PETROLEUM HISTORY SOCIETY

OIL SANDS ORAL HISTORY PROJECT

TRANSCRIPT

NORBERT RUBIN MORGENSTERN, B.A.SC. (TORONTO), D.I.C, PH.D. (LONDON), PROFESSOR EMERITUS, CIVIL AND ENVIRONMENTAL ENGINEERING, UNIVERSITY OF ALBERTA; MEMBER OF THE ORDER OF CANADA, 2000; MEMBER OF THE ALBERTA ORDER OF EXCELLENCE, 1991; FELLOW OF THE ROYAL SOCIETY OF CANADA, 1975; FELLOW OF THE CANADIAN ACADEMY OF ENGINEERING; FOREIGN ASSOCIATE OF THE U.S. NATIONAL ACADEMY OF ENGINEERING; INTERNATIONALLY RECOGNIZED AUTHORITY IN THE FIELD OF CIVIL/GEOTECHNICAL ENGINEERING.

DATE AND PLACE OF BIRTH: MAY 25, 1935, TORONTO, ON

Date and Place of Interview: 9 am, July 21, 2011 in his Edmonton residence

106 Laurier Dr NW
Edmonton, AB T5R 5P6
Tel. (780) 486-5344
E-mail: norbert.morgenstern@ualberta.ca

Work:
Geotechnical Engineering
University of Alberta
3-075 Markin/CNRL Natural Resources Engineering Faculty
Edmonton, Alberta, Canada T6G 2W2
Phone: (780) 492-5127
Fax: (780) 492-8198

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Name of Interviewer: Adriana A. Davies, CM, PhD

Name of Videographer: David Bates

Consent form signed: Yes Initials of Interviewer: AD

Last name of subject: MORGENSTERN

AD: My name is Adriana Davies, and I am an oral history researcher for the Petroleum History Society Oil Sands Oral History Project. It's 11:35 on 11 July 2011, and I'm interviewing Norbert Morgenstern in his home in Edmonton. Thank you for agreeing to be interviewed for the Oil Sands Oral History Project.

NM: My pleasure.

AD: I'd like you to give me a summary biography, with the highlights of your educational background and your career to date, and then we'll move into the specific questions related to the project.

NM: Well, let me do that as briefly as I can. I was born in Toronto on May 25th, 1935, and all of my education was in Toronto. I graduated from the University of Toronto in 1956 in Civil Engineering. After a short period in professional practice, I was awarded a scholarship called the Athlone Fellowship, which was a scholarship funded by British industry at the time, for Canadians to go to England. Obviously there was some commercial motivation, but it was a fairly prestigious scholarship, and many Canadians who did go to the UK at that time were influenced by their experience there. I had developed an interest in this emerging subject called soil mechanics, and the Imperial College of Science, out of the University of London, was achieving a reputation as the place to be to follow that subject. So it was the Athlone Fellowship that took me to London that year, at the end of that year, to start my graduate program. I then continued through the equivalent of a master's degree, called the D.I.C. [Diploma of the Imperial College] at Imperial College, and then a PhD at Imperial, and went on their staff, actually before I finished my PhD.

I stayed on the staff there from 1958 to the end of 1968. At that time I had been invited to join the University of Alberta and came to take up that position. I remember, I think it was January 4th or 6th, 1969, at the beginning, actually the very first day. I can still remember it was the coldest spell in the history of the City of Edmonton. So that was my initiation to Alberta, and this is being filmed in the house which we purchased in June of 1969, and where we've resided ever since. I've been a professor at the University of Alberta, actually a professor of civil engineering, and I was a professor until retirement from teaching about 10 years ago—2000 perhaps, 1999. I still have an office at the

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University. I still engage in our research program and in some other aspects at the university, but I've always had some consulting work as part of my career.

With my retirement from teaching, I then expanded the consulting part. So I've been at 20 percent academic to 80 percent consulting engineer. So that's, if you like, the chronological background to my life at this location, where we are now.

AD: [question unintelligible]

NM: Right okay. Yes [laughter]. Ignore the …

AD: How did you become interested in the oil sands?

NM: That's an interesting story. We were very happy in England. My wife was working at the BBC. I had this emerging academic career, with consulting on the side, at Imperial College in what was becoming the leading group in the world. A good life—very satisfying, living in London. In 1967, the National Research Council— I don't know if it was the first year that they initiated a trans-Canada lecture tour. I guess, as a blossoming Canadian abroad, I was invited to do that in the spring of '67. I was stopping at 10 places in Canada, and one place was Edmonton. I hadn't been to Edmonton before, and I hadn't been to Alberta before. One of the special interests for me was the then Dean of Engineering, Dean Bob Hardy, who was a person who started my subject in Western Canada, and is regarded as one of the two fathers of the subject in Canada. The other is a very famous man, Robert Leggett, who resided in Ottawa at the time. Bob Hardy, about which I'll speak presently in more detail, was a formative person in my life, and he told me about the oil sands. And that was my first understanding that there was something called, as he called it, the tar sands and that there were very challenging issues. And I remember very clearly that March night, being taken to dinner at the Faculty Club, and there was light across the valley, a certain dynamic in this city, and I went back to London and told my wife, "You know, if we ever went back to Canada" —and we had no intention at the time—I think I said, "Ho ho, we never will. Edmonton looked like an interesting place to be." Well, after that we had our first child, and that brings all the questions of where do we want to live for the next stage of our life, and we were getting restless, and to make a longer story somewhat shorter, in a year and a bit we were here in Edmonton.

AD: How did you get to know Dean Hardy?

NM: Well, it was formally. He was Dean when I was hired. I think the intermediary was a fellow, Stu Sinclair, who was head of civil engineering at the time, who spent a sabbatical period with us in London and got to know me. And I think in those days one could sole source a position, and I think

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it was that intermediary relationship that created the offer, kind of unconditional if you will, compared to today's process of hiring. There was a lot of other excitement about coming here. I didn't come because of the challenge of the oil sands. I actually worked a lot on landsides and dams and so on, so there are a lot of challenges in Western Canada. Plus, I knew that the Arctic was going to take off soon, and I've always been interested in northern geoscience and permafrost-related things. Another wonderful aspect of Bob Hardy was that he was the first engineer, perhaps in North America, to actually do any engineering in permafrost. So these were some of the technical enticements that I knew would be in front of me. And all of that evolved, including of course the oil sands. There's a footnote to the evolution of the oil sands because the vacancy that I filled was created by the retirement from the University of Dr. Elmer Brooker. Elmer Brooker was the bright young man in the geotechnical field who did some of the first geotechnical testing of oil sands material, and he left to form his own consulting firm, to go full time consulting, and formed a very successful company called E.W. Brooker and Associates, subsequently EBA. And, as I got deeply involved later on in the oil sands, it was initially through that company. So Elmer's retirement created the occasion for me to come, and we have some linkage in working together in the early days of the expansion of the oil sands industry in the early '70s.

AD: What was your first involvement in the oil sands?

NM: Well, I was building up the geotechnical activities at the University, building if you will on the heritage that Bob Hardy had left, running the research lab, appointing staff. And our first focus was on problems with some of the bedrock landslides here and some of the dams that had issues. And the Brooker Company had been retained to do some engineering work in the early days of the Syncrude project. As is common in my subject, if you have a difficult problem you often see some senior arms-length external review as part of the quality control. So I was invited by the Brooker organization to review some of their work and develop engineering designs for the Syncrude project.

So, my first introduction to the oil sands was through that. I remember my first visit to the site. It was in winter. I think it might have been the winter of '73, perhaps '74. I can't remember exactly. I wandered around, going up and down the valleys in snowmobiles with a senior member of the Brooker organization called Dave Devenny, who's also gone on to have a very successful career in the oil sands. That initial involvement with the Brooker organization brought me closer and closer to the Syncrude organization. And that then transformed into a much bigger assignment which actually continues to date.

