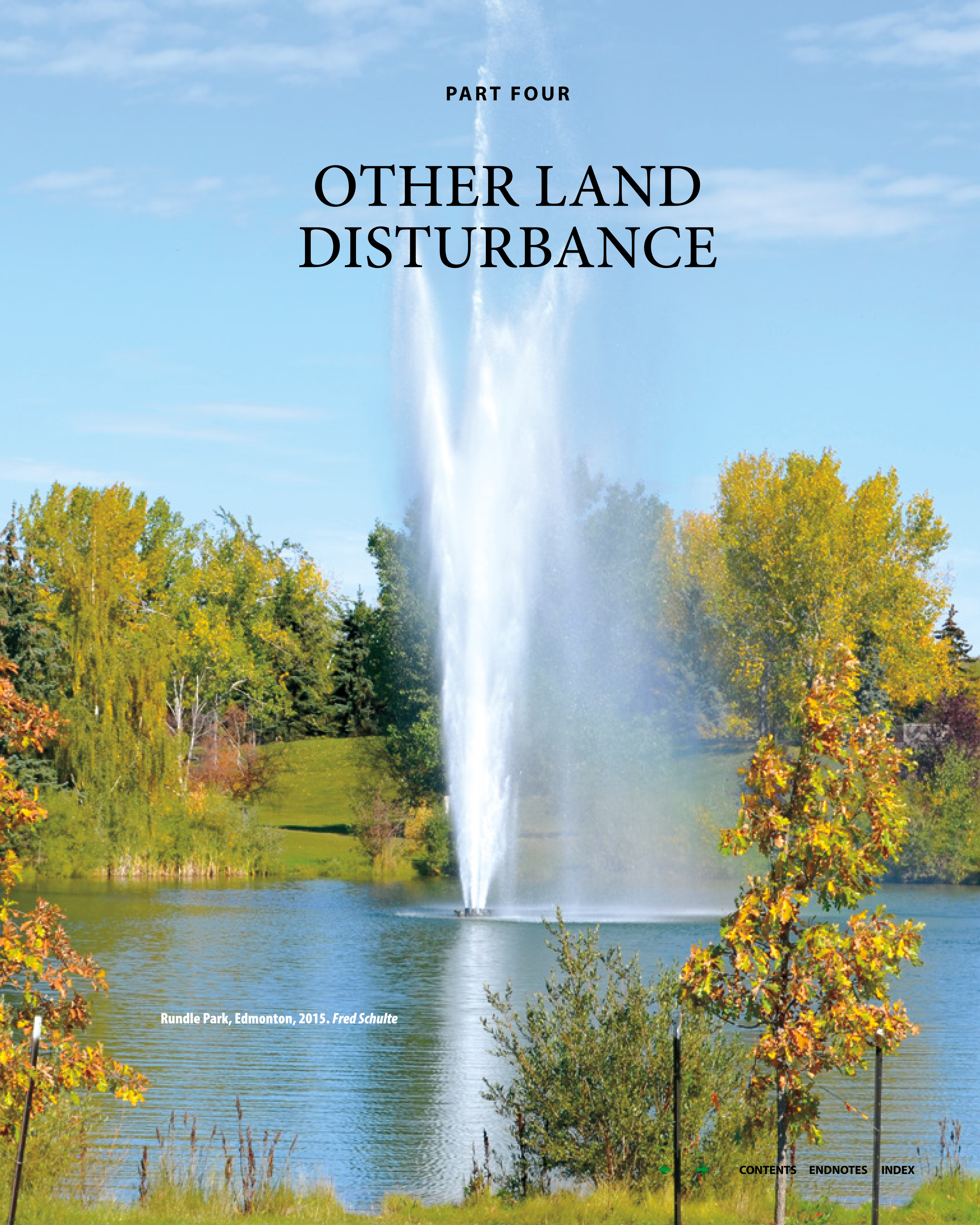
In fairness, for some prairie situations with small diameter pipe, a single lift—that is narrow trenching—can be the best approach as it is minimal disturbance. The approach to environmental awareness put Alberta in a leadership role from a soil handling on pipelines perspective. Alberta still is in a leadership role in this area, although many of the "environmentalists" would "pooh pooh" Alberta's role today with the Keystone pipeline. It is still leading edge outside of Alberta.

One thing we have had in Alberta that has not been prevalent in most other jurisdictions, is a "cooperative" approach. What I mean is that it was common for regulatory personnel, industry, and consultant experts to meet and discuss issues of concern to all to see what could be done to resolve contentious issues. This is very much in contrast to many other jurisdictions where confrontation was more often the route taken. This does not mean there were no heated, vigorous discussions because there were many of those, however, it was somewhat unique that we could have these, everyone was open to having them and we moved forward (most of the time!) from there.

Native species plant nursery in Al Fedkenheuer's back yard, August 2015. *Robert Bott*

PART FOUR

OTHER LAND DISTURBANCE



Rundle Park, Edmonton, 2015. *Fred Schulte*

Roadways

For many Albertans, roadway rights-of-way may be the only exposure they get to the success (or failure) of reclamation work. For this reason it is critical we put our best foot forward and continuously look for innovative ways to showcase reclamation outcomes.

Chris Powter

Erosion was a constant problem during the roadbuilding days of the 1960s, when roadbuilders were becoming aware of the need to reclaim side and back slopes. Operators would place a smooth, even layer of topsoil for reseeding only to see the first rainfall wash it into the ditch before the grass took hold. Just who first tried the innovative solution of "track-walking" is not clear. But it worked. The technique is to "walk" a bulldozer up and down the slope, roughening the surface and creating small pockets. "If you get the seed washing, it falls into those little indentations where the tracks are and you end up with a microclimate for seed germination," explained retired Alberta Transportation planner Don Snider.[1] By the 1990s, track-walking came into common use, with variations, and topsoil losses have been minimized.

Geotextile Reinforced Soil (GRS) structures are a recent innovation in stream crossings that reduce impacts of roadways on fish movement and water quality. This structure spans Hardisty Creek on Robb Road south of Hinton.
Robert Bott

From a complex set of interconnected Aboriginal trails and waterways, Alberta's public roads network has grown into Canada's second largest. Reclamation of rights-of-way and borrow excavations began in earnest in the 1970s. Challenges unique to road-building reclamation have included slope-erosion control, borrow excavation reclamation, constructing roads through wetlands, and protection of fish-bearing streams from siltation. These problems have encouraged some innovative solutions.

Alberta Roads: A Background

Prior to 1870 there were no public roads as such in Alberta. Rivers served as the primary transportation routes, supplemented by networks of trails and portages. Most of these overland routes had been developed by Aboriginals or by the cart brigades of Métis hunters and free traders.[2] One Aboriginal route network in particular is thought to date back at least 10,000 years, based on archaeological evidence. Known as the Old North Trail, it ran the full length of the Rocky Mountain Front Ranges of North America. In Alberta, portions of the network can be traced well north of Calgary and in Montana south of the forks of the Missouri River.[3] The trail has been mentioned or described in a number of historical accounts, and oral histories of it are still told by Aboriginal elders of the area.[4]

Although the North West Mounted Police undertook some local improvements around Fort Macleod in 1879, and the Hudson's Bay Company improved its trail networks in the north, little public road construction happened until the late 1880s. Between 1884 and 1891, the North-West Territories government surveyed 14 trails within the current provincial boundaries with a view to improvements and ferry connections. Local contractors carried out the work. Between 1892 and 1897 government road expenditures grew seven-fold.

Before 1897, earthmoving for the construction of bridge approaches and to improve roadway grades up hills and through low-lying sections was done primarily using ploughs to loosen the earth, and small horse-drawn drag scrapers (skips) to remove it—in addition to the time-honoured manual method of employing men with shovels and wheelbarrows or carts. Corduroy of logs, brush, or saplings below the road surface was commonly used to prevent traffic from bogging down in swampy and other wet sections. As the population expanded, the territorial government created the first Department of Public Works in 1897, which centralized responsibility for constructing and maintaining roads, bridges, and related works. Tools and equipment were now acquired regularly, including the new horse-drawn Champion brand road graders.[5]

After the creation of the Province of Alberta in September 1905, the provincial Department of Public Works continued to look after the construction and improvement of main roads. Local and district roads remained the responsibility of local improvement districts. About this time, automobiles became popular. When the first automobile legislation was passed in 1906, just 41 operators were granted licences. By 1912, the annual count had ballooned to nearly 2,500. In 1913, the provincial department was reorganized with the establishment of a Highways Branch, and the war years of 1914 to 1918 saw a rising demand for better roads.

Prior to 1926, Alberta highways were identified by colour. An early map shows for example the road from the US border to Calgary and Morley as the Blue Route, Calgary to Edmonton and Athabasca as the Black Route, and Crowsnest to Macleod and Medicine Hat as the Red Route.[6] In 1926, the system was abandoned in favour of numbered routes. It was needed: by 1928, the year a gravel road was completed from Edmonton to the US border, Alberta's provincial highway network totaled 2,310 kilometres.

In 1982, there were 149,435 kilometres of roads and highways in Alberta, occupying 352,266 hectares.[7] Today that has expanded to over 226,000 kilometres of public roads in the province, representing about 22 per cent of Canada's total. The main north-south route is the Queen Elizabeth II Highway (Highway 2), which provides a route through both Edmonton and Calgary and links the Alaska and Dempster Highways to Interstate Highway I-15 in Sweetgrass, Montana (known as the CANAMEX Corridor[8]). East-west Alberta is serviced by two main highways: Highway 1 (Trans-Canada) through Calgary and Highway 16 (Yellowhead) through Edmonton. Both are part of Canada's coast-to-coast highway system. Compared with all other provincial and territorial networks, Alberta ranks second only to Saskatchewan in total kilometres. Almost 165,000 kilometres of Alberta's public roads are gravel, treated, or earthen, which fall largely under municipal jurisdiction.[9]

Reclamation of Roadways

"Roadway" according to *Environmental Protection Guidelines for Roadways* is a highway or road as defined in the Public Highways Development Act: highway or road (1) means land used or surveyed for use as a public highway or road, and (2) includes a bridge forming part of a public highway or road and any structure incidental to the public highway or road or bridge.[10] Roadways within the national parks are not subject to EPEA; Parks Canada has detailed requirements for design, construction, and reclamation of these roadways.[11]

Generally, for a proper and sound roadbed the construction sequence is a base of clay with a gravel layer on top, then pavement. Unless it is to be abandoned, the road itself is permanent and not a candidate for reclamation. It is the rest of the right-of-way that most commonly receives reclamation attention. The three segments of the right-of-way are side slopes, ditch bottoms, and back slopes.[12] These segments serve to prevent water penetration undermining the roadbed. Side slopes are designed to minimize the risk of vehicle rollover when people drive off the road. Depending on the classification of the road, side slope ratios can be anywhere from 3:1 to 6:1. Standards and dimensions of segments vary, according to type of road—two lane, four lane, six lane—and type and volume of traffic anticipated (interchanges add considerably to the footprint of a roadway). Roads are generally designed for the ultimate width of pavement while allowing for safe shoulders and side slopes. Similar to railways, additional construction and reclamation challenges are created when culverts and bridges are required to cross waterbodies.

There are no approvals under the Environmental Protection and Enhancement Act (EPEA) for the construction or reclamation of roadways. However, operators require a reclamation certificate following roadway abandonment. Most urban roads are not covered by reclamation requirements.[13]

For most provincial roadways, Alberta Transportation is the operator that is required under EPEA and Conservation and Reclamation Regulation to conserve and reclaim. The department in turn directs its contractors to perform conservation and reclamation. The majority of the reclamation processes involved do not differ substantially from those required for mines, quarries, oil and gas installations, and other disturbances as described in appropriate chapters.

The Early Years

Like the coal mines, where some reclamation efforts by industry began even before the province's first reclamation legislation in 1963, some road-building reclamation activities were underway in the early years, too. G. G. (Gerry) Stotts, vice-president of the Heavy Construction Heritage Society, recalled that in the 1950s and 1960s, roadbuilders would remove and stockpile topsoil, and provincial Department of Highways crews would follow up with placing and seeding it.[14]

In 1958, after graduating from the University of Alberta

Trans-Canada Highway, Lac des Arcs interchange, 1967. Areas adjacent to the interchange would be reclaimed by Department of Highways. *Gerry Stotts*

Abandonment of Railways in Alberta

With a network currently comprising about 9,700 kilometres of track,[16] railways have been a part of Alberta's landscape for more than 130 years. The province's first was the Canadian Pacific Railway, built through Medicine Hat, Calgary, and Banff in 1882–83.

Such a history long predates land reclamation regulations, and much of the land may have been undeveloped at the time of construction. Environmental factors, such as soil salvage, were in most cases not recognized at the time, nor required by the federal government, which regulates construction and operation of national railway lines. Alberta's current reclamation criteria take these factors into account. For example, they do not address soil replacement.[17] However, operators are encouraged to salvage topsoil to be used in future reclamation. Moreover, over time, surface water drainage has in some cases established new patterns that are now stable; and much of the original land disturbance may have revegetated naturally.