AD: What did this work for Syncrude involve?

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NM: Well, the work with Syncrude was certainly transformative for me and I think in terms of geotechnical engineering. For the oil sands as a whole, the institutional structures that were set up had an impact on the industry generally. The big challenge that we were involved in, from my subject's point of view, was the mining system. The mining system that was extant at the time was that being practised at Great Canadian Oil Sands, which I'll call Suncor, because all of that folded into the Suncor organization. And their mining system was based on the technology of mining from the German ground coal mines, using rotating equipment called bucket wheels, which excavated the mine face sitting on the floor of the pit. It operated with some difficulties peculiar to coal regions and so on, but nevertheless was producing. That was the technology that was proven at a commercial state. People initially within Syncrude, and later on consultants, had the vision that there was a better mining method using draglines, which are big machines which sit on top of the mine wall and excavate the mine wall and retreat behind. These would be more productive excavation machines and have the advantage to be able to do some selective mining. With a bucket wheel, everything is there, which you take from the mine, and even if it isn't commercial to process some of that it goes through the system and, therefore, there is dilution, which makes the whole process, if you like, less economical.

With the dragline you can say we're in a zone of no ore grade, bitumen content, let's pitch the waste back in the pit as opposed to dig it out, put it on a pile, where it can then be sent to the process plant. So there's a lot of attraction to the dragline but the big issue was, if could you put a dragline on top of this wall safely or would it slide into the pit. These draglines related to that decision, became the world's largest draglines. Replacement costs were certainly many tens of millions of dollars, if I remember the original costs. So, the big challenge was the mining system at Syncrude.

What Syncrude did, because they were getting diverse opinions … their prime consultant, which was the Canadian Bechtel organization, did not support the draglines, if I remember, because they were involved in Suncor, and there was the sense that what we have experience with is the way forward. Syncrude very bravely said, "Well, we hear you, but we're going to explore the dragline technology in more detail."

So, they established what we would call a review board today. It was quite a large review board. It involved famous people around the world in my subject at that time. Professor Arthur Casagrande at Harvard and his brother were leading experts in the world. They brought in leading practitioners who were using draglines in the coalmine industry. They had some of the Syncrude staff, some other geotechnical people who had experience in the oil sand industry. Elmer Brooker was on, and I was invited, I suppose as the young blood but, nevertheless, with some experience with the oil sands and some sense of how these materials behave. Bob Hardy was there, and that's a key player. So, this was a major activity in which we studied these materials.

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We flew around the country looking at dragline operations. We recommended a trial exploration with a smaller dragline compared to what would be the commercial-scale machines and had that instrumented and studied all of that; and, ultimately, supported the recommendation that draglines were the way to go.

It came with some caution however. Today we would have said, "Well, we did a risk analysis." Well, we didn't have that formal language at the time, but there was a wonderful, crusty, experienced coal miner, called Herman Knight, who was consulting with some coal company, who worked with draglines a long time and understood how they operated, and he said, "Well, I think we should also indicate what the risk is to Syncrude in accepting the recommendation for draglines." And we chatted about his recommendation for draglines. "I think Syncrude has to reckon on losing one machine every ten years." Now the ultimate configuration that Syncrude accepted was four draglines sitting on two separate high walls: two moving north, two moving south, and so on.

That would mean that Syncrude would have to accept the risk of losing one-quarter of its production every ten years, replacing the cost of that machine, and even contemplating that there may be safety issues, potential loss of life, in terms of that risk call; and, therefore, accepting that the dragline wasn't a free ride. You're doing something in an environment of potential instability that had never been done before, not withstanding having assembled the best team in the world they could to advise. There were enough defects in the high wall system, enough ways in which one could fail, that one couldn't proceed with 100 percent confidence. Syncrude accepted that caution, and we all agreed that, as we learn, we will get better. But, nevertheless, you are making an investment decision conscious that you are buying into a certain risk. And we never lost a dragline, or you would have heard about it. We learned to mine smarter than we thought. We developed observational systems and so on.

So, it was the first introduction to what for me has been an ongoing experience with the industry. Geotechnical engineering in a broader context involves managing uncertainty in the nature of the work we do in the mining business. Later on, we can talk about tailings, as in the expanding of tailings there's an intrinsic uncertainty. You're taking risk, and a considered risk, all kinds of risk management activities, and you're involved in the continual tension of risk and reward. I think this is part of the oil sands from the beginning; when the first investment was made in the Great Canadian Oil Sands … it was all risk and no reward for a very long time. And that's the recurrent history of the industry. That there is risk, but there's also great rewards for all stakeholders. And so, from this very fascinating occasion of the consulting review board that Syncrude established became a common mechanism to guide the uncertainties that were related to geotechnical engineering going forward in the industry.

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So, after Syncrude got established, this large board was shrunk; it was, I can't remember, 12 people, and that's certainly too many to convene for more frequent operation-related meetings. I was retired from that board with others, and as those who were kept on, like Bob Hardy, I think Karl Taylor, who was the chief engineer at Bechtel stayed on, a couple of others, and as they began to pass away… Karl was the first to die, and I was asked to replace him some years later on the review board. That might have been in the middle, early '80s, or something like that, and I've been a member of that review board—still am today. And that kind of mechanism of the geotechnical review board to give guidance on the uncertainties related to the geotechnical industry, which are very substantial, has been adopted by all of the operating mines. And there is, in fact, a geotechnical review board, which has slightly different names, with Suncor, Shell, CNRL [Canadian Natural Resources Limited]. I guess that's all the operations at the moment; and North Joslyn has one going into the design stage. I happen to be a member of all of these. [Laughter]

AD: Has your consulting been limited to geotechnical issues?

NM: Yes, limited in the geotechnical area. Let me just add that geotechnical engineering impacts on certainly the mining, though less so now, which I'll speak to in a moment, is central to the tailings dams and tailings technology. It also has a role in things like foundations and buildings and tanks, but that's more conventional. And it has a great impact in the underpinning, of reclamation closure-related aspects, integrated with other technologies. So it is pervasive wherever the ground has been affected.

AD: Can you give me more information about the oil sands consulting and research?

NM: Well, these review boards were all consulting assignments. In parallel, one learned about fascinating problems. And it's certainly the way in which we built our geotechnical group at the University as having an interface in some of the leading problems around the world, wanting to develop a research program and wanting to develop a professional education program that was at the leading edge of professional practice. That's always been our ambition to do research and to train so that the payoff for consulting in the companies has been at that interface. So having understood that the oil sands, the mechanical behaviour—how strong is it, why is it that strong, how can you put a dragline and so on—seemed evident from just looking at some of the geomorphic stability of natural slopes, and seemed evident from the test excavations we did, was not evident from the traditional methodology of get a sample of the material, test it for strength, and do a calculation; so there were lots of challenges. … So we brought these projects back in to the University, … the more challenging ones became a challenge for doctoral students.

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One of the first breakthroughs really had to do with the stability issue. And it came in parallel with the work of this review board, so the research was feeding into difficult decision making, was showing that the oil sand gains its strength not because it's cemented but the particles of what we call locked sand, are sort of embedded in each other. That's because they're old—their Cretaceous age, tens of millions of years old—they've been under load for a long time. They've never been greatly heated or anything like that. But that process of being under load for a long time creates a process in which the particles penetrate into each other. They're becoming a sandstone but they're not cemented yet. They are rather like a jigsaw puzzle. You try to shear a jigsaw puzzle at interlock, it's relatively strong. You try and pull it apart, it's relatively weak. And that's basically one of the first major findings from research which a wonderful student called Maurice Dusseault—he's gone into the petroleum industry now—did for his PhD. And that fit in to part of the comfort of "Yes, indeed, we understand how this behaves and we've got more confidence in going forward industrially."

Another aspect that illustrates the interface between research and practice, another aspect of the oil sands, is that there is gas dissolved in the bitumen. And when you unload it by taking a sample or making an excavation, the gas comes out of solution, expands in a bubble, and disrupts this interlock, and the material becomes weaker. And that was studied by other graduate students, normally at the PhD level, who went on to very successful careers, now leading in consulting practices for companies, or indeed at other universities. So you always have, we sought this interface between the challenges of industrial applications in the oil sands and into developing other areas and the ability of our smart young students to contribute in a timely manner. We've been pretty successful at it, I say, with a lot of pride.

AD: You've mentioned some important researchers in your program. Could you perhaps mention others?

NM: Well today, one past student is Dr. John Sobkowicz. He's a principal with Thurber Consultants and he's one of the leading designers of tailings dams and tailings technology; he sits on a number of industrial review boards. Another is Ed McRoberts, who succeeded Bob Hardy as the leading designer for oil sand dams with what was originally Hardy and Associates which morphed into a number of other companies. He's still the leading designer and vice-president of AMEC Earth & Environmental. So they were all related in oil sands studies with us and made important and timely contributions. And there are others, as we speak about it, who will come to mind.

AD: What was the relation of the university researchers and the companies?

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NM: Well, these advisory boards that I spoke about were advisory to companies, and they actually drove company practice as opposed to research. If like myself as an academic, I would say, "Gee that's a really hot problem. I'll take that problem from another perspective. A more fundamental perspective, or anticipating problems that are not yet in the industry but will be in five years. I'll take that home and have a student work on it." The importance in our geotechnic research has been anticipatory as opposed to contractual. There are occasions in which we appreciate a contract on somebody else's problem because it brings in resources that might not otherwise happen. But our challenge is to be anticipative of the problem. Once it's been declared and is well known, then it's ready for, if you like, an industrial approach as opposed to a free-thinking approach that I think characterizes the spirit of the university.

But we're always focused, not only on oil sands work but permafrost work and many other areas on anticipating the needs of professional practice. That's our major game, is to be in advance to make a timely contribution, train somebody, and to move on to be a leader. But to be anticipatory you've got to be part of it, you've to be embedded, so to speak. You can't just sit in your office and dream up problems. You'll grow interesting problems but you won't be in the world of need. It's delicate.

AD: It is.

NM: The evolution of tailings ponds themselves is very interesting. I go back now to Bob Hardy from both his professional small organization and his academic perspective. He was the first designer of a tailings pond in the industry. Bob, I guess we're going to—when Suncor just started up, I think in ''67 or something like that—so we're looking at 1965 or so. By the way, it's interesting collecting some of the visions of geotechnological behaviour of the oil sands; there were thoughts in the early '60s that you couldn't even leave a bulldozer running on the oil sands, that they weren't strong enough and that the bulldozer would sink itself into the ground. So that indicates how far we've come, that we've come from that vision of how unfavourable they would behave to actually putting multimillion dollar machines right on top of them. And that wasn't very long. That was '63 to '65 to our decision to … by the time Suncor got mining that it was clear that was a fallacy. However, coming to tailings.

The original design for GCOS/Suncor which ended up with the Tar Island Dyke tailings structure, which was the first tailings structure which was built out into the river to some degree and is a structure about 100 meters, about 300 feet high, remarkable technical achievement—was not intended to be like that. That was not the design. The original concept, from whatever process work had been done on the oil sands in the middle '60s, and I haven't been able to find this source, but it said we'll take the tailings and we'll spill them over the escarpment, into the bank of the Athabasca River. We'll have a little collector dam—it was built originally 12 meters high, about 40 feet high,

and the water from these pumped tailings will come out and the tailings will take an 8 percent slope, rather like copper tailings in copper mines. It will take the slope, clean water … [videographer changes cartridge]. So the original concept was that the tailings would form an 8 percent slope after they were spilled over the escarpment, clean water would flow out.

This original, what we call a starter dam, would stop that water from getting into the River. One would pick it up and pump it back in because it was environmentally unacceptable. One wouldn't have to do that for very long because, I think, it was in about three or four years there would be enough real estate created by the mining that one could then take the tailings and put them in a pit. But the tailings didn't behave that way. The tailings have a certain amount of clayey material, which, by virtue of some of the chemistry of the process, becomes very dispersed and doesn't settle out. So, instead of this small dam receiving clean water that could be sent back to be processed, it was receiving what became called, later on, fine tailings; and this fine tailings couldn't be used in the process and couldn't be sent anywhere. There wasn't any place to send it.

So, Bob Hardy and his colleagues were faced with this crisis, of "hey, this stuff isn't clarifying. We've got to contain it." Instead of leaving this modest little dam with this modest accumulation of tailings, which would be finished in a few years, they had to figure out how to build a dam to continue to keep the organization going. And, there weren't any clear construction materials around to do it. The only obvious material was to use the tailings itself, and they developed techniques of what we call hydraulic fill. To use the sand itself to build the structure, at a scale that had never been done before, and to build the structure 100 meters high under ground conditions that anyone who had been a designer in the middle '60s who said "Can I do that?" The answer would have been no.

So, I mentioned earlier risk and reward. Here is another example of risk and reward. That had Hardy and his colleagues been unable to find the solution in a timely manner to this changed condition, it's fair to say that GCOS would have shut down. Given the precarious nature of investment at that time, one can only speculate, but it's perhaps fair to say that the industry would have shut down. The industry went through this very precarious financial situation in which one might have lost it, and for how long is anybody's guess. But this was a pivotal time in terms of geotechnical aspects of the oil sands industry, and one of Hardy's great achievements was to continue to figure out how to build this dam in a safe manner. And, later on, it was subject to very careful safety scrutiny, but it was certainly built with certain risk taking but considered risk taking at the time. While as provocative today as the tailings are, it's actually a remarkable technical achievement. I was somewhat involved later on. Ed McRoberts took over the responsibility for it after Bob died. We're all very proud of it as opposed to being ashamed of it [laughter], because it was pivotal in saving the industry.

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AD: The extent of the tailings ponds is an issue today?

NM: Well, it was supposed to be a small structure. And whether it would have been temporary or not, I don't know that I'd say that. But it certainly wouldn't have been the structure that it is today, and would not have had the fluid containment issue, and I will speak presently about the seepage that comes out of it, as an issue. That was not part of the vision at the time.

AD: Critics such as David Schindler today are also talking about issues of seepage and evaporation from the ponds?

NM: Yes.

AD: Could you address both?

NM: Well, let me take it in two steps: first of all, overall safety, and, secondly, there was performance, like seepage. Ultimately, there's closure and reclamation. There's stages of these structures. And dealing with Tar Island Dyke—it continued to be built and Bob was very close to it during all of its stages. Instruments were used to study for movements, to see whether the pressure was building up in the dam, and so on.

And in the early '70s, there was a mood, due to the failure of some dams in the United States, to increase the regulatory aspects of dam safety. And, actually, I chaired a committee of the Professional Association of Engineers, of which Bob Hardy was a member as well as others from Alberta Environment. At that time, Alberta Agriculture was the responsible agency. A number of other consulting people recommended that Alberta Agriculture, let me call it Alberta Environment, expand its legislative capacity within the water act and increase its capacity for regulating with respect to dam safety. And the Province of Alberta became a leader, certainly in Canada and a leader internationally, in developing dam safety regulations, and it still is, and I'll speak of the significance to the industry as a whole in a moment.