Nevertheless, all railways in Alberta—federal, provincial, or private—are subject to reclamation requirements when abandoned. In 1994, in response to a request from railway companies for information on reclamation criteria, a joint government/industry/public Steering Committee was struck to discuss issues.[18] A Working Group, comprised of members from Alberta Environmental Protection, Alberta Agriculture, Food and Rural Development, three railway companies (CN, CP, and CWR), the Farmer's Advocate, and the Alberta Association of Municipal Districts and Counties made recommendations that were incorporated into the Reclamation Criteria for Abandoned Railways.[19] This includes all rights-of-way and developed infrastructure. But the requirement to obtain a reclamation certificate depends on date of abandonment. Railways abandoned before August 15, 1978, are not subject to the requirement to obtain a reclamation certificate. For lines abandoned between August 15, 1978, and September 1, 1993, the Conservation and Reclamation Regulation, as amended, exempts operators from the obligation to get a reclamation certificate. However, operators are responsible for reclamation of those lines and are expected to meet the intent of the criteria. Finally, lines abandoned after September 1, 1993—the date of the enactment of the Environmental Protection and Enhancement Act—must obtain a reclamation certificate.[20]

Abandoned railways have a number of potential land uses so reclamation of a railway should accommodate them; the Iron Horse Trail, a reclaimed CN railway running from Waskatenau to Cold Lake (part of the Trans-Canada Trail), is an example of a recreational use.[21] The criteria take into account existing land uses, landscape stability, future potential land uses as well as the land use before the activity commenced. Future potential land uses should be determined by the operator based on their discussions with local municipalities, potential land purchasers, etc. The end use may modify some reclamation requirements. For example, railway line segments that are used as roadways may require that culverts and ballast stay in place and should not be expected to have vegetation on the road surface.

The provincial criteria define requirements for most cases. Generally, all rail infrastructure—including rails, ties, ballast, bridges, culverts, poles and lines, wires and pipelines, signs, fences, and road crossings—must be removed. The rail bed must be stable and non-erosive with no visible evidence of slope movement. Re-contouring will be required to correct stability concerns or erosive conditions found in the rail bed or caused as a result of the removal of infrastructure. The rail bed and culverts must not impede current drainage patterns. Vegetative species present must be suitable for the intended land use, with no noxious weeds present. Other weeds must not be present in densities greater than on adjacent land. Plant cover must be 80 per cent or greater.

After the reclamation certificate is issued, the operator is liable for five years for conservation and reclamation matters that were not apparent to the inspector at the time the certificate was issued. After the five-year period, the government assumes liability for conservation and reclamation problems relating to the above criteria—with the exception of contaminants, which would still need to be addressed by the operator.

The Iron Horse Trail near Cold Lake. *Chris Powter* with a civil engineering degree, Stotts went to work with a small contracting firm called J. A. Moulson Construction Ltd., which built roads. "[The Department of Highways] had the province divided up into many areas," he said.

> The highways that were going through these areas were contracted to individual contractors. Our work would not involve any reclamation. The contract documents would require some test holes. So, we could see how much topsoil there was and how much subsoil there was, and then we got down to the silt-clay granular material. We would provide the drainage, and the topsoil would be stockpiled. The contractors didn't do any reclamation. It would be the Highways Department after we'd finished. They would do the landscaping or whatever else they had to do.[15]

The roadbuilders soon negotiated with the government to do their own reclamation, and gradually the Department of Highways reduced its involvement in physical reclamation. Throughout the 1960s, Stotts was a director of the Alberta Roadbuilders and Heavy Construction Association, which did much of the lobbying. "We met with the Highways Department, and those are the kind of issues we talked about," he recalled. "They introduced new or different bid items such as fencing and topsoil removal, and then topsoil replacement came in. That would've been in the late '60s and the '70s." During this time, the government retained the reseeding function.

Regulation and Standards

In 1972, the Alberta Department of Environment completed an environmental impact statement for the proposed first 50 kilometres of new Highway 40, from the junction of the Kananaskis Lakes access road to the junction of the Trans-Canada Highway. This was the first time an environmental review of a planned development was undertaken in Alberta.* The review was a collaboration of the departments of Highways and Transport and Lands and Forests. It featured a landscape architectural design and specified the following practices:

- salvage of topsoil during construction stage for re-use before seeding
- revegetation to control erosion
- provision and preservation of buffer strips
- rounding and shaping of cuts to improve aesthetics
- reclamation and reforestation of the trunk road and other roads and trails throughout the valley that were no longer being used for the purpose they were originally designed

Don Snider, a retired environmental professional who started with Alberta Transportation in June 1983, was closely involved with later work in Kananaskis Country. Highway 40, Highway 68, Highway 541, Highway 642, and the Sheep River Road were in various states of construction. Snider was responsible for environmental construction inspections to help department staff assist contractors in meeting conditions for construction. At the time, environmental inspections were something relatively new for roadbuilders. "They were very experienced in looking after the construction," he recalled. "They were not sure what I could bring to help them out."

Snider describes those early years as "engineering and environmental work together." He started with this concept while working on Highway 40 from Grande Prairie to Grande Cache. They were building in areas of significant peatland, where techniques for roadway construction over peat were not well understood. "Some of it was still the corduroy type of roads, and then the use of filter fabrics came in. It just had never been done before in Alberta—making sure, through those areas, that water could traverse from one side of the road to the other through the peat. So you did not end up with a big wetland on one side and everything drying out on the other side."[22] Often topsoil was not saved, according to Snider. But attitudes began to change as people came to understand that without the topsoil, grass and revegetation of the side and back slopes would not succeed.

The next step was to start placing the topsoil on the slopes where grass could be planted. Initially, roadbuilders tended to place it on the slopes evenly and smoothly. This soon led to erosion challenges: it would quickly become saturated with water, slide off the slope, and get washed down to the ditch, eventually ending up in a nearby river or stream. All the advantages of having the topsoil on the slope would disappear in short order, especially with a heavy rainfall event.

Retired road engineer Gordon Parchewsky started his career with North American Road Limited after graduating from the University of Alberta as a civil engineer in 1971. He said in the 1970s there was not a lot of consideration for erosion, but that soon changed.

* This was done prior to the province establishing a formal environmental impact assessment process. Since the process was established in 1973 there have been two EIAs for roadway projects: 1975 – Alberta Transportation's Crowsnest Pass – Highway 3 Rerouting; and 1990 – Municipal District of Sturgeon's Secondary Highway #651, Lily Lake Road Crossing.

> When you got into the 1980s, companies started manufacturing things that you could use for erosion control, and pretty soon there were regulations that said you had to control your erosion. If you had a storm event, you tried to keep as much silt and so forth from going into the streams. So, it's a two-fold thing; one is trying to protect the streams and keep it more normal, which is difficult to do when you're in a construction project and you've got things torn up. If you get a fair amount of rain, it's going to start to flow and it's going to carry the silt.[23]

The best solution turned out to be track-walking—a variation on the rough mounding technique used in coal mining reclamation, such as that used by Teck Corporation described in Chapter 5. "We started instituting the track-walking prior to putting the topsoil on and then we also did the track-walking once the topsoil and seed was in," explained Snider.[24] Bulldozer operators soon mastered the technique. This method became standard after the 1990s. It was used with success in the twinning of Highway 16 and Highway 1.

With the enactment of the Environmental Protection and Enhancement Act in 1993 and its subsequent regulations, roadbuilders began filing reclamation plans with Alberta Transportation.[25] "We needed to actually hire an expert to identify what was there before we started and then that would help us in putting together a reclamation plan at the end," recalls Parchewsky. "The best way to do that was to actually collect the information and then try to replace more or less the same at the end." The technique was similar to most land reclamation: stripping the topsoil and subsoil separately and saving them in different piles.

Unlike with coal or oil sands mining, or quarries, road building could sometimes produce a surplus of topsoil, because it is not replaced in the land area created for the new road. However, the excess was not wasted. "You'd just put it in thicker in some areas," said Parchewsky. "It's better to have too much topsoil than not enough." Today, excess topsoil is often sold.

In 1993, EPEA created a new EIA process that defined mandatory and exempted activities. The widening or realignment of an existing highway, for example, was exempt from EIA requirements. In 2000, Alberta Environment issued several guidance documents relative to roadways:

- *Environmental Protection Guidelines for Roadways* to provide direction for construction, abandonment, and reclamation of roadways[26]
- *Disposal of Excess Soil Material from Roadways*[27]
- an Information Letter on the newly created class of specified land called borrow excavations,[28] which are associated with roadways

Seed mixes for revegetation evolved over the years, increasing use of local native species as they became commercially available. Yet despite revegetation and new techniques, erosion control continues to be a prime concern. Fisheries and Oceans Canada also became much more involved in its efforts to ensure that fish-bearing waters are not contaminated with silt under section 35 of the Fisheries Act. An effective solution of recent years has been the introduction of environmentally friendly polyacrylamides that can be added to silt-laden waters to clump the silt and drop it out of suspension.

Road reclamation standards and performance continue to improve in the province as innovative designs develop and new approaches evolve from experience and research. Parchewsky also thought that regulations definitely changed how people looked at things.

> Most companies followed the rules, so that's what got done. Then later on, somebody says, "Hey, if we did this, this, and this, we could improve what we're doing." As we design and determine that we can do things better, we'll keep on moving that standard up. And, we need to be cognizant of the fact that some of the old standards obviously don't meet what we wanted but we have to accept that. We just need to keep moving ahead.[29]

Borrow Excavations and their Reclamation

Road constructors rely on "common excavation," material obtained within the right-of-way, for sourcing needed earth material such as gravel and clay. However, when employing the popular cut-and-fill construction approach—in which materials such as clay or gravel are taken from the high points and used to fill the low points—common excavation quantities can be insufficient for the roadbuilders' needs. That is where borrow excavations come in: nearby areas excavated to make up the material shortfall. "Borrow" is a misnomer, as the material is not really borrowed in the true sense, but taken and used permanently somewhere else.

As with all other regulated land disturbances in the province, borrow excavations must be reclaimed to an equivalent land capability. For its roadway projects, Alberta Transportation requires a pre-disturbance assessment for all borrow excavations; this serves two purposes: to establish the pre-disturbance land capability of the site, and to provide guidance to operators to direct soil salvage. Full guidance for professionals is provided in an Alberta Transportation guide.[35] The pre-disturbance assessment records land use, terrain, soil analysis, vegetation, and any other data relevant to documenting the land capability of the site. Alberta Transportation requires all pre-disturbance assessments be signed off as approved by a professional who is a member, in good standing, of one of the following Alberta professional regulatory organizations: Alberta Institute of Agrologists; Alberta Society of Professional Biologists; Association of Professional Engineers, Geoscientists of Alberta; and the Association of Science and Engineering Technology Professionals in Alberta.

In the early years, constructors tended to choose higher ground for borrows to source the drier clays, because wet materials are less suitable for building a road base. However, that often made reclamation to equivalent land capability a difficult proposition: a dugout borrow on top of a hill does not naturally fill with water. "We'd reached an understanding with provincial land reclamation officials that as long as a dugout could hold water it would meet the requirements of equivalent land capability," explained Snider. "They just didn't want a hole in the ground that had no use. So, you could put water into it, then the adjacent farmer or landowner could use it for watering his cattle, or, if it was constructed right, it could eventually turn into a wetland of some kind."[36]

In the late 1980s, the spacing of borrow excavations became an important cost factor, as 300 metres was the optimum haul distance from the excavation. If the distance was more than 300 metres the contractor had to pay per cubic metre for hauling. So there were cases where traditional borrows could not be found close enough together. That was when operators started turning to what are called

Banff-Jasper Highway common excavation, 1958. Where common areas such as these provide inadequate roadbuilding material, contractors turn to borrow excavations, which are subject to reclamation. *Gerry Stotts*

Licence of Occupation Roads

Licence of Occupation (LOC) roads are authorized under the Public Lands Act (PLA) and are typically private access roads for forestry and energy companies. They do not fall under the regulatory definition of a "roadway," however they may be subject to EPEA and CRR rules if they are part of an activity that is defined as specified land (e.g., a well, pit, quarry, or mine). Experience with reclamation of forestry roads may provide useful information for reclamation of specified land activities.

Gerry Stotts recalled building roads to wellsites for the oil and gas industry and that these roads were to different specifications than public roads. "They were private roads. We were working for Shell or we working for Imperial Oil." His company did not do reclamation on those roads.

> But that's not to say that reclamation wasn't done on them, because the oil company would hire the local guy, a local contractor to maintain the road. I know right from Pincher Creek to the north of the province, the local contractors, that was their job. In a lot of cases, they built a road and then were hired to maintain it. It would all be done on an hourly work basis. The engineer would pay them by the hour to do any reclamation or any maintenance.[30]

Don Pope was the Integrated Land Management Specialist for Alberta Pacific Forest Industries Inc. (Al-Pac) from 1992 to 2014. He recalled building several classes of LOC roads.

> The class 1 roads are similar to a secondary highway; a high-grade county gravel road. The roads that Al-Pac put in are what we call a class 3, 4, or 5 block road. Those all get totally taken out and removed off the landscape. All the drainage that was there is restored. Generally, we don't put a crown on them or do much subgrade development. A lot of those roads are seasonal or maybe a season or two but we wouldn't use them in the most inclement weather.[31]

More permanent roads would be reclaimed.

He said occasionally they would build LOC roads on behalf of an oil company, or acquire one from an oil company, and for those there were some differences from forestry block roads.