So, it developed a capacity at first to conduct an inventory of what dams exist and how are we going to do dam safety audits. The first major audit of dam safety was on Tar Island Dam. So, that illustrates, if you like, the diligence of the regulator. It also illustrates the importance of the regulator. So, they assembled a consulting panel of people to look at the history of the design of the structure, which was going up and up and up, and evaluate whether it was safe enough for the conditions. I was a part of that panel, as was Bob Hardy, as was a number of other famous dam engineers in Canada, including some members outside of Canada; lots of capacity. This was the first major dam safety review in the country.

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AD: What year was that?

NM: I think it was ’76. There is a, I assume it’s publicly available, report, because it was a government study, a study that went to the government, probably paid for … it must have been paid for by GCOS at the time. And we were very comprehensive, very detailed; all potential failure modes were considered. Those needs were addressed and so on. And there were movements occurring in the dam. It is placed, part of it was over what we called a critical section where there was some soft alluvial river-deposited clays, which are weaker than other parts of the foundation. And there were movements occurring. The movements were significant. They weren’t catastrophic, obviously, but one paid a lot of attention to them. And there were instruments in place. It isn’t that the potential for movement was neglected. And we put a restriction on the raising of the dam, saying “Well, we’re concerned about these movements and we think that the dam should not be raised any faster to—I’m sorry—that the dam can be raised provided the rate of movement, which was modest, is not accelerated.”

So this was a, if you like, an imposition on the operating conditions for the dam, and extra drainage had to be put in to meet that condition. And this was on the condition of continued compliance for building the dam into the future.

It’s interesting that, in 1976, the question of geoenvironmental impact was not addressed. And that’s the way it was in the world, I think. I work in other industries. I work, for example, in the mining industry, also for the gold industry and so on. And I’ve been interested in deciphering in practice when the geoenvironmental sensitivity evolved. And I’ve been involved in the review of a very large dam in South Dakota for the Barrick Gold Corporation, which they inherited when they took over Homestead Mining. And this was one of the largest tailings dams in the United States—one of the first major tailings dams in the United States built to water dam standards in the early ’70s. And having gone through the archives of that report … they had a wonderful set of designers, I mean the leading people in the United States, talking about this seepage beneath the dam and whether they had to do something to manage it or not; never asked any questions about its chemistry. It all had to do with the amount of water and its erosion.

So, certainly in the ’70s, the geochemical aspects of seepage were not being addressed. They became more recognized—at least in North American practice—in the late ’70s in the uranium industry, and even into the middle ’80s they were not adequately recognized in some of the metal industries. So, we’ve got this transition that water seepage is fundamentally benign—we only have to care about it if it’s doing physical damage—to, of course, today in the mining industry around the world where water is everything. Water is the most dominant concern.

Talking about the fact that water is everything in the mining industry. I just came back on the weekend from a large project in Mongolia, which is copper and gold, and there water is more important than in the oil sands, because there's a water shortage. But water, in terms of gold and copper and, clearly, the oil sands industry, is the dominant issue in social acceptance of the operations whether it's developed countries or a developing country. So, the evolution of our water sensitivity began firstly, I think, in the uranium industry in the United States in the late '70s and then crept into oil sands in the middle '80s, perhaps '83 or '84, and I'll speak to that in a moment, and then the metal industry around the same time. Now developing any new mine one pays terrific attention to water compliance issues. That, coming back to the history then of Tar Island Dyke, this episode had to do with water sensitivity; and I can't remember the exact year, but it might have been 1984, when under the activities of Alberta Environment—whatever equivalent ministry it was at the time—what was called a bioassay of the fluid coming out of the drainage system was undertaken. The bioassay originally sounded very complicated, but it's actually the mortality of a trout fingerling in this water. The trout died.

And I can't remember who got in touch with me but they said another panel was formed to evaluate the implications of this toxic seepage getting into the river. That I think became the pivotal time in awareness of water management from a geotechnical perspective. I suppose there was a mindset that a certain dilution was acceptable, and we studied how to eliminate that. It wasn't practical to eliminate it all because some of it was actually flowing into the sandy strata beneath the dam rather than flowing out. But basically, I don't have the report in hand, but I remember agreeing with the view that we would do everything practical. Whatever was practical was to take all the seepage you could collect and pump it back up into the containment. And there wasn't any clear technology of how to stop the rest.

It was clear to us—I don't know if we knew it then but not too many years later—that what was flowing out into the river was not actually water coming from the containment. It was actually coming from the dyke itself, which was built by hydraulic procedures. There's a certain amount of process-affected water as this dyke drains down, and some of that is leaking out into the River. One of the conditions, of course, was monitoring and Suncor has proceeded, and continues today, with a lot of aquatic monitoring. Reports continue to declare no adverse effects. So, that was a time, again, of managing uncertainty, evolution of awareness, changing goalposts, all those sorts of things. So that's, if you like, a pivotal time.

Steve Hrudey, who's an important figure in the Alberta environment scene and recently coauthor of a major Royal Society of Canada report on the environment aspects of the oil sands was, in fact, the first person I remember who sampled that water that time and I think he went on to chair the

environmental commission for Alberta and so on; still, very active.

I think it must be about 10 years ago or so that the then-president of Suncor…I think Dee Parkinson it was at the time, promised the government that we will close or will reclaim Tar Island Dyke. And Suncor, bless their hearts, at very substantial cost, actually, has done that. It is now solid landscape. They did it by removing that material that could be removed elsewhere. It wasn't, if you like, a reclamation in place, but they honoured their public commitment. It's now been renamed Wapisaw Lookout, or something like that. Leakage still continues, even though there's no significant fluids contained anymore, but the sand structure still drains down, but it's at a declining rate.

AD: What about Syncrude then?

NM: Syncrude has had its own interesting history but, fortunately for Syncrude, by the time they got going—Bob Hardy was originally the designer there too, though I got involved a few years after—they realized there was this fine tails burden of tailings management that was really the big issue, that one had to continue to contain it and, ultimately, figure out a way of disposing it, meeting one's obligation. So that the Syncrude structure … actually, it was originally conceived to be not unlike the Suncor structure, but that was abandoned based on the Suncor experience … was moved up onto the upland, as a solely contained system, not out in the River,. It is of quite large dimensions, and is one of the largest earth structures, in terms of volume, of engineered fill in the world.

So, it was built and it proceeded, again with a small structure, which then was built again with the sand technology that was first proven practical at Suncor; and, recognizing that it was on a weak foundation. We have a plague in some of the local geology. On top of the oil sands there's a geological stratum called the Clearwater Shale, which is very weak in shear, like two plates sitting on each other. It's also been dragged by glaciers moving over to drag those plates, so there are zones that are weak in terms of their ability to carry load. It was some time, I guess in the mid '80s or so, that significant movements began to develop as one continued to raise Syncrude's tailings dyke. And that was handled again by the geotechnical management of risk, what we call the observational method. They had instruments then. We interpreted the instruments. We flattened the slope. We did a number of various things to demonstrate that it could be built to its final design height. An adaptive, if you like, an adaptive process. So, it was built successfully and became the model for many other tailings structures, because we have to deal with these poor foundation conditions in other sites.

AD: What about other issues such as the "birds landing on the tailings pond" issue?

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NM: Well, all operations today… operate under the condition that there is no seepage beyond lease boundaries. So, all have … might have sand channels underneath; all would have monitoring; and all would have collection systems, if the plume of process affected water is going anywhere. We'll return to that issue in a little more detail and talk about another tailings structure on the Suncor lease that confronts a lot of under-seepage in an engineered manner. But the bird issue … certainly evolved. Increasingly, the scarecrows and noise machines went on for a long period of time managing birds. Reporting systems and bird mortality and all of that seemed to be an acceptable process until the unfortunate incident at Syncrude. Birds did land on the tailings pond before the warnings systems, and at a time when there was a lot of ice-covered lakes around there wasn't much choice. So that … Syncrude was punished for that for various reasons and has accentuated the need for bird management in the industry. There's now some very substantial technology, radar detection and noise creation and other technologies. There's a lot of very careful protection of the bird habitat, if you're starting up a new tailings dam, and so forth. So that's been part of a learning curve of the bird hazard issue. And, certainly, the larger the pond, the more you have to skim bitumen and do a number of things to limit that risk.