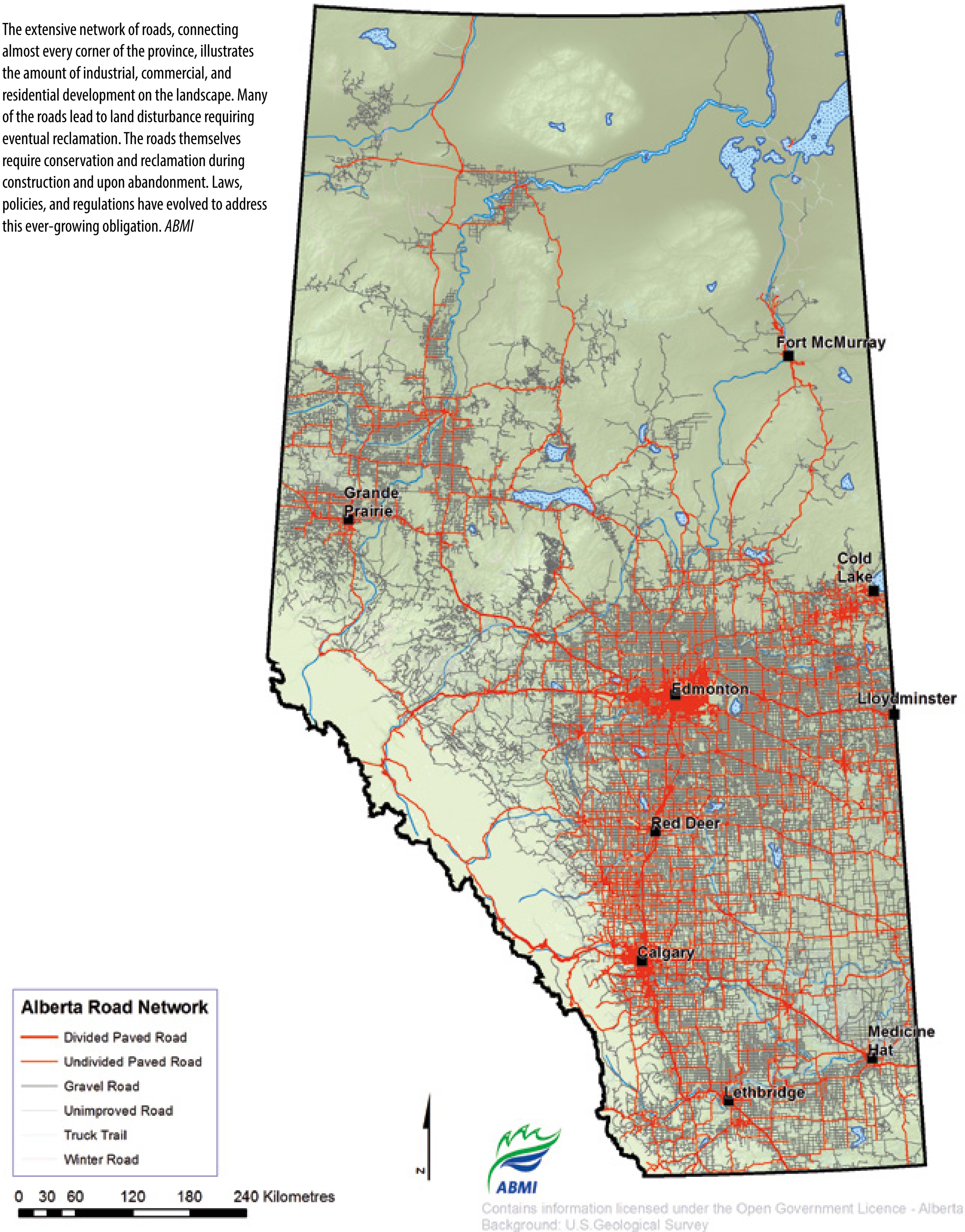
> If, for example, I wanted to get an LOC from an oil company I have to have a reclamation certificate on it first because there's a chance there might be oil spills or other contaminants on it. For the forestry companies, trees are not much of a contaminant if they fall off a truck. If I want to assign it to an oil company it would go straight through— you don't have to go through the reclamation certificate process. In one case you are a regulated occupant and in the other a non-regulated occupant. Oil companies are considered regulated occupants. Forestry companies are not.[32]

An LOC road used by oil and forestry companies west of Conklin. *Robert Bott*

Over his 23 years of building LOC roads with Al-Pac, Pope noticed changes. Standards changed tremendously over the years. "The specifications started to change back around '97, '98 when they got a little more stringent, a little more dictatorial. The major changes were they held you to doing it. You made sure you were getting it done the way they originally asked. The changes came much more in force and inspections much more regular." Today's standards for forestry roads inspections are outlined in the government's standard operating procedures for forestry operations.[33]

Pope cited the main challenges he experienced in reclamation of LOC roads. "Getting the water table back is unquestionably the biggest one," he said. Once that is done, another problem often arises. "What ends up happening most of the time is even if we reclaimed a road somebody came in after and opened it up again. You can argue what you want about reclaiming but people are building roads where Al-Pac had temporary roads. They'll build new roads—for exploration, gravel, anything. So much of the good work that has been done has been undone many times."[34] However, re-use of the same road clearings may help to minimize the overall impact and "footprint."

The extensive network of roads, connecting almost every corner of the province, illustrates the amount of industrial, commercial, and residential development on the landscape. Many of the roads lead to land disturbance requiring eventual reclamation. The roads themselves require conservation and reclamation during construction and upon abandonment. Laws, policies, and regulations have evolved to address this ever-growing obligation. *ABMI*



"landscape borrows," which were much shallower, but much broader, takes of material. This led to impounded water challenges when reclaiming. "A landscape borrow is normally a maximum depth of one metre; and the land can go back to being a crop," explained Snider. "If it was a cereal crop or just hay, the landscape borrows can be very large. We've had landscape borrows that are 65 acres [26 hectares] in size, because of the amount of the material that we needed."

Snider said that some landowners were sceptical of landscape borrows at first, but were soon on side when the concept, the reclamation process, and compensation for crops were explained to them. The process involved first taking topsoil and subsoil depth measurements, then as with most land reclamation schemes, stripping them separately and stockpiling them for later replacement. Needed material was then taken out for the road. When finished, "you go back in, deep rip it and disc it." You put back the subsoil, then a minimum of 80 per cent of the original topsoil depth, said Snider. Landowners often had to be compensated for three or four years of crop damages afterwards because of the time required for the soil to return to its original growing state. Generally, it was well received. "I think we were very successful at that time with those big landscape borrows."[37]

As a road engineer, Parchewsky worked with landscape borrows. He explained that to reclaim one, you would contour it so that it would drain. "If you take a hill and you take out the material from your hill, it makes it pretty easy to drain that. At the end of the day, you have to build to drain it because if you can't drain it, then you have a wetland." But sometimes they are fairly flat; there is no hill. "But, you can still go in there and take a whole bunch of material out over a large area, so you might be taking out a metre or a metre and a half of material. You do your stripping and then, usually, the land is sloping one way or another." He said for reclamation considerations it was important after stripping to know which way the water will naturally run. "So if you landscape it properly, you'll actually be able to drain your water off into a corner that then goes—or maybe it doesn't even go—into a stream, but it's kind of a low area and eventually it ends up in the stream. You don't trap the water so you don't have a wetland. If you trap the water, you're creating a wetland."[38] Which, as we will see later, can also qualify as an approved end land use under EPEA.

Full guidance for operators reclaiming borrow excavations, regardless of size, is provided by Alberta Transportation guidelines, starting with preparation of a reclamation plan.[39] It follows the aforementioned *Pre-Disturbance Assessment Guide*. The document covers processes such as topsoil stripping, handling, and storage. For example, ensuring stockpile areas are well away from other activities, keeping them high and dry—never storing salvaged topsoil or subsoil in a ditch, slough, depression, or drainage way.

Special considerations are established for back slope borrows, as per the guide. Questions operators should ask themselves are:

- Will the new slope be safe and stable?
- Will the new landscape pond water or cause excess soil moisture on the site and affect vegetation?
- Will runoff water channel through the site causing rill and gully erosion?
- If the reclaimed landscape will be a dugout, will it collect and hold water?

The guide recommends a number of operations to rebuild the terrain or landscape after borrow has been removed, all affecting final site reclamation:

- The site must be graded and re-contoured.
- Both topsoil and subsoil must be replaced evenly and without excessive mixing.
- An adequate seedbed must be prepared.
- Excessive soil compaction must be prevented or eliminated during and after each of these operations.

A post-disturbance assessment must then be carried out. This involves collecting soil, terrain, and vegetation data on a reclaimed borrow excavation site as specified. Data from the site are compared with data from undisturbed controls, to determine if the site has been returned to equivalent capability. These controls are normally undisturbed land adjacent to the disturbance, chosen to have similar characteristics to the borrow excavation site prior to disturbance. Full guidance for professionals is provided in the Alberta Transportation guideline on post-disturbance.[40] Sign-off is required by one of the professionals as was defined above for pre-disturbance assessments.

EPEA requires that a reclamation certificate be obtained from Alberta Environment and Parks for a borrow excavation with a total surface disturbance (including the excavation, haul roads, stockpiles, and other related facilities) of 5 hectares and greater.[41] Smaller borrow excavations are exempt, but the operator retains liability for reclamation problems that may arise in the future.

Reclaiming and Revegetating Slopes

Seed mixes for revegetation have changed over the years. Before native grass mixtures were on the market, contractors used what was commercially available such as Kentucky Blue Grass and Creeping Red Fescue. In 1973, government and industry began to study the establishment and survival of ground cover vegetation on roadsides, utility rights-of-way, and non-cultivated disturbed areas in Alberta.[42] Working with Alberta Agriculture and the reclamation inspectors, seed mixtures were gradually changed to species native to their respective eco zones. "You would specify what type of plants you had in each area and develop seed mixes for different parts of the provinces, based upon eco zones," noted Snider. The topsoil is tested for the addition of fertilizer if required. Native, non-invasive seed mixes are now available commercially to match the needs of most areas. While there are good reasons why roadway revegetation mixes consist only of grasses and legumes, such as public safety and erosion control, other jurisdictions have looked at alternatives to enhance the aesthetics and ecological values of the extensive right-of-way areas.[43]

Seeding methods have been subject to some trial and error because of the varying slopes encountered in road-building. The Alberta Transportation Guide helps operators by explaining the current options: drill seeding, broadcast seeding, or hydroseeding. Choice of method depends on the plants to be seeded, soil conditions, and potential for erosion. Snider recalled that hydroseeding was initially more common. Hydroseeding is a form of broadcast seeding in which the seeds are dispersed in a liquid under pressure. The liquid is usually water although it may include fertilizer, a tackifier to increase stickiness, mulch, or other additives. Hydroseeding is very effective on steep slopes or on rough-surfaced materials that cannot be drill seeded. It is often seen on new road right-of-way slopes as a pale green carpet before the contained seeds sprout.

Parchewsky said for road reclamation purposes, hydroseeding is the most expensive method but has been proven highly effective and therefore popular. "It's more effective only because you have protection from erosion while your seed germinates," he said. "Then the plants need to get big enough so that they actually can control water. What grass

Early stage revegetation, plus erosion control products and methods on the northeast embankment approach to the Highway 22 bridge over the North Saskatchewan River. *Chris Powter* does is slow down the water to a trickle and then it doesn't erode anything." Hydroseeding has its share of drawbacks, though. A leading one is that during low rainfall years like 2015 the grass roots may not adequately develop in the first year, resulting in lack of support to hold the slope before the application medium biodegrades.[44]

Prior to reseeding, a primary consideration is maintaining any type of soil, silt, or fine material in place during the road construction phase. One of the most sensitive and important issues today is protection of fish-bearing streams from silt runoff during construction phases. Erosion and sediment control therefore become of paramount concern. How is this best done? "There are a couple of things," offered Gil Barber of Cascade Geotechnical. "One, you work in time periods that don't have rainfall. Second, you do things in small sections so that you are not opening up huge areas at a time. For example, if you are doing a highway project you only do let's say a kilometre or two at a time so you can close it off fairly quickly."[45]

Today there are several products on the market designed to remove sediment from silty water before it runs into a fish-bearing stream. "A main trend is in the use of polyacrylamides right now," said Barber.

> These are a granular material that you can add to silt-laden waters that clump the silt together into larger lumps and drop it out of suspension. It acts as a flocculant. There are many that are totally fish-friendly and environmentally very neutral. Alberta Transportation has approved a number of them for highway use. They will take very silty, dirty water and clean it in a matter of minutes.
>
> Polyacrylamides are applied in a granular form along a channel where you may have things like straw wattles that go across the channels periodically. Wattles are plastic mesh tubes or jute bags filled with straw. Or there are permeable ditch checks—porous plastic structures—they slow the velocity so the water coming down the channel hits one of these, slows it as either it drains through it, or the flow creates a transient dam and the water flows over the top. At these points you can add the polyacrylamide to this structure so it gets mixed in with the water as it passes through. You can salt shake it into them. The process is very efficient; sediment collects in the ditch bottom and stays there.[46]

The drainage plans now direct runoff water to storm ponds that handle silt and peak flows. A second feature is the design, which follows a natural pond look. In Calgary, the ponds are being utilized as visual features in a pathway network.

Prior to 1990, broken concrete and RAP (reclaimed asphalt pavement) were classified as waste that should be placed in a landfill. The Regional Health Services had responsibility. Recognizing the problem of wasted dump space, Calgary Health Region (Norm Carlson, as lead) got the three local regions, local AENV, and AT together to develop a protocol that would see clean material (not contaminated with spills or containing problems like the asbestos inclusion test) become a "re-engineered material." That permitted recycling. Members of the sand and gravel industry supplied background info from the US. When AENV took over responsibility for landfills around 1993 the practice of recycling was continued. Even the City of Calgary changed its bylaw to allow this material to be used.[47]

Roads through Wetlands

In the 1950s and 1960s, Gerry Stotts recalled there was little concern about wetlands. "We weren't worried about drying out the wetlands," he said. "You built a dam so that that the wetland would be maintained on the one side of the road. You built your road and maybe put a culvert in there so that you had an overflow from the dam and then you maintained the wetland on the other side."[48]

Constructing roads through wetlands, such as peatlands, presents unique challenges, especially for reclamation practitioners. Subsurface flows, for example, must be maintained from one side of the road to the other. As late as the early 1980s, recalled Snider, it was not usually raised as a concern.

Not anymore. In 1993, Snider worked with the Alberta Water Resources Commission to develop, write, and implement the first wetland policy for the White Area in Alberta (the settled area). He had a simple rule: "When you have a wetland that's in the way, you miss, minimize, or mitigate. You go around it when you're doing your location of the roadway; you try to minimize the impacts on it. If for good engineering reasons and many other reasons, you have to completely impact that wetland then you must provide mitigation to construct a new one." Because so many wetlands have been lost in Alberta, reclamation to wetlands counts as a legitimate equivalent end land use under EPEA. Developing appropriate design requirements for provincial wetlands has continued for the past 20 years.

If it is necessary to go through a wetland, regardless of which part of the right-of-way is affected, then both excavation and salvage techniques are important. Salvaged material is stockpiled separately because it contains the natural seed source. It has all the proper growing medium and "we will take it to get the first flush of the new wetland growing," explained Snider. The government has

Removal of a road constructed across a fen peatland in 2013. *Jenna Pilon*

worked with a number of landowners on converting borrow excavations into wetlands and many are at first sceptical. Many want the water but wonder how they will water their cattle.

"So we work out a compromise," said Snider. "We may fence three-quarters of it and then just put a ramp down where the cattle can get in. Or, we may say, how about we just develop a watering hole for you over here and leave this as a wetland and for many of them it's no problem." Provided the landowners have assurances of adequate water into the future, he said the compromises have worked well.[49]

Reclaiming Abandoned Roads

With the exception of segments taken out of use during realignments, only rarely is a road taken completely out of use and decommissioned. Where a complete road, or road segment, is taken out of commission, reclamation includes removing all the asphalt, then taking off the granular component. The RAP is normally given to the contractor who can reuse it within an asphalt mix, feeding it through in small amounts at a time. The granular material may be reused on service roads or approach roads instead of using virgin material.

Any culverts are taken out, and the remaining roadbed is then re-contoured as closely as possible to the original land contours. Reclamation is then as is standard with other disturbances starting with laying subsoil and then topsoil. This material will usually be imported, as no local stockpiles will be available from the initial disturbance. It is then seeded with native species. In some areas trees may be planted as seedlings.

Conclusion

From little attention to reclaiming the land to new technology for eliminating most siltation of waterways, Parchewsky's words sum up the ongoing evolution of land reclamation in Alberta's roadbuilding sector. "To me it's an evolution," he said. "This whole environmental thing and life in general keeps progressing." He said earlier practitioners should not be blamed for anything. "You can't look at something that was done 50 years ago and say, 'well, that's a disaster,' because those people never signed to do the same things as we would expect somebody to have done with a permit today. It evolved—I believe it's an evolution of what we thought was the right thing to do."[50]

Pits

Sand, Gravel, Clay, and Marl

Land reclamation must be part of every gravel pit operation, without compromise.

Doug Badke

Few visitors to Hawrelak Park today would recognize that it was once the site of sprawling industrial operations. The land, acquired by the City of Edmonton through a tax forfeit in 1922, became a garbage dump and then hosted gravel excavation, crushing, and stockpiling until the commercially accessible resource was exhausted in 1952. City Council then decided to turn the land into a park, and construction began in 1959.[1]

The ring lake in Hawrelak Park, Edmonton, 2009. *WinterforceMedia*

In 1913, the Marlboro Cement Plant was built by the Edmonton Portland Cement Company. Marlboro was located 25 kilometres west of Edson, Alberta. The site was chosen for its proximity to the marl deposits and the Grand Trunk Pacific Railway. The plant operated until 1931 when it was purchased by Canada Cement and subsequently shut down. *Glenbow Archives NA-3240-163*

Alberta's Environmental Protection and Enhancement Act defines pits as excavations to remove sand, gravel, clay, and marl.[2] The reclamation requirements are similar to those for other surface disturbances, and practices have evolved more or less in parallel to other sectors. One key difference is that on private lands, the surface rights owners also have the mineral rights to these resources, whereas rights to most other non-renewable subsurface resources are held by the Crown or third parties.

The great majority of pit operations in Alberta extract aggregate (the collective term for sand, gravel, and crushed rock), which plays vital roles in the economy and infrastructure. Clay is extracted for road construction and for water containment applications such as lining dugouts and waste sites, and there is some production of ceramic clays in the Medicine Hat area.[3] Clay excavations supporting roadway construction are a separate activity type called "borrow excavations" (discussed in Chapter 10).* Marl is lime-rich mud or mudstone used as a soil amendment in agriculture; in the past, there was some use of marl in cement manufacture in Alberta.[4]

Sand, gravel, clay, and marl are often found close to the water table, or beneath it. Reclamation can create wetlands or water bodies. Water diversion, dewatering, and effects on water quality are typical concerns during development, operation, and reclamation.

Surface extraction often changes land use. Landowners, municipalities, regional authorities, and provincial government departments make decisions about desired end use. Operations may be subject to municipal bylaws, zoning, and development plans in addition to provincial conservation and reclamation regulations and federal and provincial water regulations.

Many parks have been developed on former sand and gravel extraction sites such as Edmonton's Valley Zoo-Laurier Park, Rundle Park, and Hermitage Park[7] and the Blue Ridge Recreation Area in Woodlands County.[8] The Riverbend Subdivision[9] and Quarry Park,[10] both located in southeast Calgary, were developed on reclaimed gravel pits, providing an example of protecting the gravel resource from sterilization, extracting it and then using the land for another high value end use.

Most of this chapter addresses aggregate. Clay and marl operations are relatively minor by comparison, employ similar practices, and are subject to the same reclamation requirements.

* Excavations that supply material solely for construction of access roads or industrial pads are treated as part of the specific activity (e.g., a well or a plant site) not as pits.

This 1910 photo shows a clay pit at a brick yard near Innisfail. Since the late 19th century clay has been extracted in Alberta for brick-making, ceramic manufacture, and water containment.[5] There was also some limited development of bentonite clay deposits in the Onoway and Rosalind areas for use in drilling fluids.[6] *Glenbow Archives NA-1709-10*

The Aggregate Industry

The largest use of aggregate is for road building; it provides both the base and the driving surface, whether in raw form on gravel roads or as a major component of asphalt or concrete on paved roads. Sand and gravel comprise about 80 per cent of concrete and 95 per cent of asphalt pavement. Other major uses include construction fill, drainage projects, as base under the ballast on railway tracks, and providing traction on winter roads. Sand also has specialized uses that range from the surface of playgrounds to the "proppant"* in hydraulic fracturing of oil and gas wells.*

Building a typical single-family house uses about 160 tonnes of sand and gravel—almost a dozen 15-tonne truckloads; constructing a kilometre of highway might use 30,000 tonnes.[11] According to the Alberta Sand and Gravel Association (ASGA), the province's annual production ranges from 42 to 62 million tonnes, or about 3 to 4 million truckloads.[12] That amounts to 10 to 15 tonnes or almost a full truckload annually for each Albertan. The aggregate produced in Alberta each year could form a wall, 3.8 metres high and 1 metre thick, around the entire 3,990-kilometre perimeter of the province.[13]

Transportation is a major cost factor for aggregate. The ASGA estimates that each kilometre of haul adds $0.15 to the cost per tonne.[14] The closer the supplier is to the intended use, the better; there is less truck traffic on the road, less wear and tear on roads, lower vehicle emissions, and lower cost of constructing infrastructure in general. As cities and industries expand, the most accessible resources get exhausted. In the past, many valuable deposits were covered by developments—"sterilized"—before extraction of the aggregate could occur. Government planners and the industry now try to integrate extraction with development. In northeastern Alberta, for example, aggregate overlying the oil sands deposits is now recovered prior to the oil sands mining, and reclamation occurs much later as part of the mine development.[15] The sand and gravel industry was instrumental in getting legislation changed to permit the recycling of gravel, recovered asphalt product, and broken concrete.[16] The City of Edmonton began a recycling program on winter road sand, following a pilot project in 2003, and now recovers 70 per cent of the sand used, of which 80 per cent is reused,[17] saving purchase and landfill costs and reducing environmental impacts.[18]

According to Alberta Environment and Parks, in 2015 there were 650 aggregate pits on public land, 884 large pits (greater than 5 hectares) on private land, and between 1,500 and 2,000 smaller pits on private land.[19]

Although the size varies widely, the basic components of an active pit are generally the same:

- earthmoving equipment to excavate, move, and load material
- machinery to crush and screen the aggregate into the desired sizes
- one or more stockpiles ready for loading into trucks

Aggregate washing may also be part of the operation, and there may be pumps to remove water if the pit is below the water table. Depending on land contours, a ramp may be needed for truck access. Topsoil and overburden, if initially present on the site, are stockpiled for use in future reclamation—unless other development is planned for the site that will not require the soil. Wherever possible, direct placement of topsoil and subsoil from active excavation areas on depleted areas is done to improve reclamation success and reduce double handling of soil materials.

Evolution

Glaciers ground down Alberta's mountains for nearly a million years. Flows under the glaciers and the outrush of water as they retreated left the province with a rich endowment of sand and gravel deposits. Many of them are located near, beside, or under current or former waterbodies.

* Silica sand is often injected into oil and gas wells during hydraulic fracturing. The sand props open the pores of rock as they are fractured by high-pressure fluid. Sand used for this purpose must meet exacting "frac sand" standards established by the American Petroleum Institute. Frac sand is produced by Canada Silica Industries near Peace River and Sil Industrial Minerals near Bruderheim. Another frac sand operation has been proposed north of Fort McMurray.

(Above) This photo from Calgary in the first decade of the 20th century shows gravel being harvested beside the Bow River near the Eau Claire sawmill (today's Eau Claire district and Prince's Island Park). *Glenbow Archives NA-2365-89*

The photo below shows a train hauling gravel for Calgary Power's Kananaskis Falls hydroelectric project, constructed between 1909 and 1913. G*lenbow Archives NA-3802-6*

By the 1930s, more powerful earthmoving equipment and trucks led to development of larger regional pits. The crawler tractor in the photo of the Blackfalds gravel pit near Lacombe appears to be a gasoline-powered Caterpillar Sixty, introduced by the company in 1925.[23] *Glenbow Archives ND-2-374*

Although the resource in Alberta is large, it is finite, and there are limits to the amount that can be produced economically with acceptable environmental and social impacts.

Alberta's first "gravel rush" accompanied the building of the railways from 1883 onwards, soon followed by the building of towns and cities and roads. Horse-drawn wagons and sometimes rail cars hauled gravel from deposits to construction sites. Even rural homes needed gravel for foundations, drainage, and roads, as noted in a local history of the Lacombe area: "In 1922 gravel was hauled for a new house from a pit on the Red Deer River where the East Bridge crosses," Agnes Munce recalled. "Four horses and a wagon were used to haul the gravel on this 12-mile [19-kilometre] round trip. The next year a spacious and comfortable home was built."[20] The 1919 *City of Calgary Year Book* boasted that, "one would never imagine Calgary to have been at one time a gravel pit, at least in places."[21]

In a local history of the Stony Plain district, Betty Mitchell recalled gravel as one of the various ways that her father, Phillip Fischer, helped the family survive tough times in the 1930s. "Daddy made a good strong gravel box which he used to haul gravel from our pit to then new No. 16 Highway west."[22]

Evidence of regulation in the pre-1950 era is scant. Governments always controlled dispositions on Crown lands and kept records of them. Municipalities and counties exercised some control through bylaws and zoning, if they chose to. Municipalities such as Lethbridge (1917), Spruce Grove (1940),[24] and Conrich (1944) operated their own pits.[25] Federal and (after 1930) provincial mines and minerals officials had nominal authority on non-freehold private land under the then-prevailing legal position that sub-surface mineral leases included sand and gravel along with the rights to "mines, minerals, petroleum, gas, coal and valuable stone." Despite this, many landowners apparently extracted sand and gravel on their property without reference to mineral rights or regulation.

Private Land

In *Western Minerals v. Gaumont*, a court case launched in 1949 and argued in 1950, the mineral rights holder challenged the rights of landowners to the sand and gravel on their property (also discussed in Chapter 3). The lower court judge ruled in favour of the mineral rights holder in February 1951. The landowners appealed the decision and were supported in the appeal by a construction company, the Farmers Union of Alberta, and the provincial government. Meanwhile, the government of Premier Ernest Manning quickly passed the Sand and Gravel Act,[26] effective April 7, 1951, establishing that sand and gravel belonged to the surface rights owner, not the mineral rights owner. The Alberta Appellate Division and the Supreme Court of Canada subsequently upheld the province's position and that of the landowners.[27] The Clay and Marl Act in 1961 similarly extended surface rights to include extraction of clay and marl underlying the property.[28] *

Private landowners encountered few restrictions on sand and gravel development from April 1951 until August 1978,† when Part 3 of the Land Surface Conservation and Reclamation Act was proclaimed.[29] Pits were specifically included in the 1973 Land Surface Conservation and Reclamation Act[30] (LSCRA), which required reclamation and certification of abandoned pits, but until the 1978 regulation, did not spell out how this was to be achieved. During this period, municipal and county officials continued to control pits on their lands and in their jurisdictions, if they chose to do so, and provincial officials continued to regu-

* The Alberta Mines and Minerals Act and the Surface Rights Act have also excluded peat operations from the "mineral" definition.