AD: Have there been significant changes in the building of the ponds?

NM: Yes, we had the original Tar Island Dyke, which had its problems. And the lessons from that were learned as one went to the Syncrude structure but it had weak Clearwater shale foundations. Those were also encountered in some of the later structures on the Suncor site and handled from the learnings that we got from Syncrude. But, then, as Suncor continued to expand, it was forced to go on a site that had a lot of sand channels in the foundation of the dam. Again, the regulation required no migration of process-affected water to lease boundaries, but we had the prospect of process-affected water seeping from behind the dam, and even these sand structures leaking into these sand channels and out into the Athabasca or to one of the ancillary channels that flow into the Athabasca.

So, this process was studied in considerable detail and modeled, and we have cut off walls in some locations. We have pump collection systems in other locations, and a commitment to gather, at first to inhibit any migration off these boundaries, and to gather it and recycle it back into the pond, and a commitment that that monitoring and management will go on until the water is of such characteristic that it could be released to the environment. So, this was a way of managing leaky foundations for the future, which raises some of the long-term obligations the industry is obliged to regard as it begins to think of its closure scenario.

AD: Have you been involved in any of the regulatory work?

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NM: I've only been involved a little bit on the dam safety side. I work too close with industry to deal with the tailings side, but I've certainly written in public about some of those regulations. But let me talk, firstly, about the dam safety side. I recently gave a keynote address, about a year ago, at a major mine waste tailings conference, dealing with improving safety of tailings. As part of that presentation, I made the statement that, in my view, the best dam safety program in the world is the dam safety program we have in Alberta applied to the oil sands industry; and, for a varied number of reasons, which the paper spells out. And I spoke about what underpins such a, trustworthy system. … I liken its underpinning to a three-legged stool. One leg is the owner and owner-related stakeholders and all of those people who have an obligation and a care to do the right thing. The other is the technical group, the consultants, and so on, that indicate how to do the right thing. And a strong regulatory environment, that insures in some transparent way that the right thing is being done. Without three legs, this system gets a little unstable, and I'm pleased that, certainly, in terms of dam safety we have three strong legs underpinning the dam safety system.

That system is not so well supported in many other developed countries to the degree that we have here. And, I think, it deserves a lot of recognition. It also deserves ongoing support within government. Budgets go up and down, and one sometimes worries about diminution of the technical capacity. Regulation is only as good as the technical support it has in government. We've had periods in Alberta government where there has been an excessive reliance on what might be perceived as self regulation in the industry, and we've gone away from that. I think we increasingly understand that government, in order to gain the benefits, also has to make the investment in the appropriate skill set, capacity. It's not just the regulations. It's the skill set that's implemented with the regulations.

AD: But you can't regulate everything and accidents happen?

NM: Yup. Well, accidents are always very bad news. My world is dominated by uncertainty. It's just the nature of dealing with natural materials and complex processes and so on. It's important in my world not to have accidents. We can have changed conditions, but we've got to have anticipation of how to manage the change. There is a process that we're very proud of in geotechnical engineering, called the observational method. If you gave it a fancy name you'd call it consequential risk analysis, if you like, and the person who thought of the whole subject, a very famous engineer called Karl Terzaghi, was the first to articulate it, and some others, including myself, have written about it. What it does is … You take a design of a dam or a tunnel or whatever the case, and you know that there's uncertainty in all of the inputs into that design. There's uncertainty in terms of data, because we don't live in a simple world of having a manufacturer producing a replicated entity.

Construction has its own complexities. There's uncertainty related to how it's constructed, though we have quality control and all of that. There's even human uncertainty in our system. So, you anticipate, you design on your best model of all of those things. But you then develop a system of monitoring to anticipate, to find ahead of time, deviations from that design basis. But that's not enough just to monitor it. You also have in your design method a way of addressing that in a safe and acceptable manner. And, if an owner says, "I can't afford to do that kind of risk management," in my world you can't afford to work with that owner. So, the modern geotechnical engineer brings with him the obligation of the owner to countenance what will happen if things go wrong, in a considered manner. This might be called adaptive management, if you like, but the issue is to be perceptive of change. So that's not an accident. Accidents are things that that system didn't work with. To have an accident happen is very upsetting. But to have change required is part of my business every day.

AD: There is no guarantee that accidents won't happen.

NM: Ya, and that's not understood. It's not understood by many.

AD: Going back …

NM: Well, firstly, the challenge is ongoing. We're not, from the part of the world I work in which is the mining and the waste management thing, we're still in a formative stage. We're not a mature industry. I look at the industry as having three aspects: the mining, the bitumen recovery that Karl Clark and other researchers looked at, and, then, there's the upgrading. I think the upgrading—I know nothing about it—but my sense is that a complicated refinery and a mature business has its own stuff that comes out that has to be worried about, but at least it's perhaps one of the more mature parts of the business.

I think those that come into the business from other parts of the oil industry find the mining aspect and the bitumen recovery aspect really a difficult learning curve, and they don't, certainly haven't learned about that in other parts of the oil industry. Of course, the scale, the footprint of the oil sands industry is large. To say that it's the largest in the world, perhaps as a single industry it may well be, although I do a certain amount of work in Western Australia where there's a lot of base metal and gold mining, and the accumulative effects of all these smaller mines over time have a comparable footprint.

It leaves a large footprint. And they are on a geological environment that is diverse. There is diversity in the oil sands deposits themselves, but there's also diversity in the over-lying geology because of the complexity of the geology and geomorphic processes that have come through the area. In glacial times, when Lake Agassiz, in geological times, broke and they had huge floods

through this part of the region, digging channels of sand which create some of the seepage we talked about; glaciers overriding and disrupting the strength of sediments and so on. We have complicated geology underneath the oil sands, where there is what's called the prairie evaporites- it's salt deposits that are dissolved over thousands of years, and so there's subsidence in the limestone that underlies the oil sands, giving rise to complicated geological and geotechnical issues there.

So, each site has its own challenges, and those of us who work a lot in the industry are respectful of those challenges. A lot of best available technology goes into deciphering all the geomechanical, geological, geochemical issues that we have, that we have to confront to meet the monitoring requirements of acceptance, not just technically but there is the social licence to operate that is an increasingly more visible part of the industry than it was in its formative years.

AD: Has the industry complied with regulations?

NM: I think from my experience the industry has always been compliant. So, whatever was asked of it, it responded. Whether it took leadership in its response or not is varied with time. I think it's important to think back it wasn't many years ago that we had only two operators and both were struggling to stay in business. I mean oil was 15 or 18 dollars a barrel and to do things beyond what you needed to maintain positive cash flow was a tough challenge for any manager or any advisor. That wasn't long ago.

But the biggest issue I've been close to is the tailings issue. We've talked about containment, and we know how to do that. The next issue is what are we going to do with that stuff? And, clearly, the accumulation of the fine tails that were first discovered in 1967, I guess, grew and grew and grew and grew. There was a pivotal set of hearings—I think it was 1997—I appeared on the panel for Syncrude at the hearing to expand, and the question was "What are we doing with this large accumulation of fine tailings," as we began to call it. And Syncrude promised a certain reduction in the rate of their accumulation as part of their licence to proceed and had some technologies in place to manage that, which were not successful.