† Provincial inspectors could use the general provisions of the 1963 Surface Reclamation Act to address egregious situations on private land when required.

late operations on public lands. In December 1979, the Regulated Sand, Gravel, Clay and Marl Surface Operations Regulation took effect, requiring pit operators to obtain an approval.[31]

Vic Walls, chief executive of Red Deer-based Border Paving, who began with the company in 1958, cited the example of extraction along the Red Deer River: "All our gravel used to come from across the river. We'd haul it across on the ice in the wintertime—go out there, make an ice bridge, and haul for a couple of months. They set the crusher on the other side of the river and just worked 24 hours a day and brought it across. Reclamation—are you kidding? Never even thought about it." In a 1982 conference presentation Doug Badke, land manager for BURNCO Rock Products Ltd., said that in the early days "as gravel bearing deposit lands were virtually useless for agricultural purposes … no one was really opposed to opening a gravel pit. Furthermore, no one gave much thought to reclaiming these mined out pits. Over the years these pits became a convenient place to dispose of old abandoned cars, animal carcasses, and other garbage or refuse."[32] He also noted that "there are many firms that would rather cut the selling price of gravel by not including land reclamation in their mining plans. Land reclamation must be part of every gravel pit operation, without compromise. Reclamation standards should apply equally to every pit operator whether large or small, or whether the pit operator is a municipal or provincial government body."[33]

From the 1950s through the 1970s, Walls said, "there was no real regulation, in terms of enforcement, in terms of somebody coming around and saying, 'What are you doing?' As far as land reclamation was concerned, there were rules, but they were largely overlooked, not adhered to, and people did pretty much what they wanted. The evolution of rules from the county perspective was very slow."[34]

By the mid-1970s, pressure grew for more effective regulation, planning, and industry practices. Urban and industrial development and road building accelerated demand for aggregate—at a time when many deposits closest to construction sites were either depleted or already had development on top of them. Meanwhile, public, political, and environmental concerns increased regarding land use, traffic, noise, dust, and impacts on water resources arising from sand and gravel operations. Walls recalled that Bill Yurko, Lougheed's Environment minister from 1971 to 1975, began the push for more effective regulation and industry practices.

In 1975, 10 of the larger firms formed the Alberta Sand and Gravel Association (ASGA) to coordinate their dealings with the government. "A very close relationship was formed between members of the association and people from Alberta Environment who had to deal with land reclamation activities," Walls said. "They never did anything with respect to regulatory changes without talking to people from the association. The association developed the best rapport of any industry organization, I'm sure."

One major focus of public concern, government interest, and industry activity was the Villeneuve area in Sturgeon County, west of St. Albert—an area of rich aggregate deposits amid agricultural land, wetlands, and country homes. In 1976, Alberta Environment commissioned a report by G. R. Shelley and Associates, *Villeneuve Gravel Development and Reclamation Study*, which recommended a combination of reclamation and alternative land uses to resolve the conflicts. This marked the beginning of integrated planning, development, and reclamation that continues in the Villeneuve area today (discussed later in this chapter).

The December 1979 regulation declared that all large sand, gravel, clay, and marl pits were "regulated surface operations" requiring prior approval, security deposits, and reclamation plans, in addition to certification. The submission for approval of larger pits had to address surface disturbance, geotechnical stability, and water management issues. The provincial and municipal governments were exempt from the security deposit requirement, but they had to meet the other provisions. Bruce Patterson, former Alberta Environment reclamation inspector, recalls that at that time lots of fingers were being pointed at Alberta Transportation for not being good stewards of the land. He said that the deputy minister, Bob Cronkite, gave direction that the department would be leaders in meeting the standards. Over the years the department staffs, including Bruce Blue and Don Snider, have worked to show the government is prepared to lead and through grant conditions require municipalities to also comply.[35] Topsoil conservation became a requirement after 1983 amendments to the LSCRA.

The definition of "large" pits changed several times. From 1979 to 1982, it was based on production greater than 250 tonnes per day, and the security deposit was 10 cents per tonne. In 1982, the definition changed to pits with an area greater than 5 acres (2 hectares), and the security deposit was set at $250 per acre (0.4 hectare). Then, in 1996, concerned that too many small operators were being swept up into a complex regulatory system, the government narrowed the scope by the simple expedient of raising the approval threshold from "5 acres" to "5 hectares."

Walls said the ASGA lobbied for the security deposits and hoped they would serve as "a barrier to entry to scalawags that have no intention of ever doing anything." Later, as the deposits accumulated with little action on the

Rundle Park, a former aggregate extraction site, was reclaimed and became part of Edmonton's Capital City Recreation Park which opened in 1978 and linked existing parks and recreational facilities with trails for walking and biking between Fort Edmonton and Rundle Park. *Fred Schulte* ground, Walls said he was disappointed that the money was not put directly into reclaiming abandoned pits. As of March 31, 2014, the Environmental Protection Security Fund held $94,895,672 for registered pits.[36]

From Education to Enforcement

In the 1980s, Alberta Environment focused initially on educating all operators to plan ahead, conserve topsoil, and incorporate progressive reclamation into their operations. In a 1987 conference Dennis Bratton, head of the Regulated Surface Operations Branch in Alberta Environment, described the status of the sand and gravel program.

> From our records we estimate that pits cover some 70 sections of land and well over 50 per cent of this land is CLI 4* or better … The sand and gravel program started in 1982 by notifying all the pit operators (about 1,000) in the province of the legislation and how it affects them. By 1987, over half of all pits had been inspected and operators and landowners notified. If the pit was over 5 acres the department worked with the operator to get an approval. The plan is to finish the province by 1990. The approach was educational—showing operators they can save money and get valuable reclaimed land for less total cost than with their current practices—mostly by reducing double handling of soils.[37]

During that period, the Alberta Environment sand and gravel approval coordinators often encountered the attitude, "Well, there's still gravel there, so I might be able to get some more money later on."[38] In other words, there was no point doing reclamation work that might be disturbed at some later time.

As part of the educational program to inform operators about regulatory requirements and the benefits of environmental protection, the sand and gravel coordinators often assisted in preparation of reclamation plans. This was a unique situation to the sand and gravel industry and a reflection of the fact that the industry comprised a majority of small operators. It also reflected the "educational" emphasis and direction of Alberta Environment management policy of the time. Officials soon recognized, however, that this could lead to problems later during enforcement or certification processes if the operators said, "Well, we did what you told us to do." As a result, the department issued information letters and guidelines describing the regulatory requirements and explaining how to apply for development and reclamation plan approvals—signalling a transition from education to enforcement.

In 1992, researchers commissioned by the Reclamation Research Technical Advisory Committee (supported by the Heritage Savings Trust Fund Land Reclamation Program) produced *A User Guide to Pit & Quarry Reclamation in Alberta*.[42] The 158-page, illustrated publication provided operators with step-by-step instruction on everything from soil salvage to slope stability to revegetation. The guide specified that topsoil and subsoil should be salvaged in separate "lifts" for use in reclamation. It spelled out requirements for buffer zones, erosion and drainage control, and maximum slope of reclaimed pits. The guide noted that there could be additional requirements for better-quality agricultural land, valley breaks, and wildlife habitat.

View of Lafarge pit from the northwest looking southeast towards Calgary city centre in 1989; road in front is 85th Street. *Glenbow Archives NA-5654-662h*

The Environmental Protection and Enhancement Act (EPEA) and the accompanying Conservation and Reclamation Regulation, proclaimed on September 1, 1993, included pits as "specified lands" requiring reclamation to "equivalent land capability." The regulation increased the security

* The Canada Land Inventory (CLI) classifications show the varying potential of areas for agricultural production. They indicate the classes and subclasses according to the Soil Capability Classification of Agriculture, which is based on characteristics of the soil as determined by soil surveys. Class 1 is the highest quality, while CLI 4 is marginal.

Old Pits: Dilemma or Opportunity?

Old pits present interesting challenges and opportunities for communities, industry, and regulators. There are at least four scenarios that arise. The first involves pre-legislation pits that are not reclaimed because no one is responsible under the law. Unfortunately, there are many examples of these derelict pits across the province.

The second scenario involves pre-legislation pits that are reclaimed because someone steps up and does the work as part of a subsequent development scheme (usually in return for access to remaining aggregate). The City of Calgary annexed the area around what would become Carburn Park in 1961. As part of a transition from industrial to residential and recreational land use, the city purchased 21 hectares of riverside property from Burnco Industries and its subsidiary, Carburn Aggregates, while Burnco acquired 9.7 hectares farther east for gravel extraction. The extraction ceased in 1978, and the escarpment was reduced in height to create fill for the Riverbend residential development. After rejecting a golf course proposal, the city approved a plan for natural areas and trails in 1981. The following year, in an economic recession, the city dropped park development from its capital budget. Burnco then offered to fund, design, and build the first phase of the park in exchange for the right to extract gravel for two seasons. City Council approved the plan, and the extraction area was reclaimed as ponds and walking trails.[39]

In some cases, old pits self-reclaim—creating a dilemma for regulators. Don Snider, a former Alberta Transportation planner, noted that some pits can be open for 30 to 50 years, with extraction activity levels depending on contracts. Sometimes the older disturbed areas are idled and become naturally colonized with trees and shrubs. If a decision is made to close the pit, the operator and regulator need to determine if disturbing the natural reclamation to meet current reclamation criteria is a better solution than accepting the existing condition so as not to further disturb the site.[40]

The area now known as Terwillegar Park[41] in Edmonton is an example of the fourth possibility—sites that are not reclaimed, or are partially reclaimed, but still find productive uses. It was excavated for sand and gravel from 1949 to 1986. Terwillegar was partially reclaimed by the Alberta Heritage Savings Trust Fund Land Reclamation Program, which funded many reclamation projects on municipal sites between 1978 and 1994. The park is now heavily used as a dog park and mountain biking site. Since 2008, following extensive planning and public consultation, the City of Edmonton has been developing the park's recreational amenities and natural areas.

Carburn Park beside the Bow River in southeast Calgary was a gravel extraction site until the 1980s when it was reclaimed through an arrangement between Burnco and the City of Calgary. *City of Calgary*

deposit for larger pits from $250 per hectare to the anticipated "full cost" of planned reclamation (often secured by letters of credit for larger security deposits).

The government also attempted to address public concerns about pits in close proximity to urban and suburban development. "Where you have cities, where you have development, you need gravel," Environment Minister Brian Evans told the legislature on April 14, 1994:[43]

> Whether it's for roadways or whether it's for fill when a basement is poured or what have you, you need gravel. That's not going to go away nor is the apparent conflict between residential owners and industrial uses. In that area that the hon. member was referring to, he was saying: what is the liaison with Transportation and Utilities? Well, we have a very good liaison. We try to anticipate issues. We try to ensure that there is an adequate supply of gravel for this province for the roadways that we're so very proud of. We also want a process that allows public input into these decisions, and that's not only at the provincial level, because oftentimes what's required is a change of the municipal plan or municipal zoning to accommodate a gravel pit. So the municipalities involved do get into this and often have public meetings. Quite frankly, there have been a number of applications that have not been successful because as a result of those public meetings, the gravel companies have pulled back their applications. You know, they want to be good corporate citizens as well, and they recognize that there are some problems if there are a number of people in a community that come out to protest a change of land use. [The opposition member also raised questions about] reclamation rules. Well, of course we have rules for reclamation, a very important component, although we are trying to move away from direct involvement in reclamation issues except in those instances where human health and safety is at issue. So we will keep working on that.

In 1996, a five-page Conservation and Reclamation Information Letter, Environmental Protection Guidelines for Pits,[44] reiterated the regulatory requirements and clearly set out the distinctions among the three classes of pits:

- Class I—greater than 5 hectares and requiring prior development and reclamation approval pursuant to EPEA
- Class II—less than 5 hectares on private land, not requiring an EPEA approval prior to development, but still subject to reclamation and certification requirements; the information letter was of particular relevance to these pits
- Pits on public lands, licensed or leased under the Public Lands Act, subject to that act and EPEA, and requiring certification

The information letter made it clear that conditions in an EPEA approval, or the surface materials licence or lease on public lands, took precedence over the guidelines. The letter also noted that pits of any size, on either private or public land, "may require an approval under the Water Resources Act if water is used (e.g., for gravel washing) or diverted (e.g., for pit dewatering) or if the pit is within the floodplain of a watercourse or waterbody."[45]

"The objective may be to reclaim the site so that predevelopment conditions and land use are returned, or alternately, to reclaim the site so that post-development conditions and land use are quite different than before," the information letter said. "Begin early consultation with the landowner, appropriate provincial agencies, and the local municipality to determine and document the desired end land use."

Draft reclamation criteria for sand and gravel pits were issued in 1998.[46] In the same year, a departmental reorganization shifted the issuing of development and reclamation approvals from Edmonton to regional offices.

Code of Practice

This regulatory scheme was soon challenged. In 2001, the director of Alberta Environment's Bow Region approved an application for a large sand and gravel operation near the Bow River southeast of Calgary.[47] An area resident had opposed the application and took her case to the Environmental Appeals Board, which upheld the director's approval. However, a Court of Queen's Bench judge overturned that ruling in May 2003 and sent the matter back to the board for further hearing.[48] In September 2004, the resident withdrew her appeal.[49]

The lengthy adversarial process was a factor in the government's 2003 amendment to EPEA establishing codes of practice in lieu of approvals.[50] Environment Minister Lorne Taylor told the Legislature on April 28, 2003:[51]

> I want to assure all members that every application will continue to be reviewed individually, as will every reclamation certificate. So a gravel pit operator makes an application for a gravel pit. What we want to do in the permit of approval is we

> want to put in the codes of practice that regard the operation and the reclamation of that site. This will very clearly indicate to the operators up front and beforehand what they must do, so they cannot come back to Alberta Environment after and say: Well, you didn't say this, and you didn't say that, and we didn't expect this, and we didn't expect that. It'll be very clear up front to the public what the code of practice is, to the gravel pit operator what the code of practice is, and to the people in the affected area what the reclamation must be. As well, Mr. Speaker, this bill allows for any violation of the code of practice to be enforced with an EPO, environmental protection order. So it strengthens the hand of Alberta Environment in getting these reclamations completed at the end when the pit has to be reclaimed. We can say: "Well, look back at your approval. Your approval says that you must do such and such. Now you must do it, and if you don't do it, we can immediately go to an EPO, which will shorten drastically the reclamation time."

After the EPEA amendment passed in November 2003, Alberta Environment convened a task group to provide input on a code of practice for pits. The group included representatives from government departments, the Alberta Sand and Gravel Association, the Alberta Roadbuilders and Heavy Construction Association, the Alberta Association of Municipal Districts and Counties, the Alberta Urban Municipalities Association, and consultants. The government issued the Code of Practice for Pits in September 2004,[52] and a guide to implementation came out a month later.[53]

The code applied to all pits larger than 5 hectares on private land (with two key exclusions—borrow excavations and a pit, or a portion of a pit, on which a waste management facility is operating or operated pursuant to a valid approval or registration under the act).[54] It required registration, reclamation plans, security deposits, status reports every five years, and a final report. The code would apply to all previously approved operations by November 2008. The smaller Class II pits on private land, and all pits on public land, would continue to be regulated under EPEA provisions for reclamation and certification.

"Alberta Environment inspectors will conduct random, unannounced inspections, as well as planned inspections, to determine if registration holders are following the Code of Practice," the guide stated. "Inspections will likely be more frequent if a registration holder has a history of non-compliance and/or if the pit is in an area where there are environmental issues or public concerns. Failure to follow the Code of Practice may result in enforcement action. Enforcement options are varied and depend on the circumstances of the non-compliance."[55]

Municipalities

In parallel with provincial policies, counties and municipalities have played an increasingly active role in planning and regulating sand and gravel development since the 1980s. An amendment to the Municipal Government Act in 2005 authorized municipalities to collect levies from sand and gravel operators.[63] "Municipalities and industry support this levy, and they agree that sand and gravel operations should provide more funding for mitigation or other initiatives to demonstrate more clearly that communities benefit from these operations," the minister of Municipal Affairs told the legislature on March 22, 2005.[64]

In contrast to sparse regulation in the 1980s, in this century all of Alberta's municipal governments have regulatory provisions relating to pits. An example of coordinated planning was the *Sturgeon County Calahoo-Villeneuve Sand and Gravel Extraction Area Structure Plan*, prepared in 2001 and updated in 2007.

Despite earlier concerns and conflicts in the Villeneuve area, planners told a 2002 conference: "In reality, both municipal and provincial authorities have regulated sand and gravel extraction for the past 20 years. This has led to a growing number of reclaimed pits, as extraction activity expands. Because these are effectively reclaimed for agricultural purposes, they are hardly noticeable to the casual observer, being somewhat lower in elevation than the surrounding agricultural landscape. In 2001, it was estimated that about 650 hectares (1,600 acres) of land in the Calahoo-Villeneuve area were active sand and gravel operations, while about 330 hectares (820 acres) had been reclaimed."[65]

Along with provisions such as setbacks from residences and protection of water resources, the Calahoo-Villeneuve plan identified some "no extraction" areas and other "quick extraction zones" from which aggregate could only be taken for a defined time period.[66] Other communities such as Peace River looked to zoning as a means to control pit development.[67]

Public input also became more prominent in pit planning. For example, Alberta Transportation conducted three years of public consultations and technical studies before awarding a contract in 2005 to the BLV Group for development of extensive gravel deposits at Spy Hill on Calgary's northern outskirts. A large volume of aggregate was required initially for construction of the Stoney Trail ring

Peat Operations

Peat is living and partially decomposed organic matter formed by sphagnum moss, sedges, and other semi-aquatic plans in waterlogged areas.[56] Peatlands occur in large areas of western and northern Alberta. About two dozen bogs are harvested commercially for peat in Alberta. Achieving equivalent land capability can be a challenge to reclamation of these sites.

Undisturbed peat is about 95 per cent water. Harvesting peat involves draining the bog and mechanically removing a thin layer off the top, allowing the next layer to dry, then repeating as long as it is commercially viable. There are 17 dispositions for peat harvest on public lands, and between 5 and 10 operations on private land.[57] A 1974 report prepared for the Conservation and Utilization Committee suggested that depleted bogs would likely be converted to other uses such as agriculture, forestry, or wildlife habitat,[58] which has been the practice for most reclamation since then. A 1993 report of research funded by the Reclamation Research Technical Advisory Committee provided some insights into the nature of disturbance associated with peat operations in Alberta.[59] A follow-up study of the natural regeneration of peatlands after horticultural peat extraction at the Sun Gro Horticulture Canada Ltd. site west of Edmonton concluded that success depends on the land manager's timelines—5 to 10 years is likely required to colonize and stabilize the site and it will be decades before the original species composition is achieved. The study also confirmed the importance of water table management.[60]

Premier Tech, which has seven operations in Alberta, harvested the 140-hectare Paxson Bog near Athabasca from 1986 to 2007. Based on extensive testing on the site and experience in its Quebec operations, the company closed drainage ditches to trap precipitation and re-wet the area, then in 2015 planned to strip enough moss from a nearby bog to distribute on the Paxson site. However, the work had to be postponed for a year after a dry summer lowered the water table and reduced the supply of straw mulch needed for the regeneration.[61]

Premier Tech reclamation specialist Jacques Gagnon said transplanting the moss is fairly simple: "We just use a manure spreader." He said the source bog would not be damaged, as the source area only needs to be about one-tenth the area of the site to be reclaimed. The goal is to return about half of the Paxson harvest area to productive peatland, while the higher and drier areas would be planted with black spruce.

Susan McGillivray, a reclamation policy specialist with Alberta Environment and Parks, said reclamation requirements for peat operations were still being developed in 2015. Although peat accumulates very slowly, she said it would be important to demonstrate that a site was on a "trajectory" to the desired ecological function. (The "trajectory" approach is already used for certification of wellsites in forested areas.) The report will determine the requirements for conservation and reclamation plans submitted during the approval process for public land dispositions, but will also be applicable to private land sites.[62]

A partially harvested peat bog near Athabasca in 2001. Peatlands are found in western and northern Alberta.
Robert Bott

A gravel pit near the Athabasca River in Hinton, 2014. Water management is an important aspect of pit operations. *Robert Bott*

road, and some of the land would then be used for municipal landfill. The BLV Group is a joint venture of Burnco Rock Products Ltd., Lafarge Canada Inc., and Volker Stevin Contracting Ltd., and the gravel is available for other uses in addition to transportation.

"It's getting way better," Vic Walls said. "There's no question about it." However, he expressed concern about the large numbers of pits that have not been reclaimed.[68] Unless directed by the municipal government or in response to directions provided by reclamation inspectors (usually following a landowner complaint or an inspection), operators on private land have little incentive to complete reclamation and obtain certification. "The issue is the same for all smaller disturbances that don't have annual lease payments—there is no strong economic driver to get the certificate," said former Alberta Environment official Chris Powter. "Larger operators who have posted financial security and have to report liabilities under financial rules have greater incentive to reclaim sites, though not necessarily to follow through and get a certificate. The additional issue for pits has been previously noted: there is always a bit more aggregate. The operator is likely to say, 'I just might get another contract—you wouldn't want me to reclaim then redisturb, would you?'"[69]

Commenting on this issue, the ASGA said that current operations "work in a strong regulatory environment," and the industry continues to examine "approaches to the older sites with limited security having been posted."[70]

Public Lands

Regulation of pits was somewhat different on the 60 per cent of Alberta that is provincial Crown land—mainly located in the foothills and boreal regions. The Public Lands Act set different security rates, allowed for royalties to the government, and gave government officials direct control over the location, operations, and reclamation of extraction sites. Operators on public lands also had to comply with provincial requirements for conservation and reclamation; on-the-ground practices evolved more or less in parallel with those in the rest of the province.

The sand and gravel industry encountered public lands regulation more frequently in the 1950s, 1960s, and 1970s as roads were built into the Green Area of the province, the oil and gas industry extended its operations into the foothills and boreal regions, and the government began to award area-based Forest Management Agreements to forest companies.

On public lands, "reclamation is something that has been ongoing for a number of years—long before it came in to become part of the legislation requirements," said Murray Anderson, an official with Sustainable Resource Development and its predecessors since 1974. He said the problems arose when pits were opened and then remained inactive for a long period of time. "We never had very strong ways to go back to get the sites looked after and reclaimed.[71]

In the 1980s, Anderson said, "we started building more requirements, we developed stronger guidelines and how-to's for operators, so that became now part of the disposition." The requirements included soil salvage and, if necessary, a second "lift" of subsoil. These requirements were codified in a 1990 publication called *Sifting Through Sand and Gravel: Procedures for Developing and Reclaiming a Sand & Gravel Pit*. According to the document, it was developed to assist operators and department staff to follow the new policy to increase effectiveness in managing the sand and gravel resource in relation to all other developments or interests in the area.[72]

The 1992 RRTAC[73] user guide provided additional practical instruction on the proper planning, development, operation, and reclamation of pits. *Sifting Through Sand and Gravel* was updated in 1994[74] and was completely rewritten as *A Guide to "Surface Material" Resource Extraction on Public Land* in 2001. The 2001 edition indicated that it superceded *Sifting Through Sand and Gravel* and parts of the *User Guide to Pits & Quarries* that refer to public land.[75] Further elaboration, including more emphasis on progressive reclamation, came in the 2010 *Best Management Practices User Manual for Aggregate Operators on Public Land*.[76]

Producing a Sand and Gravel Conservation Business Plan became a requirement to obtain a disposition, whether for short-term licences and longer-term leases, regardless of pit size. Unlike oil and gas dispositions, on-site government inspections have continued for compliance and

These photos from 2001 (above) and 2010 illustrate progressive reclamation at a pit near Red Deer. The stockpile is in the same place in both photos, but the active excavation area has moved farther away while reclamation proceeds on the previous extraction sites. *Border Paving*

reclamation certification. Like on private and municipal land, reclamation is based on the EPEA objective of equivalent land capability. "The end use is determined partly from what may happen on the area," Anderson said. "We also look at the end land use in terms of how it fits in with the adjacent sites. In some cases, if you take out a lot of material, maybe we have to have a different kind of end land use in terms of how it has to fit in. But, most times, we can make it so it fits in with the adjacent areas."

In 2006, the government published an allocation policy for aggregate dispositions on public lands.[77] The policy gave priority to allocations in the "public interest" (such as use by Alberta Transportation or municipalities) and to deposits "in peril" due to pending or approved developments on a site. Sites up to 80 acres (32 hectares) would be awarded to applicants on a "first come, first served" basis, while larger sites could be tendered for competitive bidding.

Until the early 1990s, the government also operated public pits providing aggregate for other users. "We could no longer afford to keep staff there to do that," Anderson said. The government then began selecting private-sector pit managers based on a request-for-proposal (RFP) process. The operator, like the holders of licences and leases, pays a royalty on the aggregate extracted. The 2006 policy continued the provision for awarding public pits.

Several third-party public pits operate in the oil sands area on land intended for future mining, so they do not have reclamation requirements, although they must still stockpile topsoil and subsoil. Reclamation will eventually become the responsibility of the oil sands mine operator; interim uses of the sites after gravel removal include storage yards and work camps.

Anderson said an upcoming challenge will be integrating public lands dispositions into the regional plans being developed under Alberta's Land Use Framework. In some cases, speedier reclamation could reduce the "footprint" of sand and gravel operations and thus reduce the impacts on other values such as biodiversity and recreation. "Let's still maintain some of the other values there, and we could still take out a fairly significant quantity of sand and gravel," he said. "Keep the footprint to a minimum and allow some of the other activities there and have those sites reclaimed as quickly as possible. We're looking at that to help enhance the speed of recovery."