We have actually developed, we think, the most powerful technology to do that at the University of Alberta in some of our research, which became what is called CT, composite tailings, consolidated tailings, in which we indicated that a very practical, and economic and commercially productive procedure, could be developed by sequestering these fines in the sand itself, and we could get to a reclaimable landscape. And that was piloted at a commercial scale at Syncrude, and it has become a major component going forward at both Syncrude and Shell, and other parts of the industry. So, there's been evolution, and one of my colleagues—I mentioned him earlier—John Sobkowicz, has

published, from the same conference that I gave a keynote address a year ago, a paper summarizing all of research and development related to tailings over the decades. There's just a huge number of technologies in play and even more today as the regulatory environment becomes tougher.

So, industry has not been negligent. The problem has been very challenging. There was a sense, and there still is a sense, that as a permanent way forward, that we could sequester these fine tailings under a lake, an enclosure, and that lake would be a bioreactor to some of these toxic effluents—such as napthanic acid particularly, and one would end up with dischargeable water. These hearings, to which I appeared together with other people, made the projection of water capped lakes as a way of treating these materials with a view to pilot this commercially in, I think, the year 2011 or 2012. And then, I don't remember the details, a five-year study period and then get environmental approval for this to be an ongoing technology. And that's still a way forward; it's still part of the Syncrude business case, whether they're a year away from proceeding and, whether they're timely or not; it's certainly proceeding in the business case and with government approval.

However, in the intervening time, aggravated by the birds, aggravated by impatience, aggravated by the sense that "gee this industry is growing, growing, growing, much more than we first discussed in the '90s, and what are we going to do if we have billions of cubic meters of this stuff?" Shouldn't we be proceeding faster to get rid of this accumulation of fine tails? Which then led to a more aggressive government regulatory environment, and industry is struggling to find the technologies to be compliant.

So that's been the evolution of managing the contents of these ponds. I would add that there is yet an unaddressed issue that, if we get rid of the fine tails, we now have a lot of water that's stored in these fine tails and we still have to deal with the management of the process-affected water. Some can be used in the process itself. Some might be sent to the SAGD operations, but we're still in a zero discharge in the environment, and we still have to work through the next technical challenge of how to we get from a non-discharge to a discharge. How do we clean the water up?

I think I'm not giving away any secrets to say that the implication of water treatment is emerging in the business planning of all operators today. And that's going to be, I think, the next phase of challenge to understand what we have to do to treat water for a variety of purposes—to reuse or to discharge—what are the criteria for discharge? So there are a number of issues that are still on the risk road [laughter] path that are imminent for the next five years, say.

AD: Do you want to talk about SAGD [Steam-Asssisted Gravity Drainage]?

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NM: Geotechnical work is only very slightly involved in SAGD. One of our past students, Professor Rick Chalaturnyk, is an expert adviser on SAGD. He's in our group, geotechnical group, at the University. My own involvement is minimal. I see it as a potential user of some of the process-affected water and there'd be a synergy in that they're water needs, surface mining disposal needs. I do get a bit involved in where there is shallow SAGD, and, in order to keep the pressure and the temperature in place, we're relying on what's called the cap rock. And this cap rock is the same Clearwater shale that has given us so much problem in foundations in dams. You can make this cap rock unstable under certain conditions. For example, in the North Joslyn site they actually blew up their SAGD, shallow SAGD operation operating at too high a pressure. So, I do get involved in a little bit of that, but it's not a large part of my activity there. I'm interested in this cap rock stability issue. Many of these operations are much deeper and it isn't a major issue from a ground heave, ground disruption perspective.

AD: I've heard that SAGD operations do not have as high a recovery rate as mining operations. Do you want to talk about that?

NM: The truth of it is that it doesn't recover the same amount of bitumen, but it has advantages of not being as capital intensive. I think the marketplace within the regulatory environment will dictate. Certainly, 30 years from now I expect that SAGD will be more dominant than mining. There's always been a limit to the amount that one can mine, so, if the price of oil goes up, the ability to mine more increases, but… I think they're about equal in terms of production today. Certainly, the long-term growth of SAGD, if it performs properly, and there's a lot of variation in its performance, will make it the dominant one. But, in terms of let's say, a conservation and resource point of view, our recovery is 90/95 percent, in that range, from a bitumen recovery point of view. From a mining operation, SAGD operations go from 20 to 50. We, the public stakeholders, are interested in maximizing our recoveries and, of course, minimizing our other losses, which might be environmental, though that's still not clear what the long-term losses will be.

AD: What are in your opinion some major achievements?

NM: Well, that was a lot of action in my field, onn the reclamation side—it was very challenging in all of these fields. But we've made enormous strides. Firstly, the closure of the Tar Island Dyke gave us some learnings, but there's more learning developing as we speak because the east half of the original Syncrude mine is in the process of being reclaimed on its wet tailings footprint, as we speak. And, within a year or two, you'll see a wave of green advancing on, in situ if you will, on that deposit. I'm waiting anxiously for that to happen because then I'll see the full cycle of the beginning of mining that deposit to its closure. So, let me speak a little bit about the technologies of closure. We had a wonderful student who had worked with Syncrude and came back to work under the

direction of myself and one of my colleagues, David Sego, to do a PhD in what we call landscape engineering. His name is Gord McKenna, and he's now with a consulting company [BGC Engineering], and he's one of the leaders in landscape engineering - designing the landscape and creating, if you will, the skeleton, the physical skeleton, onto which the biological surface will ultimately be placed.

Reclaiming the dry waste dumps as we have done, with certification at Syncrude, is relatively straightforward. There are a lot of regulatory hurdles, a lot of minutiae to be satisfied but, in terms of having done it, we've done it at least once full cycle. It wasn't easy. Although we don't quite know how to certify these things in the oil sands industry, we've done that. It's the wet landscapes that are very challenging. So, there's a lot happening today and we have got a clear framework of the geotechnical underpinnings, the hydrological underpinnings. We've got a technical understanding of how to reclaim on some of these soils which are somewhat saline and so on, and the question is how to do it effectively and how to do it with economically. And some of the materials are very soupy, and whether they can be reclaimed to a solid landscape or be some kind of wetland—all of these things need to be considered in a balanced ecosystem.

For me, this is one of the most exciting problems we have in Alberta today, and one of the greatest opportunities. I think that if many of us looked at it as an opportunity as opposed to a problem, then, I think they'd share more of my optimism. We're involved in the greatest ecosystem reconstruction project in the world, and we've engaged it with a lot of resources. I think that there will be technical changes, there will be a number of ways of draining ground, and so on, but I think we haven't yet understood the opportunities, the industrial opportunities to become the world's best ecosystem reconstructor.

I don't think we've understood the administrative structure needed to really get to a satisfying closure on this issue, for all stakeholders: those who live there, those that are shareholders, those resident in Alberta, and so on. And I think that's just formative. The current mindset, if you like, of the company is that the company has a licence, the company is entitled to walk away in decades of time and comply with whatever regulations to get closure, and certification, and so on. And I'm not sure that's actually possible.

I do a lot of work as I indicated with the mining, metal mining companies, … we've barely closed a mine anywhere in the world, to walk away in a sense. So the concept of perpetual care is going to need considerable consideration in this industry. We haven't yet had that public debate. In the beginning, we talk about it privately, but soon it will need to be talked about publicly. And the organization of perpetual care, the funding of it, there are models to be held—whether they're appropriate or not needs discussion—but what will it look like? And I envisage a sort of, let's call it

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Wood Buffalo Region Management Organization, or something like that, in which there are water utilities—cleaning water, delivering water—let's call it "EPCOR North" with all the best technology. And there is an erosion protection organization, and there's this and there's that, all managing this land in its reconstructed form. It won't be the same ecosystem that of course was disrupted, but we will be compliant to have one that is equivalent, at least in commercial value. Whether it will be equivalent from the social values, remains to be seen. You need a time perspective.