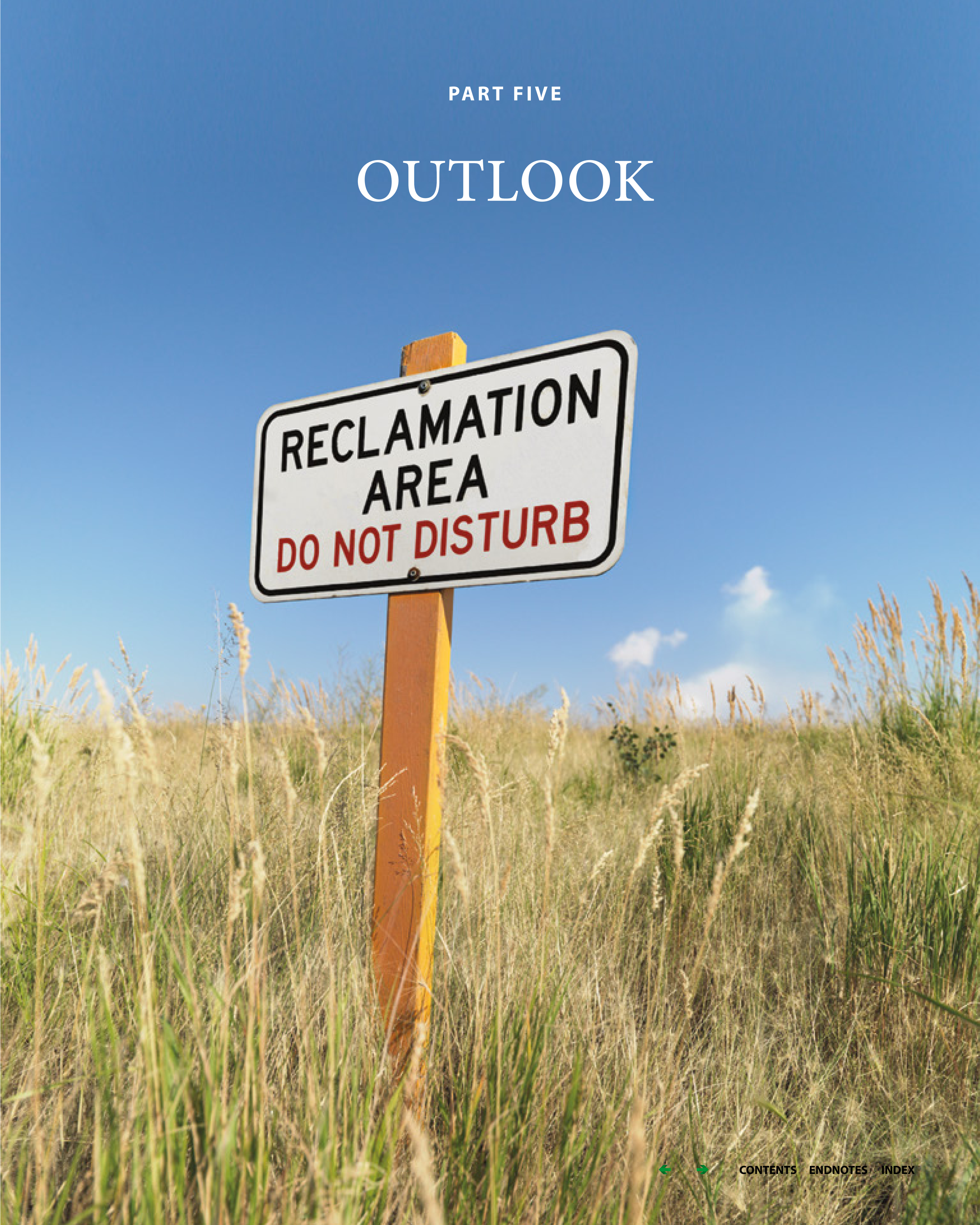
Conclusion

The aggregate industry has been remarkably successful at developing and implementing creative reclamation solutions for pits, especially in and near urban centres. The Alberta Sand and Gravel Association and Alberta Transportation have proven to be instrumental in bridging the gap between regulators and the industry—representing the industry on various task forces and committees developing policies and procedures; creating forums for regulators to share issues and concerns with companies; and, in the case of Alberta Transportation, incorporating detailed environmental protection measures into contract specifications.[78]

There remain a number of challenges for the sector, including differences in regulation of public and private land pits (currently being worked on),[79] a lack of clear reclamation certification requirements, and difficulty in identifying when a pit is finally closed and therefore ready for final reclamation. Both industry and government would be better served if there were more pit closures and reclamation certificates issued and if there were publicly available disturbance and reclamation status information (as is the case for coal and oil sands[80]). The latter was contemplated through the data collected in the Five Year Report required under the Code of Practice for Pits.[81] One of legacies of a long, pre-legislation development history is that there remain derelict (orphan) pits in many communities that are eyesores and project an unfair image of today's industry. The Alberta Sand and Gravel Association has recognized this concern and recommended that a portion of the Community Aggregate Payment Levy be used "to research reclamation techniques and reclaim orphaned and abandoned sites."[82] This would be a significant step in the evolution of the industry.

PART FIVE

OUTLOOK



Challenges and Opportunities

The genius of the place is made up of the physical, biological, social, and historical forces which together give its uniqueness to each locality or region. All great cities have a genius of their own which transcends geographical location, commercial importance, and size. And so is it for each region of the world. Man always adds something to nature, and thereby transforms it, but his interventions are successful only to the extent that he respects the genius of the place.

René Dubos[1]

René Jules Dubos (1901–82), the American microbiologist and conservationist who coined the phrase "think globally, act locally," believed that people could enjoy, preserve, and enhance the value of an ecosystem if they thoroughly understood and respected the spirit or "genius" that made it what it is. As he noted in a 1970 lecture at the University of California School of Forestry and Conservation, this spirit embodies the complex interaction over time of physical, biological, and human forces.

In the Alberta context, "land capability" evolved as a practical expression of the "genius" envisioned by Dubos. Albertans recognized that we must make sure that the inherent values are not lost as human activities alter more and more of the landscape.

The 1970 date of Dubos's talk is significant. As Henry Thiessen described in Chapter 3, the publication of Rachel Carson's Silent Spring *in 1962 marked the beginning of growing environmental awareness in Alberta as it did elsewhere in Canada, North America, and globally. The creation of Alberta Environment in 1971, and the enactment of the Land Surface Conservation and Reclamation Act in 1973, are examples of government recognizing and adapting to the emerging environmental movement. By that time, a great deal had been learned here from the on-the-ground experiences of provincial and municipal inspectors and public lands officials since passage of Alberta's pioneering Surface Reclamation Act in 1963.*

In retrospect, the early 1970s marked a "tipping point" when environmental, social, and economic forces combined to push land conservation and reclamation in a new direction. The election of a new provincial government in 1971 opened the door for new approaches, although the groundwork had already been laid under the previous regime.

In October 2015, former premier Alison Redford said that the election of new governments in Alberta and Canada could signal another tipping point for environmental and energy policies.[2] If that proves to be the case, land conservation and reclamation policy changes will benefit from a half century of practical experience, an enormous body of knowledge gained, skilled and committed practitioners, a decade of debates leading to the still-unfolding Land Use Framework, and ongoing concerns about the impacts of energy in general and oil sands development in particular.

International student working on species for revegetation. *M. Anne Naeth*

In the course of researching this book, the authors and the experts on the steering committee and among our reviewers observed successes and failures. We identified both challenges and opportunities that await decision-makers and practitioners in the next half century of land conservation and reclamation in Alberta. This chapter outlines some of the salient findings.

A number of themes are repeated across the chapters:

- There is a considerable body of knowledge, experience, and expertise in conservation, reclamation, and certification for wellsites and plains coal mines. A lot of reclamation has been done in oil sands mines, mountain coal mines, pits, pipelines, borrow excavations, and roadways; but there is limited experience with certification of these sites. There is limited experience with conservation and reclamation, and almost no certification, for in situ oil sands, exploration operations, quarries, peat operations, railways, plants, transmission lines, and telecommunication systems.
- Cooperation between industry and regulators, and in later years other stakeholders, was at the core of the successful evolution of policy and practice. This cooperation included a sense of shared ownership of solutions, joint research to find answers, and open exchange of issues and knowledge. A shift away from the concept of shared ownership risks a loss of the trust and innovation that drove success.
- Frequent face-to-face interaction between regulators and industry—in meetings, field trips, and site inspections, and between regulators and the public in reclamation certificate inquiries and complaint response inspections—was invaluable in building trust and leveraging the knowledge that different parties brought to decision-making.
- Consistent and coordinated cross-ministry policy and regulatory decisions, clearly seen in the work of the Conservation and Utilization Committee and the Development and Reclamation Review Committee, benefits both industry and regulators.
- The adoption of pre-planning of disturbances in 1973 was a significant step forward. The plans were extensively reviewed and approved and the path was then set as to what would result. The implication of an approved plan was that the activity would be acceptable to society; that approval and certification would be assessed against that plan.
- The increased emphasis on conservation since 1983 has helped improve chances of reclamation success, reduce environmental footprint, and lower costs.
- A broad range of education and knowledge-sharing opportunities has provided Alberta with significant technical capacity to address conservation and reclamation challenges.
- There is a lack of publicly accessible information on the level of disturbance and reclamation for many sectors. The emphasis on mineable oil sands disturbance distorts public awareness of the impacts of other types of industrial activity. Industry, government, and the public would benefit from a better inventory of the amount of land disturbed, reclaimed, and certified. The data could help prioritize efforts to make industrial developments truly "sustainable" in the sense of returning disturbed lands as quickly as possible to subsequent productive use.
- The vast majority of reclamation certificates have been issued for wellsites, in large part because there is an economic driver to get the certificate—the termination of annual lease payments—that does not exist for other activities. If certification is considered to be a cornerstone of the regulatory system, then more needs to be done to drive operators to get certificates. Pipelines and road rights-of-way (other than the roadbed) are unique in that the disturbances are reclaimed immediately after construction but cannot currently be certified until after abandonment; if the goal of reclamation is to return lands to productive use then perhaps this post-construction reclamation work needs to be formally acknowledged.
- Different conservation and reclamation policies and requirements for sites on public land and sites on private land continue to exist and make it difficult for government to explain requirements to stakeholders and to companies that work across the province.
- Shifting the objective of reclamation from productivity to capability after 1983 was

pivotal in reclamation planning and practice. Yet, 32 years later we are no closer to having a common understanding about what this elusive capability objective means, how to make transparent decisions around alternative land uses, and how to assess success.

- Changes in policy and practice, however well intended, often lead to unintended consequences that then require additional policy responses. For example, an emphasis on plant cover as a criterion of success drove use of grass/legume mixes in forested land or crested wheatgrass in native prairie. Similarly, a preference for productive upland forest led in situ operators to leave elevated (upland) roads and well pads in wetlands.

Additional reclamation principles and practices that have served us well since the 1963 legislation include:

- context in planning and development—provincial policies, regional policies and plans, local community input, and input from those directly affected regarding land-use goals and priorities
- public and Aboriginal consultation
- regulator familiarity with operations and particular site conditions
- site-specific requirements, reflecting particular ecological and social conditions
- flexibility in how to reclaim, given the diversity of disturbance types spread out over a broad range of ecological conditions and land uses

A major challenge for the future is to learn from the past and build on existing knowledge and expertise. Significant progress has been made in advancing reclamation practices in Alberta. However, the development of measures to assess the success of these practices, combining science-based tools with environmental and social goals, has not kept pace. Challenges specific to the government and each of the sectors follow.

People: Society, Laws, and Regulations

The creation of the Department of Environment in 1971 with a mandate to coordinate policies, programs, services and administrative procedures in matters pertaining to the environment resulted in a unique government-industry-public planning approach to land conservation and reclamation matters. Inspectors from the Land Conservation and Reclamation Council worked directly with landowners, municipal inspectors, and industry representatives to address landowner complaints. The council's inspectors also held on-site inquiries to ensure that all factors were considered before reclamation certificates were issued for reclaimed land.

Changes in regulatory delivery of reclamation activities, such as audits for upstream oil and gas sites and codes of practice for pits, have reduced the historical interaction between government, industry, and landowners that was a key strength of the early regulatory system. At the same time, these changes streamlined the system with the intent of maintaining good conservation and reclamation. Enforcement handles problems that arise. The audit of a percentage of the sites that received reclamation certificates provides a check and balance on the process and the operators.

A reorganization of the Department of the Environment in 1998 resulted in a regionalization of most programs. The change provided more expertise to some regions such as the oil sands area around Fort McMurray, but it was less beneficial for some other regions and the central coordinating function. Improved reclamation criteria and codes of practice will continue to enhance environmental performance.

The Alberta Energy Regulator (AER) was established in 2013 and is authorized to make decisions on applications for energy development, monitoring for compliance assurance including conservation and reclamation requirements, decommissioning of developments, issuing reclamation certificates, and all other aspects of energy resource activities. The AER regulates oil and gas wells, pipelines, gas processing plants, oil sands mines, in situ oil sands schemes, bitumen upgraders on mine sites, coal mines, and coal processing plants. Alberta Environment and Parks continues to be responsible for conservation and reclamation of all non-energy specified land activities.

The major challenge will be to balance stakeholder and public input with the need to have effective, efficient, and timely processes that allow proponents and operators to develop their projects and to bring closure to their activities at the end of operations.

Ensuring consistency of policy and oversight approaches between energy and non-energy activities will take extra effort with the separation of these sectors.

Knowledge

Alberta's government, industries, specialist contractors, consultants, and academics have amassed an enormous body of knowledge about the province's landforms, soils, hydrology, and vegetation. Without this, the progress to date in land conservation and reclamation would not have been possible. Educational institutions have developed programs to train the next generation of scientists and practitioners.