I remember when we began to discuss reclamation obligations. In Syncrude, they have the obligation to replace commercial forest more or less to what existed because forestry in the province of Alberta has always been a factor in sustainable development, has always been the dominant player in what a reclaimed landscape would be. And, I remember discussions we had, because we had at that time an advisory board on landscape requirements, which I was part of. And we had other stakeholders, let's consult other stakeholders, so if you went to First Nations, they'd say "Gee, we want moose land," as opposed to commercial forest. You know, moose don't want dry uplands; they want boggy lowlands. So, one sensed that satisfying a multiplicity of stakeholders requires much more flexible thinking. I think that's still all formative.

At the moment, the licence for each company comes from the government, and it comes with a kind of equivalent statement that I've just made, and I hope reasonably correctly, but the realities of what all the stakeholders want, and whether the industry can evolve to optimize that satisfaction, is still formative, both institutionally and governmental. Company structures to meet that long-term obligation, I think, are just beginning to be thought about. The challenge of figuring them out is just emerging. I don't believe that a closure management tie to existing leases will sustain itself in the future in this remarkable challenge that we have in ecosystem reconstruction. But I'm optimistic about the outcome [laughter].

AD: Is the concept of ecosystem reconstruction being talked about?

NM: Those discussions are just taking place. They're taking place amongst those of us who look, if you will, beyond the current commercial world.

AD: This issue requires involvement of various disciplines as well as the public and private-sectors, doesn't it?

NM: I don't think there's a formal framework, but I think that people understand that, for example, the water issue won't be handled by a single lease holder. And if it won't be handled by a single lease, how else is it that we can overcome the lease boundaries? Or, coming back to the Suncor requirement to monitor the waters from this tailings pond for decades, perhaps decades beyond

their operation. What's the framework for doing that? So, all of these things are beginning to accumulate in terms of the long-term vision.

And what is the solution for the long-term vision? I would say that I haven't seen in my metal mining work any significant projects start out today without recognizing perpetual care. If you can't do it in a goldmine, how are you going to do it in the largest ecosystem reconstruction project in the world. Is perpetual care the way forward? But perpetual care has a lot of positive aspects. I wouldn't look at it negatively. It's not a way of saving money. It's a way of enhancing reliability, creating wonderful jobs. People are going to live there, and all sorts of things, and wonderful value-added opportunities. But it has to be paid for by industry. Nevertheless, it's not a negative. So I don't see, I don't see activities involving Peru, Chile, Canada, Mongolia, elsewhere; I don't see any proposals proceeding today with having mining companies, national mining companies, that don't recognize at the outset perpetual care.

AD: What about the role of government in this?

NM: Oh yes, government is essential. Government's have not been recognizing perpetual care until it's been demonstrated as the best way forward, but you're not going to be able to establish a perpetual care organization, trust—how do you finance it, how do you administer it?—without government being at the table.

AD: Where did the concept of perpetual care originate?

NM: I think the origins came from the remediation of some of the very badly-polluted metal mines and how would they be handled. I think that's their beginning. And I think they've been reinforced by … if you're generating acid, let's say, in a metal mine, what are you going to do when you stop mining? So, perpetual care has become first of all an inherited aspect of the industry, and an acceptable, at least administratively, financially, a way forward for this, provided you can promise a stable government. You need stability, of course, in a nation, to have trust in perpetual care.

AD: Should governments take leadership in this?

NM: Well governments … I wouldn't say governments take the lead. I think it has to evolve, firstly, within industry. I'm not an expert on the financial aspects, but all of our industries that are publicly traded have to go public in their declaration of closure costs. And those closure costs have to be declared within a business plan, and a business plan is tied to a licence. So, once different kinds of licences, or licence adjustments, emerge, then, some of that tied in to financial disclosure could be modified. Now, all closure plans are subject every five years to a five-year revision within our system, all the oil sands operations. You have a closure plan, and, then, every five years you get it

adjusted based on operational changes, perhaps based on new compliance requirements. So, as this concept of perpetual care gets traction, if it gets traction, then there is a mechanism for government and industry to get together and say, let's change the five-year plan to morph into something else.

AD: Do university research establishments have a role to play in this?

NM: Yes.

AD: What would that role be?

NM: I think the concept of perpetual care is not well understood by those who are doing, if you like, the scientific stuff. But there are some people who do think that a policy that understands this discussion should be explored, and there are some of the people that I chat to, and we discuss how we're going to expand the discussion. It's not yet a proposition.

AD: How can it be "made into a proposition"?

NM: The perpetual care issue is how to do it in a more reliable manner, given the longevity of the system. So, even today, one is obliged to meet certain ecosystem balance requirements. There is regulation tied to current reclamation, so it's embedded in the current technology. Well, we're going to be having conditions; for example, we have salty water. We've got lots of salty environments north of Fort McMurray anyways, so that isn't necessarily a no-no, but it's a question of what is the balance?

AD: Can this be done through regulations?

NM: I guess my answer is yes and no [laughter]. It depends upon the area. The most significant impact of regulation in my field has been what's called Directive 74, which is the regulation that has come out of the ERCB on demanding certain tailings responses, dealing with these fine tails management and achieving a reclaimable surface. I'm on public record having published what I think is scientifically correct - the direction is wanting to do the right thing and its intent is needed,, although I think it's flawed in some of its technical requirements. To have expanded the demand on industry was timely, and I don't think anybody disagrees with that.

AD: Can you tell me a bit more about Directive 74?

NM: It came out I think about a year ago. [3 Feb 2009 – ERCB *Directive* 074: Tailings Performance Criteria and Requirements for *Oil Sands* Mining Schemes] There was a lot of pressure from the various stakeholders—Pembina Institute and others saying, "Look, all these fine tails are accumulating and the industry is disturbing so much land and it isn't reclaiming fast enough. What

are you going to do?" This became a part of the discussion in the industry over the last year where they saw this as a perception, public perception problem. That would be number one. We responded by bringing in a more stringent regulatory framework, which required compliance by all operators to modify their tailings. And, I think, that's gone through a circle of submission and approval and modification, requiring billions of dollars of incremental expenditures. So it's still playing itself out.

AD: What about the issue of carbon capture?

NM: I'm not very close to that. I certainly understand its integrity in capturing related to this cap rock business. One of my colleagues works a lot closer with some of the work that's going on in Weyburn [Weyburn-Midale Carbon Dioxide Project in Saskatchewan] and so on. My sense is that it's not directly related… it's unlikely we're going to be tying oil-sand-mining-related issues to carbon capture, because of the diffuse aspects of the carbon issue. It's more tied to coal, or more tied to refinery aspects where they collect and then store. So I think it's part of our Alberta industry scene.

I think the government actually has the right strategy, because it is a technology that will contribute to the carbon issue but can also pay for itself along the way, in part, by using it for tertiary recovery of depleted reservoirs. I think that's a very good fit. Plus, we have good geology-tested reservoir sites that are depleted, that indicate that they have taken pressure in the past and can take some more pressure again. So, I think it's a good fit, but I don't think I have a lot to add in any more detail, and I think it's peripheral to the oil sand mining world.

AD: I note that you've received an Order of Canada as well as a number of professional awards and recognition.

NM: Well, I [laughter] I like to think it's recognition for basically the work primarily that we've done at the University of Alberta. I was fortunate enough to provide some leadership to the activity in geotechnical engineering over the decades. And we've developed a world-class group, not only for oil sands work. We led modern permafrost engineering …[Videographer changes cartridge]

AD: We were talking about the awards you've received.

NM: Well, I like to think it's recognition for the work at the University of Alberta in developing such an excellent geotechnical program, both in terms of man-power training, research contributions, which were not only the oil sand industry but also permafrost engineering; work in landslides; natural hazards; and a number of other geotechnical areas. I had wonderful graduate students who, as I mentioned earlier, went on to great successes, and I think my colleagues and I have enjoyed that as well as our own personal successes. I guess I've had the greatest share of the recognition from that. I've also had the opportunity to contribute as a senior advisor and consultant

on some of the leading resource development projects in the world. And, I think, that's been part of that recognition as well. It's been a good ride.

AD: In terms of this Oil Sands Oral History Project is there anyone that you would recommend that we should interview to get more information about different aspects of the science?

NM: Well, let me just take the opportunity to mention two people that you can't, because they both passed away. The first is Bob Hardy, who had such a huge contribution to the industry. And the second, who just recently passed away, is Alec Hemstock, and I haven't mentioned him. Alec was the first actually to do the geotechnical tests on oil sand material in the early days of Imperial Oil's development, pre-Syncrude, and was part of the early days of the Syncrude project. He spent many decades as a senior scientific adviser to Imperial Oil on many of their frontier resource development projects. But of that generation, I wonder whether George Govier is a name that you know? [AD: he is definitely on our list] Well, that's good. Then, as I proceed, let's say from old to younger [laughter] Dave Devenny is well worth capturing. He's alive and well in Calgary. His consulting practice is under the name The Rock Doctor, and he's had many decades of involvement in the industry. I think Ed McRoberts, who became, if you like, took over Bob Hardy's mantle as the senior designer in consulting practice, is another person well worth capturing,—he's still very active as a senior consultant. He recently left Edmonton and is now resident in Vancouver and he's vice-president of AMEC Earth and Environmental Engineering. Elmer Booker might be worth visiting, because he's still around; hasn't been active technically but able, I hope, to reminisce on his early involvement in the Syncrude project. So those are some of the people that come to my mind.

AD: Well, we've talked about various aspects of the oil sands industry, not just of the technology to do with the oil sands, but also the environmental aspects. I think that we would agree that today there's a huge emphasis on the environmental issues in the media. There've been environmental disasters such as the recent oil spill on the Gulf coast. We know that the name "oil sands" was adopted because Clark suggested it because he felt that they had categorically proved that the tar sands were bituminous sands—the scientific name—for sources of oil. Well now, of course, the term "dirty oil," you know, "tar sands" is a negative. I wonder if you would like to comment on this issue.

NM: Well, certainly Bob Hardy, who was my mentor in a sense, always called them tar sands and didn't find that pejorative [laughter] in any way, but that was some time ago. There are two issues here, and both are important. I think that they flow from trust, trying to establish trust. No doubt that for a number of reasons there isn't a lot of trust in the proclamations of the industry. There shouldn't be a lot of trust, by the way, in some of the proclamations of some of the environmental

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activists [laughter]. And that has two implications. One is at the, if you will, scientific level, and the other is at the public level, and let me try and separate the two.

When I was first starting out in the industry, there was a sense of, and I don't know if it was public, company policy; there was a sense that there was no commercial interest in things that had to do with the environment and, therefore, one is free to publish, etc.; and, as the industry grew, that freedom diminished, I guess I've had to sign some secrecy agreements for some commercial work, and there is a sense that you were more restrained than in the past. As a result, the industry didn't get its own good stories out in vehicles that were subject to scrutiny; let's say refereed journals of technical matter which provide enhanced credibility at the technical level, so that other technical people could understand what's going on, could have trust in information.

So, the industry fell behind in publishing that kind of information, and I'm not saying that because I'm fundamentally an academic. I'm saying that because, if you want to engage in a debate, if you are trustworthy and your information is reliable and your work is reliable, that's one way of achieving credibility as opposed to something that may have the same content but hasn't gone through the same kind of test.

There's a lot of catch up within the industry to achieve credibility in the scientific community. It's been very easy to criticize them by those who are disposed to do that, and it's been difficult for them to say, "Look we published that kind of results in that journal, and that had an excellent review board and so on. You may debate the findings but at least it has been through that kind of review." My advice to the industry is to make it part of your business to encourage your people not to have to do that on a Saturday afternoon but as part of your business to get that information out in a transparent form, so that all stakeholders can engage in quality information.

The question of communicating at the non-technical level is not my specialty, though I do work a fair bit in hazards and risk analysis and risk communication is part of the business. I think the industry has not had enough recognition for what it has done. For example, it did all kinds of reclamation that didn't get through certification. I think that people have to understand more about the efforts and what is going on within a system, within guidelines, with regulations, and so on. I would add that government itself has also lost a lot of trust, particularly related to water issues. And that's being repaired hopefully as we speak.

The social licence to operate is something we talk a lot about in the mining industry, and I think that the oil sands industry has it—it hasn't been negligent. I know Syncrude best of all; I know all of them, in fact, have made enormous efforts for regional employment, for employment opportunities for all sorts of things, for consultation. I'm puzzled, actually, why the social licence to operate

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appears as challenged as it appears. Maybe it isn't as challenged as it is. Certainly, the efforts that have been made, for outreach for all kinds of stakeholders, have been enormous. And it may be the spirit of the times that those that have been negative about the industry have had different methods to get their message across that aren't open, perhaps, to corporations. I just speculated.

AD: In terms of the global economy and the huge multinationals that are involved in the industry, you know when the industry is located in the community and you know the owner and he's a neighbour, that's one thing. When there's a faceless corporation that basically isn't known to the public, other than reporting on shares, or reporting on how they address environmental issues only when they are forced to do that, this is a different matter.

NM: Yes, there's still distrust of the companies. Obviously, they're more engaged now than they were because they've been pressed more than they had been. And they're learning how to do it, but we live in skeptical times, and there's no easy answer other than to keep at it, to engage in every way possible. I think whether it's open houses, whatever it is, certainly openness and transparency is the key, and I think that the industry that I'm close to has lots to be proud of and little to be ashamed of, and I think they'll have to learn how to get the message out.

AD: Is there anything else that you want to share with me about the industry?

NM: I think the recent report by Steve Hrudey and his panel, published by the Royal Society of Canada, is a very good snapshot of objectivity and technical assessment of where we are in terms of the environmental challenges in the oil sands. I think it deserves reading by any serious student. I think it was conducted in a totally objective way by very skilled people. And, I think, it touched the balance pretty well from my experience with the industry. I think it provides the right framework for where we are today.

AD: What prompted it?

NM: Well, the Royal Society has a mission to undertake evidence-based studies on subjects of interest. And, I think, probably Steve himself might have suggested that topic. I remember having some discussions with him in that regard. Or whether it came from outside or whether there was some assessment of topics, and they had a certain amount of money so concluded, "let's put it into here", I don't know the details. I myself sit on the Science Advisory Committee - Scientific Advisory Committee - of the Council of Canadian Academies that does evidence-based studies for the federal government.

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I know that we were contemplating something similar at the request of one of the federal departments and found that the Royal Society initiative pre-empted us in that regard, and did an excellent job. So, it was obviously in the public pulse at the time, and there probably wasn't anything more direct than awareness that here's an issue of public importance. We have some money for studies, we've got a terrific leader for it. Let's do it, and they did it very well.

AD: Were they all Fellows of the Royal Society?

NM: No, it was a public document; in terms of Fellows of the Royal Society? No, no, in fact they were—I don't know how many were fellows—but it wasn't just within. They reached out across the country, in fact, for appropriate toxicologists, aquatic biologists, whatever, in order to populate the panel. It was a well-populated panel. It had, I think, some regional imbalance in terms of people in Alberta, but that may be the nature of the beast.

AD: Thank you very much.

NM: You're welcome

AD: We believe that the Oil Sands Oral History Project is important in setting down the stories of the development of the industry and the interviews will reside in the Glenbow Archives.

NM: Pleased to be part of it.