Government, industry, and academia have been leaders in developing innovative practices such as three-lift salvage, winter soil salvage, using native vegetation, creating wildlife habitat, horizontal drilling for water crossings, and minimizing erosion on disturbed lands. There is continued effort to develop methods to minimize disturbance and accelerate reclamation. Particular focus areas include: developing wetlands, pit lakes, and connecting streams; reclaiming peatlands; assessing how to incorporate Aboriginal values and needs into reclamation; developing an understanding of the potential impacts of climate change on reclamation success; and, exploring use of remote sensing to assess reclamation success.

The challenges will be to continue building the knowledge base, ensure that information is accessible to all who need it, and support the institutions that disseminate it. At the same time, there is a need to make historical information more accessible (old knowledge to complement new knowledge), and to extend the timeframe for research and monitoring work to get a better understanding of the long-term success of conservation and reclamation practices.

Coal

The coal industry has adapted to the changes in expectations and regulations. As research brought new practices to the reclamation business, government and industry have incorporated these into the approved plans. This cycle has happened numerous times. Over the decades, as standards changed, an immense, almost overwhelming, body of information has been compiled on each parcel of land disturbed: for example, timing of activities, specific practices, soil quality conditions, water tables, crop yields, and wildlife use. By 2010, some 31,000 hectares had been disturbed by coal mining. While large portions (about half) have been reclaimed, only 7 per cent have been certified. In 2014, some $403 million were held in reclamation security for coal mines.

The reclamation certification process has stalled; industry has submitted applications, but they sit with the regulators. This is partly due to concerns over potential impacts and acceptance of liabilities. The complexity of the process, involving a variety of agencies and different legislation, is another factor. Corporate concern over loss of control of land or leases, either immediate or future, also plays a role.

With an increasing desire of government and some stakeholders to phase out coal-fired power plants, timely and cost-effective reclamation will become increasingly important. The key reclamation challenge today and looking forward is defining success and putting an effective, timely process in place to keep coal reclamation current with mining and to define the end of the reclamation process, especially for mountain mines. Practices and processes that have served well in the past—collaboration, research, practical site considerations, and the like—will help address this challenge.

Quarries

Limestone, sandstone, and shale are the major quarry operations in Alberta, together with ammonite and various decorative rock types. As non-energy activities, they are regulated by Alberta Environment and Parks under the Environmental Protection and Enhancement Act and the Conservation and Reclamation Regulation. Some of the public land dispositions date back over a century, and reclamation did not become a focus until the late 1970s. Like coal mines, quarries are found in plains, foothills, and mountain regions of Alberta, as well as in the boreal forest.

The industry practices and regulation of quarries evolved more or less in parallel with those for coal, including features such as end-pit lakes and the creation of wildlife habitat. One innovative approach, rock sculpting, shows promise as a way to create desirable landscapes in the reclamation of mountain quarries. A project in the Athabasca region proposes to establish more natural wetland complexes instead of a traditional end-pit lake.

The high visibility of quarries in areas like the Bow Corridor will continue to pressure government and industry to demonstrate what reclamation success

looks like. The long lifespan of many quarries means that eventual reclamation and certification are likely to occur in much different environmental, social, and economic circumstances than when they were planned and approved. If development of Alberta's mineral resources expands with an increasing emphasis on economic diversification, there will be a steep learning curve for Alberta to address issues such as acid mine drainage, metal contamination, and potentially radioactivity. The challenge will be adapting to those changes in a way that is environmentally desirable and acceptable to all concerned parties.

Oil Sands

Oil sands development creates extensive disturbed areas that remain active for many years before reclamation can start. The processing of the oil sands results in large storage facilities for produced sand and wet tailings, creating a huge reclamation challenge that will take decades and cost billions of dollars to complete. Eventually, reclamation will also apply to the extraction and upgrading plants and their stockpile areas for sulphur and coke.

Reclaimed fen. *Syncrude Canada Ltd.*

The government has now required the reduction of wet tailings and provision of target dates to close the existing ponds. A number of oil sands operators are actively pursuing new wet tailings treatment technology, with significant progress achieved and information shared among the operators. The use of processes that generate "solid" tailings will greatly advance the oil sands sector, potentially changing the pace of reclamation as well as the mix of reclamation options.

As of year-end 2013, mining operations in the Fort McMurray area had affected almost 90,000 hectares. Of this total, 8,000 hectares are in some stage of reclamation. As of 2015, 104 hectares have been certified, an indication that, similar to coal mining, there are challenges in the pace of the reclamation certification process. One major factor influencing the timing of reclamation certification is the requirement for oil sands operators to re-create a landform and reconstructed soil that will support boreal landscapes—a mosaic of uplands, wetlands, lakes, and streams. Once the reclamation is complete, oil sands operators must evaluate reclamation success against the approval conditions and, eventually, oil sands-specific reclamation criteria. The time required to prove success through monitoring can be quite long.

As of June 30, 2013, the province held more than $1 billion in reclamation security. The actual cost of reclamation could be in the order of at least $10 to $15 billion, all of which will eventually be fully secured under the province's Mine Financial Security Program.

In terms of capital investment, the oil sands collectively represent the largest energy project on the planet—but also the largest reclamation effort. Given the long lifespans of oil sands mines and plants, the biggest challenge facing the industry is the ever-changing goalposts for success. This is further complicated by rapidly changing tailings technologies, proximity to Aboriginal communities, and intense, and often harsh, criticism and scrutiny by people outside Alberta.

Wellsites

Prior to 1947, about 2,000 oil and gas wells had been drilled in Alberta. By October 2015, the government had licensed a cumulative total of 492,562 wells. This number included 55,000 mostly long horizontal wells for in situ bitumen production; horizontal drilling allows a number of wells to be drilled from one well pad, reducing the disturbance area. The Alberta Energy Regulator listed about 275,000 wells as "operational" in 2015.[3]

More than 170,000 wells have been abandoned. Of these, 66,000 have received reclamation certificates, and about 37,000 were "exempt" from certification requirements because they were abandoned on private land prior to 1963, on public land prior to 1978, or on federal land. There are also approximately 46,000 defunct licences (re-entered or cancelled). The operators remain liable for the remaining 68,000 abandoned, uncertified wellsites and the 275,000 operational sites. Energy price shocks contribute to the inventory of orphan wells (without a financially responsible operator); the AER listed 272 wells in this category in October 2015 and the Orphan Well Association is expecting many more to come.

Reclamation of in situ facilities poses several unique challenges in comparison to conventional oil and gas and oil sands mining. In situ results in a high density of relatively small scale (in comparison to mining) disturbances concentrated in an area, which severely fragments a forest. Disturbances range widely in intensity, spatial and temporal scale, and the many different forest types and ecosystems; and there are considerable chances that a reclaimed facility will be re-disturbed. Furthermore, construction of in situ facilities occurs on a variety of forest types and ecosystems, which can have variable levels of resiliency.

The AER also lists a cumulative total of almost 31,000 oil and gas "facilities" licensed in Alberta. These range from gas compressors and oil batteries to large sulphur-recovery gas processing plants. Of the 2,700 abandoned facilities, only 39 have received reclamation certificates, and another 87 are exempt.

The future reclamation challenges for depleted conventional and in situ production facilities are significant. The number of abandoned wells will likely increase due to low or fluctuating oil and gas prices. The number of orphan wells is a concern. Since there are no deadlines for reclaiming abandoned wells, the number of non-certified sites will likely increase. The auditing process to confirm appropriate reclamation has now been the norm for more than a decade on private land—almost two decades on public lands—but it may not necessarily reflect the needs and expectations of landowners and the public.

Pipelines

Two-thirds of Alberta's 415,000 kilometres of provincially regulated energy pipelines were built since 1990. More than half carry natural gas. About 35,000 kilometres are listed as "discontinued" and 37,000 kilometres as "abandoned." Most are regulated by the Alberta Energy Regulator (AER); the Alberta Utilities Commission (AUC) regulates local distribution pipelines. The National Energy Board regulates an additional 30,700 kilometres of pipeline in Alberta, including interprovincial and international pipelines and the major natural gas transmission system. In 1963, when Alberta enacted the Surface Reclamation Act, there were 7,725 kilometres of oil pipelines and 16,825 kilometres of gas pipelines in the province.

The focus on conservation and reclamation continues for pipelines crossing the many different types of landscapes in Alberta. Public interest and concerns about the types of liquid products carried in proposed pipeline projects and the location of the pipeline rights-of-way are also at an all-time high.

Pipeline construction and operation activities—including right-of-way reclamation and erosion control, inspection, repair, decommissioning, and abandonment—normally span many decades. Once the company stops using the pipeline, it can apply to the Alberta Energy Regulator for abandonment. After extensive study and data collection, the company may then apply for a reclamation certificate, although there are conflicting views on the number of certificates actually issued to date.

Pipelines are unique in that the primary reclamation occurs before operation and abandonment. As a result, the focus of the pipeline industry over the last 50 years has been on conservation and reclamation during construction and quickly fixing and reclaiming problems during operation. Final abandonment and reclamation certification are now getting more attention from industry and regulators.

With pipelines as large as 54 inches (1,350 millimetres) being currently proposed in Alberta, one of the questions facing government and industry is the ultimate fate of the pipe—should it be removed? Pressure for removal of all sizes of pipe is increasing as Alberta's urban and rural residential areas expand.

Industry and governments face significant challenges with future abandonment and reclamation certifica-

tion of many thousands of kilometres of pipelines. A cooperative approach will be required with the input of the public, landowners, industry, and governments to achieve practical approaches and solutions. Given that pipelines are reclaimed after construction and will have formed part of the operating landscape for decades, an additional challenge may be justifying the rationale for requiring what is essentially an expensive paper exercise to obtain a reclamation certificate when the pipe is left in the ground.

Roadways

There are more than 226,000 kilometres of public roads in the province, of which almost 165,000 kilometres are gravel, treated, or earthen. There are no approvals under the Environmental Protection and Enhancement Act (EPEA) for the construction or reclamation of roadways. However, operators require a reclamation certificate following roadway abandonment. Most urban roads are not covered by reclamation requirements.[4] For most provincial roadways, Alberta Transportation is the operator that is required under EPEA and the Conservation and Reclamation Regulation to conserve and reclaim. The department in turn directs its contractors to perform conservation and reclamation. The majority of the reclamation processes involved do not differ substantially from those required for mines, quarries, oil and gas installations, and other disturbances. Practices have evolved to reduce erosion, enhance revegetation, and improve reclamation of borrow excavations.

For many Albertans, roadway rights-of-way may be the only exposure they get to the success (or failure) of reclamation work. For this reason it is critical we put our best foot forward and continuously look for innovative ways to showcase reclamation outcomes. The challenge for Alberta Transportation and other road builders and operators is to maintain high standards and continue innovations such as the creation of wetlands on borrow excavations.

Pits

There are about 650 pits on public land. On private land there are about 884 pits that are 5 hectares or larger and between 1,500 to 2,000 pits on private land that are less than 5 hectares.

Gravel deposits often underlie valuable land slated for commercial and industrial development, leading to land-use conflicts. Pit development raises public concerns about quality of life (noise, dust, nuisance) and the environment (especially groundwater). Some municipalities have viewed pits as an "incompatible land use" in some areas within their boundaries. Regional approaches and coordination between rural municipalities will be critical in the future to ensure consistency in the regulation of smaller municipal pits and the larger commercial operations.

Regulatory oversight of the industry has shifted from education and assistance to authorizations and compliance over the last 50 years. While some operators are very knowledgeable and capable and have the financial and technical resources to operate very large pits, there are many smaller operators working on pits that do not receive the same level of regulatory scrutiny. These operations can expand to the point that they meet the trigger for regulatory authorization (5 hectares on private land). In some cases the upfront conservation work that would enable successful reclamation may not have been done; thus both industry and the regulators are playing catch-up to arrive at an acceptable outcome. Finally, there remain significant differences in how pits are regulated on private and public lands—in terms of requirements, process, and financial security.

Reclamation of pits on high-quality agricultural lands to equivalent agricultural capability is a significant challenge. Another major challenge is developing a set of practical reclamation criteria applicable to the broad range of pit sizes and depths that will result in a very diverse set of social and ecological outcomes. Reclamation of pre-legislation abandoned pits through an orphan-fund approach would provide environmental and social benefits and could be a significant public relations gain for the industry.

Conclusion

The seeds of reclamation success have been planted and nurtured for 52 years. By identifying the principles and practices that have led to success, and weeding out those that have not borne fruit, conservation and reclamation will continue to support sustainable development of Alberta's non-renewable resources. Notwithstanding the significant advancements in knowledge and practice that we have made so far, Alberta's biggest advantage is, and will continue to be, our practitioners. The value of their commitment to excellence and willingness to work cooperatively to achieve a common goal cannot be overestimated.

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All links in the citations were valid as of October 26, 2015.

The employer or status (e.g., retired) of individuals named in the personal communications or interviews is as of October 2015, not the date of the correspondence or interview nor the time being referred to by the person in their comments.

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Footprints celebrates five decades of land conservation and reclamation in Alberta. The book describes the programs, regulatory approaches, scientific advances, and industrial innovations that arose in response to the province's growing industrial activities—such as mining, oil and gas operations, and other land disturbances.

This history is supported and enlivened by the first-hand experience of those who played a direct role in the evolution of conservation and reclamation in Alberta. As such, it provides an important context for future development and refinement of Alberta's environmental priorities and initiatives.

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Albert Einstein

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